

		<b>STRATEGIC ASSET MANAGEMENT SHEQ MANAGEMENT SYSTEM PIPELINE DESIGN TECHNICAL SPECIFICATION</b>	
<b>TITLE: TECHNICAL SPECIFICATION FOR PIPELINE EXCAVATION, BACKFILLING AND PIPE TRENCHES AND PIPE LAYING, SPECIAL AND TESTING AND INVESTIGATIONS AND RETURNABLE SCHEDULES (TS)</b>		<b>DOC. NO: SAM DOP 00001 TS</b>	
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<b>AUTHOR:</b>  ..... <b>Senior Civil Technologist</b>	<b>FORMAT APPROVAL</b>  ..... <b>Quality Management Officer</b>	<b>AUTHORISED BY:</b>  ..... <b>Design Office Manager</b>	

**TECHNICAL SPECIFICATION FOR PIPELINE  
EXCAVATION, BACKFILLING AND PIPE TRENCHES  
AND PIPE LAYING, SPECIAL AND TESTING AND INVESTIGATIONS AND  
RETURNABLE SCHEDULES (TS)**



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## **TS 1. EXCAVATION, BACKFILLING, ETC OF PIPE TRENCHES**

### **TS 1.1 GENERAL REQUIREMENTS**

Under this Section of the contract the Contractor shall: -

- (i) Set out the works, clear the working strip, establish an access road, pipe storage strip, pipe storage mounds and pipe laying platform alongside the trench.
- (ii) Remove, store and replace topsoil.
- (iii) Excavate the trench, prepare the trench floor and construct the pipe bedding for the pipeline in accordance with the dimensions detailed on the drawings and stated in the Bill of Quantities.
- (iv) Enlarge and deepen the trench for joint holes where required, excavate for valve chambers, structures and any additional excavation as required by the Engineer.
- (v) Carry out crossings of roads, railways, services and pipelines
- (vi) Expose existing pipelines for sufficient length to allow connections between new pipe and existing pipe to be installed.
- (vii) Construct the pipe bedding when the pipes have been installed.
- (viii) Supply, fill and backfill the trench after the pipe installation has been completed and backfill the structures after construction is completed, cart away and dispose of surplus spoil where required and generally reinstate the working strip.
- (ix) Maintain the trench, trench floor and/or pipe bed until the pipe and fittings are installed, maintain the trench until backfilling is instructed by the Engineer, and maintain the backfilled trench for twelve months after the final completion of the work.
- (x) ***Where the pipeline is located on dolomite underlain land, be aware of the hazards of working on dolomite and thus:***
  - ***Employ the services of a competent person (as defined in SANS 1936-1, Section 3.3 and Annex A).***
  - ***Perform all construction work to the requirements of SANS 1936-3.***
  - ***Perform daily inspections of the pipe trench to identify cracks and subsidences in the ground surface adjacent to and inside the pipe trench. All cracks and subsidences shall be immediately reported to the competent person and no work performed within 50m from the cracked and/or subsided area until the competent person has declared the area safe for entry.***
  - ***Any cavity observed in the trench excavation or sinkhole shall be reported to the competent person immediately and all work in such area suspended until the competent person has investigated and recommended rehabilitation/ precautionary measures.***
  - ***No water shall be allowed to pond within 50m of the pipe trench and measures shall be implemented to ensure that no water will enter the pipe trench and excavations for valve chambers, etc.***

- ***Any water that may have entered the pipe trench or excavations shall be pumped out without delay.***
- ***Pipes shall be installed with zero leakage.***
- ***The backfilling of all trenches and excavations shall be performed to the required specifications to ensure that the backfilled pipe trench/excavation shall be less permeable than the surrounding in situ materials.***

## **TS 1.2      RATE OF PROGRESS**

- TS 1.2.1      The Contractor shall maintain a rate of progress of the excavation work and preparation of the pipe bedding not less than that stipulated in the programme set out in Project Specification. In this connection continuous stretches of trench shall be excavated and rock and hard outcrop shall be removed as encountered.
- TS 1.2.2      No payment shall be made for discontinuous stretches of trench except where reasonable lengths of trench in hard material have been completed ahead of the work.
- TS 1.2.3      The length of open trench ahead of the pipe laying shall not exceed 2 000m in open terrain and shall not exceed 300m in residential areas.
- TS 1.2.4      Where the route of the pipeline is in soil of low shear strength, and/or is waterlogged the Contractor shall excavate the trench, prepare the pipe bed and complete the backfilling to fit in with the pipe laying so that the trench shall be open for as short a time as possible.
- TS 1.2.5      Rand Water shall not be liable for any additional costs incurred by the Contractor while the work proceeds at a rate slower than the rates set out in Project Specification.
- TS 1.2.6      Joint holes, valve chambers and thrust blocks shall be excavated to suit the prescribed programme in Project Specification.
- TS 1.2.7      At all stages of the excavation including portions in rock the Contractor shall obtain the position of joint holes, valve chambers and thrust blocks timeously from the Resident Engineer so that no delay to pipe laying and chamber construction occurs from the blasting, breaking, trimming and clearing operations for these items.
- TS 1.2.8      The installation of pipes will commence as soon as the excavation, preparation of the trench floor and pipe bed and excavation of Joint holes has proceeded far enough.

## **TS 1.3      ACCESS TO WORKING AREA**

- TS 1.3.1      Prior to carrying out the excavation the contractor shall (except in restricted areas) clear the width necessary to accommodate the trench, banks of spoil, a pipe laying platform, an access road and a pipe storage strip, of all trees, bush, rubbish, boulders, rock outcrops and other objectionable material.
- TS 1.3.2      The bulk excavation shall be undertaken in such a way that reasonable access to the trench side for the delivery of pipes and pipe laying operations is provided within the working strip along the entire length of the trench.

- TS 1.3.3 The Contractor shall be responsible for providing the pipe laying platform, the access road and the pipe storage strip. Soft and wet areas shall be stabilized by the addition of suitable compacted material from the excavations and the Contractor shall maintain the working strip in a reasonable condition during the period when pipes are being delivered and during the installation of the pipes and construction of the structures.
- TS 1.3.4** ***Where the pipeline is located on dolomite underlain land, the Contractor shall ensure that no stormwater runoff will enter the pipe trench and that no ponding of stormwater shall occur within 50m of the trench as a consequence of the construction activities by the construction of soil berms/channels/fills to drain water away from the pipe trench.***
- TS 1.3.5 The Contractor shall apply to the Resident Engineer for his ruling on which side of the trench the working strip is to be prepared
- TS 1.3.6 The Contractor shall take the necessary measures to control dust resulting from his activities on public roads and on the working area. Roads and working areas shall be regularly sprayed with water and loaded trucks covered by tarpaulins.
- TS 1.3.7 The Contractor shall provide and maintain suitable access to each house, garage, stand, plot, farm, business premises etc on the pipeline route. Where necessary a temporary bridge shall be constructed across the trench to maintain access and these bridges shall be safe and suitably protected by approved guards, fencing, lights, etc.
- TS 1.3.8 The initial wayleaves and communications with Interested and Affected Parties will be handled by Rand Water and will be handed to the Contractor at the kick **off** meeting. Once handed to the Contractor maintenance and up keeping of the wayleaves will be the Contractors responsibility for duration of the contract at no cost to Rand Water.
- TS 1.4 SIZE OF TRENCHES**
- TS 1.4.1 Before commencing the work, the Contractor shall apply for and obtain detailed longitudinal section drawings or and instructions to enable the work to be set out.
- TS 1.4.2 The trench shall be excavated to the minimum specified width and be generally in accordance with the relevant details shown Drawing No. R0 27141. For the minimum width between the sides of the pipe and the trench wall excavation shall be as per R0 27141.
- TS 1.4.3 The actual depths computed from the details on the longitudinal section drawings will vary to avoid existing services, etc, and relate to the contours of the ground and the levels necessary to obtain a true grade from the bottom of the trench.
- TS 1.4.4 During the, course of the work the Engineer will prescribe the actual depth of the trench bottom below the specified pipe invert level to take into account local soil conditions.
- TS 1.4.5 To comply with the regulations promulgated under the Occupational Health and Safety Act (latest edition) it may be necessary to either batter the trenches to the angle of repose of the in-situ material or to shore the sides of the trench.



The responsibility to comply with any requirements of the above Act however, shall be that of the Contractor.

## **TS 1.5 JOINT HOLES**

Before the pipes are laid the floor shall be cut and the bottom of the trench deepened for joint holes where required, the minimum lengths and depths of which are shown on the drawings. A minimum clearance of 1000mm to the barrel of the steel pipe is required from the pipe sides and bottom for welding and making good of field joint castings. This work shall be carried out as directed and shall be completed well in advance of the pipe laying. The exact position of each joint hole shall be prescribed by the Engineer.

## **TS 1.6 ADDITIONAL EXCAVATION**

TS 1.6.1 Excavation which is of a greater width or depth than the prescribed dimensions for the trench bulk excavation or sundry additional excavation of any nature shall be carried out by the Contractor to the Engineer's instructions. Such additional excavation shall include widening and deepening the normal pipe trench for valve chambers, thrust blocks, and other structures and for excavations ordered by the Engineer and not described under TS 1.4 and TS 1.5. Such additional excavations shall be carried out as and when required by the Engineer. Only that portion of the excavations in excess of the prescribed dimensions for the trench shall be paid for as additional excavations.

TS 1.6.2 Additional excavation will be required to expose existing Rand Water Board pipelines to allow the installation of connections to the new pipeline. In exposing the newly installed or existing pipelines the Contractor shall excavate by machine, or by hand if necessary, around and under the pipelines taking care to avoid damage to the bitumen coated pipes. Any damage caused to pipe coatings during excavations will be made good by the Contractor. It is likely that the additional excavations will have to be carried out at points distant from the main excavating head or in congested areas. The Contractor shall provide at the site separate excavating machines and hand labour to deal with the additional excavation expeditiously.

## **TS 1.7 SETTING OUT AND CARE OF SURVEY PEGS**

TS 1.7.1 Line and level pegs for the centre line of the pipes only will be set out by the Engineer. The Contractor shall be responsible for the care and accurate referencing of all pegs and no peg shall be taken out or moved without the permission of the Engineer. Any error which may occur in this setting out will be the responsibility of the Contractor and he shall remedy such errors at his own expense.

TS 1.7.2 In the event of pegs being damaged or removed as a result of the Contractor's activities the pegs will be replaced by Rand Water surveyors at a cost of R1000.00 per peg and the cost thereof will be deducted from any moneys due to the Contractor.

TS 1.7.3 The Contractor shall be responsible for locating property beacons or pegs along the route of the pipeline and shall be responsible for the care of these beacons or pegs. The cost of replacing damaged survey beacons or pegs will be recovered from the Contractor.

TS 1.7.4 The Contractor shall check the condition of all line and level pegs and satisfy himself that they have not been disturbed and are true in regard to position and level. If pegs have been destroyed, disturbed or damaged before the site is handed over to the Contractor, the Engineer will arrange to have new pegs installed. A peg which has been disturbed shall not be used unless its true position and level has been re-established and the new values have been verified by the Engineer.

## **TS 1.8 LINE AND GRADE OF TRENCH**

TS 1.8.1 The Contractor shall set out the trench accurately in accordance with the data supplied by the Engineer in terms of TS 1.7TS 1.7.

TS 1.8.2 Before commencing the setting out the Contractor shall clear and roughly grade the surface over the full width of the trench.

TS 1.8.3 The Contractor shall provide, erect, set to line and level and maintain approved substantial profiles along the length of the trench at the 50m line and level pegs and at changes of grade and direction. Each profile shall have its chainage marked on it and shall be fitted with a horizontal cross-bar set at a predetermined height above the trench floor level and have setting marks which will define the centre-line of the trench. Where required by the Engineer the Contractor shall provide a profile with the cross-bar extending across the full width of the trench. A profile shall remain in position during all stages of the trench excavation and the trench floor and pipe bed preparation and until the backfilling is completed past the chainage of the profile.

TS 1.8.4 The Contractor shall provide sets of boning rods, templates and piano wire, for the sole use of the Rand Water Representative, for checking the level, grade and width of the trench relative to the centre-line. The Contractor shall also provide, set and level all the pegs required to transfer lines and levels to the trench floor to control the preparation of the trench floor and pipe bed.

TS 1.8.5 The Contractor shall maintain correct line and grade throughout the work. Precise control of the grade of the trench floor is required and the Contractor shall compute the trench floor levels at each pipe joint position indicated by the Engineer and install a level peg at the position of each joint and each change of grade to enable the pipe to be installed in accordance with the levels and grades shown on the relevant longitudinal section drawings. The accuracy of the computation of and transfer of levels from the levelled pegs provided by the Engineer at the trench side to those installed by the Contractor to establish the trench floor shall be within 3mm of the correct level. The competent person appointed by the Contractor in terms of Project Specification shall be fully experienced and competent in the use of engineering surveying equipment and techniques.

## **TS 1.9 HANDLING OF EXCAVATED MATERIAL**

TS 1.9.1 Spoil is defined for the purpose of this Contract as excavated material from the trench and other excavations placed and stored in temporary piles to be used for filling, backfilling into the trench or loaded and transported from the site as the work proceeds.

TS 1.9.2 In so far as space is available within the working strip, such space may be used within the limitations imposed by TS 1.9 for temporary storage of spoil in the pipe laying platform, pipe mounds and stockpiles to be used for backfilling

provided that no material shall be stored in violation of any ordinance and that no watercourse or drainage channel is obstructed.

- TS 1.9.3 All spoil from the trench shall be kept within defined limits and deposited alongside the trench as directed by the Engineer. All spoil shall be deposited so as to cause the minimum inconvenience to traffic, and shall be kept well clear of all manholes, culverts, railway tracks, etc, and free access to fire hydrants is to be maintained at all times.
- TS 1.9.4 Rubble, road materials, broken pavement, unsuitable soil, waste concrete, rock or boulders over 150mm in greatest dimensions and other undesirable materials together with the excavated material that cannot be utilized shall not be mixed with suitable backfill material but shall be loaded and carted off site by the Contractor as the excavation proceeds. (Refer to TS 1.23).
- TS 1.9.5 The toe of the spoil bank shall be trimmed well back from the edge of the trench so as to leave the minimum of 1,0m clear between the edge of the spoil bank and the edge of the trench. The Contractor shall keep this strip clear of spoil at all times
- TS 1.9.6 The spoil bank on the side of the trench where the pipe laying plant will operate shall be levelled, trimmed and in some cases cleared down to ground level to the Engineer's instructions.

#### **TS 1.10 MATERIAL FOR FILL**

- TS 1.10.1 Selected granular material - For Stage 1 backfilled of steel pipes
- TS 1.10.1.1 Only approved selected granular material shall be used for the preparation of the pipe bed for the pipelines and for Stage I backfilling around steel pipes up to 300mm above the top of the pipe, unless otherwise directed by the Engineer.
- TS 1.10.2 Selected fill (material) – For Stage 2 Backfill of steel pipes
- TS 1.10.2.1 Selected fill (material) shall comprise mainly soil, fine material, gravel or shattered rock available from the trench excavation but shall not contain any stones, boulders or shattered rock fragments with maximum dimensions in excess of 150mm.
- TS 1.10.2.2 Selected fill (material) shall be provided for backfilling the trench from the level 300mm above the pipe. The top of the backfill is here defined as the underside of the 300mm topsoil layer, or the underside of the foundation of the township road, whichever is applicable, the natural ground level as determined by the Engineer, or in special circumstances such as in agricultural lands or market gardens, the level prescribed by the Engineer.
- TS 1.10.2.3 Where the pipeline is located on dolomite underlain land, the backfill materials below, on the sides and above the pipe, shall be less permeable than the surrounding in situ material. This shall be achieved by the following:***
- a) the minimum compaction standard shall be 93% of Modified AASHTO maximum dry density (MDD) at optimum moisture content (OMC), provided the permeability requirements are met. In order to achieve this density, the maximum layer thickness used shall be 150mm;***

- b) where the materials excavated from the trench are used for bedding, surround and backfill material, the material shall be compacted to at least 93% of Mod. AASHTO MDD at OMC or to the density of the in situ soil, whichever is higher;**
- c) where imported materials are used for bedding, surround or backfill material, laboratory permeability and density tests can be conducted on both the in situ trench material and the imported materials to ensure that the bedding, surround and backfill materials are less permeable than the in situ soil after compaction to at least 93% of Mod. AASHTO MDD at OMC, or the imported material shall conform to the following:**
  - **$PI < 16\%$ ;**
  - **Percentage passing 0,075mm sieve size between 25% and 30%;**
  - **$D_{10} < 0,007\text{mm}$ . ( $D_{10}$ : effective particle size in mm for which 10%**  
**of the particles are smaller than that size)**
- d) bedding material shall conform to SANS 1200LB (Clause 3.1), subject to:**
  - **maximum particle size 6mm;**
  - **$PI < 12\%$ ;**
  - **$D_{10} < 0,007\text{mm}$ .**

- TS 1.10.3      General for selected backfill material (for stage 1 and Stage 2)
- TS 1.10.3.1    Where in the opinion of the Engineer or geotechnical investigation report no material suitable for use as selected fill is available from the excavations within 200m distance of where it is required then the Contractor shall either import selected fill to the trench side or load and transport selected fill from material selected and stockpiled at another point along the pipe trench.
- TS 1.10.3.2    Importation of selected fill shall be undertaken by the Contractor from approved borrow pits away from the working strip which shall be negotiated for, established, worked and finally smoothed over and tidied or reinstated by the Contractor in accordance with the property owner's requirements and no

overhaul will be paid and shall be included in the rates for bedding, stage 1 and stage 2.

TS 1.10.3.3 The Contractor shall arrange for laboratory testing of representative samples as indicated by the Engineer to determine maximum dry density (MDD) and optimum moisture content (OMC) in accordance with AASTHTO T-180.

TS 1.10.3.4 Prior to filling of trenches the Contractor shall determine the moisture content of stockpiles of fill material and adjust the moisture content to suit the approved method of compaction and equipment to be used in terms of Clause TS 1.22.

**TS 1.10.3.5 *Where the pipeline is located on dolomite underlain land the imported selected fill material shall conform to the requirements of TS 1.10.2.3.***

TS 1.10.4 Stone

TS 1.10.4.1 Stone non-friable quartzite, dolomite or other suitable rock, in accordance with SANS1083 (latest edition) crushed and screened to the specified sizes, of good shape, clean and free from dust. The voids ratio of the stone shall not exceed 47 per cent and the maximum dimension shall not be more than 38mm. Samples of the stone shall be submitted to the Engineer for his approval before use.

TS 1.10.5 Soilcrete fill (Soil cement grout)

TS 1.10.5.1 Soil for soil cement shall be selected from the trench excavations or, if no suitable soil is available from that source, an imported soil from a borrow area to be negotiated for by the Contractor. The material shall be a fine sandy or clayey-sand soil with a plasticity index of not more than 10 and shall comply with the following grading requirements: -

Sieve Size mm	Percentage Passing		
9,5	100		
6,7	95	-	100
4,75	90	-	100
2,36	85	-	100
1,18	80	-	100
0,60	70	-	100
0,30	60	-	90
0,15	10	-	70
0,075	0	-	25

TS 1.10.5.2 Cement for soilcrete shall be Portland cement CEM 1 42.5, 42.5R or 52.5 or a combination of these cements which shall comply with the latest requirements of SANS 50197-1 (latest edition). Cement shall be delivered to the site in a dry condition undamaged by exposure to the weather and shall be stored on the site in approved weather and damp-proof conditions.

TS 1.10.5.3 The soilcrete shall be designed to produce a flowable mix that will flow freely into the trench or formwork and under the pipe without segregation and which in addition will attain the specified compressive strengths and have low drying shrinkage.

TS 1.10.5.4 The proportions of soil, cement and water shall be based upon laboratory tests made with soil, cement and water to be used on the work. The Contractor shall

timeously submit a detailed report of the proposed soilcrete mix design to the Engineer for his approval before the work begins. The report shall show that the mix complies with the specification and shall give for at least three different water contents, the flow of consistency, 7-day and 28-day compressive strengths and the drying shrinkage.

- TS 1.10.5.5 The flow of consistency of the mix shall be tested in accordance with the latest edition requirements of ASTM D6103-97. A guide flow consistency for the laboratory mix is a spread diameter of 200mm. Based on the laboratory report and field trials the Engineer will specify a suitable range of flow consistency. The site mix shall be sampled and tested by the Contractor prior to and at the point of placement in the trench. Any batch not complying with specification shall be removed from site or disposed of as directed by the Engineer.
- TS 1.10.5.6 The compressive strength shall be determined from 150-mm cubes sampled at the point of placement. The Contractor shall sample a minimum of 6 cubes per day. After filling the cube moulds with the soilcrete mix the top surface shall be sealed with a non-porous plate. Once the initial set has taken place the top plate shall be removed and the filled cube mould placed in a sealed plastic bag and stored on site between 20 to 250 °C until required for testing. Testing shall take place at a laboratory to be approved by the Engineer. The testing machine and test method shall comply with the latest requirements of ASTM D4832-95. The soilcrete compressive strength shall be a minimum of 0,2MPa at 7 days and a maximum of 0,9MPa at 28 days.
- TS 1.10.5.7 The drying shrinkage shall be determined from samples prepared using the 280 mm x 50 mm x 50 mm moulds specified in the latest edition of SANS 5836. Soilcrete samples of the required flow consistency shall be oven-dried to constant mass and the linear shrinkage of each sample reported to the nearest 0,1 percent. The site mix shall be sampled by the Contractor prior to and at the point of placement in the trench. A minimum of 6 samples per day shall be collected and tested in an approved laboratory.
- TS 1.10.5.8 All soilcrete shall be batched and mixed under the supervision of a competent and experienced person as per Project Specification. The quantity of water used in each batch of soilcrete shall be carefully adjusted to maintain the required flow consistency for the approved mix. Allowance shall be made for the moisture content of the soil which shall be determined either by weighing and drying or other approved methods. All soilcrete shall be thoroughly mixed and the whole of each batch shall be uniform, free of lumps and free from segregation.
- TS 1.10.5.9 Soilcrete shall be transported to and placed in the trench using suitable plant and equipment to avoid segregation, to ensure proper flow underneath the pipe and to prevent soilcrete entering between the geofabric bond breaker and the pipe coating. The Contractor shall take all necessary precautions, to be approved by the Engineer, to avoid pipe floatation such as placing the soilcrete fill in more than one layer.
- TS 1.10.5.10 The frequency of sampling for compressive strength and drying shrinkage shall be reduced to 6 samples per week once consistent results have been achieved in accordance with the quality control plan
- TS 1.10.6 Foamed Cement mortar



- TS 1.10.6.1 As an alternative to soilcrete fill the Contractor may, subject to the approval in writing by the Engineer, use a foamed cement mortar comprising of cement, pozzolamic material, sand, water, superplasticizer and stabilized foam.
- TS 1.10.6.2 The foamed cement mortar shall be batched as a wet mortar mix and transported to the side of the trench where it is to be placed. A stabilized foam shall then be added to the wet mortar mix to increase the workability and reduce the wet density to  $1200 \pm 50 \text{ kg/m}^3$  before placing the mix into the trench.
- TS 1.10.6.3 Clauses TS 1.10.5.2 to TS 1.10.5.10 shall apply to foamed cement mortar as applicable for use as a pipe bedding material.
- TS 1.10.6.4 Where foamed cement mortar is used as a grout to fill the annulus between the jacked pipe crossing sleeve and the inserted Rand Water steel pipeline, it shall comply in addition with the following requirements; -

The mortar used for the foamed cement mortar shall consist of cement, flyash and silica sand. The water to bind ratio shall not exceed 0,31 by mass. The cement to be used shall be at least CEM1 42,5N or higher. The silica sand must be a clean dry single graded sand with 100 per cent passing through the 1180-micron sieve and not more than 10 per cent passing through the 75 micron sieve.

TS 1.10.7 Crusher run fill

- TS 1.10.7.1 Crusher run fill shall comprise a stable mixture of fragmented rock and fine binder material complying with the following grading requirements: -

Sieve Size mm	Percentage Passing		
26,5	100		
19	85	-	95
13.2	71	-	84
4,75	42	-	60
2,0	27		45
0,425	13	-	27
0,075	5	-	12

The following indices and limits shall not be exceeded: -

Maximum flake index: 35; Atterberg Limits: 25; Plasticity Index: 6 and Linear Shrinkage: 3

- TS 1.10.7.2 The crusher run fill shall be thoroughly mixed to provide a homogeneously graded material and the quantity of water to provide the optimum moisture content for compaction to 85 percent of solid density shall then be added and the material again thoroughly mixed.
- TS 1.10.7.3 The crusher run fill shall then be placed in the trench and compacted as required at the optimum moisture content. The Contractor shall take all necessary measures to prevent drying out of the material prior to the completion of compaction.
- TS 1.10.8 Blinding

- TS 1.10.8.1 The blinding layer used to seal the geofabric encasing crusher run material or 38-mm stone shall be 50mm thick 15MPa site concrete.
- TS 1.10.9 Geofabric
- TS 1.10.9.1 The geofabric to be used as a bond breaker between the steel pipe outside coating and the soilcrete fill of the pipe bedding shall be a non-woven, continuous filament, needles punched, polyester geotextile complying with SANS 10221. It shall be strapped to the pipe and held in place with flat non-metallic strapping bands. Mild steel or galvanized wire will not be permitted to hold the geotextile in place. There shall be no tenting of the geofabric over the pipe trapezoidal stiffness and the geofabric shall extend a distance of at least 50mm above the top of the soilcrete fill pipe bedding.
- TS 1.10.9.2 The geofabric to be used to encase 38mm stone bedding used in construction of the trench floor shall be the same geotextile specified in TS 1.10.9.1 above.
- TS 1.11 PREPARATION OF THE TRENCH FLOOR**
- TS 1.11.1 Overbreak and over-excavation
- TS 1.11.1.1 It is to be expected that during the bulk excavation material will be removed from below the prescribed trench floor position. In cases where the floor is formed of rock the additional depth will for purposes of this contract be termed overbreak and this can be expected to vary according to the nature of the rock, the jointing planes, the extent of weathering of the rock, the methods and procedures used in the blasting of the rock and the expertise of the personnel undertaking the blasting. In the case where the floor is formed in soil the additional depth will for purposes of this contract be termed over-excavation.
- TS 1.11.1.2 There will be no direct payment for the cost of removing and disposing of the volume of material removed from below the prescribed floor level or for the cost of rebuilding overbreak and over-excavation to the prescribed floor level, or for trimming the actual floor surface to the required grade and preparing it to the degree of evenness and to the specified tolerance to receive the pipe bed.
- TS 1.11.1.3 The overbreak and/or over-excavation shall be rebuilt to the prescribed trench floor level using either selected granular material or foamed cement mortar or soilcrete fill or approved crusher run material encased in geofabric in accordance with Drawing No. R0 27141.
- TS 1.11.2 Cleaning trench bottom surfaces
- The Contractor shall clear and clean the trench bottom of all disturbed material, rubble, shattered rock, mud and standing water before placing the pipe bed and before a length of trench is handed to the Contractor appointed to carry out the work under TS 2. Each interface between filling layers shall be cleared and cleaned of all loose material, rubble, shattered rock, mud and standing water before the succeeding filling layer is placed.
- TS 1.11.3 Preparation of the floor where it is founded in soil **of** inadequate bearing capacity
- TS 1.11.3.1 The bearing capacity of the material encountered at the prescribed floor level of the trench will be determined by the Engineer from time to time as the excavation of the trench proceeds. Should the bearing capacity be inadequate the Contractor shall further excavate the floor to a depth to be specified by the



Engineer. When the bulk excavation has been approved by the Engineer the Contractor shall supply and place a layer of Bidim Grade A6 geofabric or equivalent on the trench floor and refill to the specified trench floor level with minimum of 19-mm stone in accordance with TS 1.10.4 placed in 200mm finished thickness layers compacted by three passes of an approved "walk behind" vibratory roller with a static mass exceeding 1 000 kg. A subsequent layer of geofabric shall be placed on top of the compacted stone and covered with a 50mm thick blinding layer before the pipes are installed.

TS 1.11.4 Preparation of the floor where it is founded .in suitable soil of adequate bearing capacity

TS 1.11.4.1 The Contractor shall carry out the bulk excavation to slightly above the specified trench floor level/pipe invert level and then after trimming and grading the surface, the floor shall be compacted to a smooth surface at the specified floor level by an approved vibratory roller.

TS 1.11.4.2 If the trench is dug to a depth below the prescribed floor level the Contractor shall at his cost, refill the over-excavation with selected granular material or foamed cement mortar or soilcrete fill or approved crusher run material encased in geofabric in accordance with Drawing No. R0 27141.

***TS 1.11.4.3 Where the pipe trench is located on dolomite underlain land and the trench has been excavated to a depth below the prescribed floor level, the Contractor shall at his cost refill and compact the over-excavation with selected material conforming to the requirements of TS 1.10.2.3 or impermeable cement mortar or dense impermeable soilcrete fill.***

TS 1.11.5 Preparation of the floor where there is a change in the relative compressibility at a soil-to-rock interface

TS 1.11.5.1 Where instructed by the Engineer, the Contractor shall form a transition zone by ramping the floor down as the soil-to-rock interface is approached. The ramp so formed shall be filled with, the same material selected for refilling the overbreak or over excavation referred to in Clause TS 1.11.4.

TS 1.11.6 Finish of trench floor surface

TS 1.11.6.1 The finished surface of the trench floor shall be a plane with a vertical alignment that does not deviate from its designed position by more than 50mm. At points of change in the grade of the pipeline the Contractor shall obtain from the Engineer a ruling on whether the trench floor grade is to be fixed between joint holes or between the grading pegs designated on the section drawing.

TS 1.11.6.2 After completion of the trench floor surface for all steel pipes the Contractor shall excavate the joint holes in accordance with the details on Drawing No. R0 27141 and clean the surface in accordance with TS 1.11.2.

## **TS 1.12 CONSTRUCTION OF PIPE BED**

TS 1.12.1 Pipe bed foundation

TS 1.12.1.1 When the trench floor has been brought to the prescribed level the Contractor shall construct the pipe bed as per R0 27141 with layer of granular material

selected granular material in accordance with TS 1.10.1 compacted to 90 per cent modified AASHTO density at optimum moisture content.

**TS 1.12.1.2** *Where the pipeline is located on dolomite underlain land, the pipe bed shall only be constructed according to the requirements of TS 1.10.2.3.*

TS 1.12.2 Pipe bed (Surface and joint holes)

TS 1.12.2.1 Immediately before the pipe is installed the pipe bed shall be boned between, or set from piano wires strung between pegs placed at each pipe joint and at each change of grade.

TS 1.12.2.2 The levels, grades and lines of the finished 1m middle width of the pipe bed shall be within + 10mm and -10mm of that stated on the longitudinal section drawings. The transverse gradient of the pipe bed across the trench shall not exceed 1 to 50.

TS 1.12.2.3 At points of change of grade, the Contractor shall obtain a ruling from the Engineer on whether the grade of the pipe bed shall be fixed between joint holes or between the survey pegs for the grading stated on the longitudinal section drawings.

TS 1.12.2.4 After completion of a length of pipe bed and its approval by the Engineer the Contractor shall carry out the excavation of the joint holes in accordance with the details on Drawing No. R0 27141 and TS 1.5 and clean the surface of the pipe bed in accordance with TS 1.11.

TS 1.12.2.5 The trench shall not be considered complete for pipe laying purposes until the pipe bed and joint holes have been completed by the Contractor, accepted by the Engineer and handed over to the Contractor appointed to carry out the work specified under TS 2 of the contract.

TS 1.12.3 Pipe bed for steel pipe using soilcrete/ flowable mix specified

TS 1.12.3.1 For pipes where proper compaction of selected granular material in the pipe trenches becomes difficult a flowable fill of soilcrete or foamed cement mortar shall be used to construct the pipe bed.

**TS 1.12.3.2** When the pipe has been installed the Contractor appointed to carry out the work under TS 1 of the contract shall clean out the floor of the trench in accordance with TS 1.11 and place the soilcrete fill or foamed cement mortar as detailed on Drawing No. R0 27141. *Where the pipeline is located on dolomite, the Contractor shall ensure that the soilcrete or foamed cement mortar is dense and impermeable.*

**TS 1.12.3.3** The soilcrete fill or foamed cement mortar may be placed underneath the pipe for the full trench width or side shutters may be used to limit the width of the flowable fill. If side shutters are used, the gap between the side shutters and the side of the trench excavation shall be at least equal to the required dimension indicated on Drawing No. R0 27141 so that suitable equipment can be employed to compact selected granular material of Stage 1 backfill to the required density. *Where the pipeline is located on dolomite, only material that conforms to the requirements of TS 1.10.2.3, shall be used as backfill material.*

TS 1.12.3.4 The soilcrete fill or foamed cement mortar for the pipe bedding shall be placed up to levels on the side of the steel pipe that create an angle of 90 degrees of

support can be projected to the centre of the pipe (top of pipe bed approximately 300mm above invert level). To prevent flotation of the pipe the maximum height to which soilcrete fill shall be placed in one lift is 250mm above the pipe invert. If foamed cement mortar is used for the pipe bed, it can be placed in one lift provided the required wet density of 1200kg/m<sup>3</sup> is complied with (refer to above TS 1.10.6.2).

- TS 1.12.3.5 The soilcrete fill or foamed cement mortar prepared in accordance with Clauses TS 1.10.5 and TS 1.10.6 respectively shall be placed and compacted by immersion vibrators and by rodding. Objectionable segregation and voids which might materially reduce the strength of the pipe support system shall not be permitted. The Contractor shall state in Returnable Schedules details of the equipment and methods to be adopted for mixing, transporting, placing and compacting soilcrete fill or foamed cement mortar.

## **TS 1.13 CROSSING OF ROADS AND RAILWAYS**

### **TS 1.13.1 Minor roads**

- TS 1.13.1.1 The pipeline to be laid across any road designated as a "Minor road" shall be installed in a trench of normal width and depth for the full width of the road in accordance with the details shown on Drawing No. R0 27141.

### **TS 1.13.2 Major roads and Railways**

- TS 1.13.2.1 The pipelines shall be laid across roads designated as "Major roads" and within railway reserves by the following means: -

- TS 1.13.2.2 In an existing reinforced concrete pipe sleeve installed under this contract or separate contract or jacked pipe crossings installed in accordance with TS 1.14.

- TS 1.13.2.3 When the pipe laying head reaches the sleeve, the Contractor shall excavate the trench up to each end of the sleeve and prepare the trench for the pipe installation. After completion of the pipe installation, and bricking up of the ends of the sleeve, the Contractor shall backfill the trench in accordance with the details on Drawing No. R0 27141 and the longitudinal section drawings.

- TS 1.13.2.4 The grouting of the annulus between the concrete pipe sleeve and the installed Rand Water steel pipeline shall be with foamed cement mortar complying with the requirements of TS 1.10.6.4.

### **TS 1.13.3 In existing reinforced concrete culverts**

- TS 1.13.3.1 No excavation or backfilling work shall be carried out within the reserves of these roads or railways unless ordered by the Engineer. The Rand Water steel pipeline will be installed through the culvert in accordance with TS 2.

### **TS 1.13.4 Farm tracks etc**

The pipeline to be laid across a road designated as a "farm track" shall be installed in a trench of normal width and depth in accordance with the details shown on Drawing No. R0 27141. The Contractor shall ensure a minimum interruption to access to farms, plots, stands etc and shall provide access by means of part closing of road, by temporary deviation, or by bridging of the track.

## **TS 1.14 JACKED PIPE CROSSING**

### **TS 1.14.1 MATERIALS AND WORKMANSHIP**

#### **TS 1.14.1.1 Pipes for jacking**

This section shall be read in conjunction with Project Specification and SANS 1200 LG.

Pipes for jacking shall be SC Type reinforced concrete manufactured in accordance with SANS 677: Concrete Non Pressure Pipes latest edition to the D load specified on the drawings. All pipe joints shall be sealed. The actual diameters of the pipes shall not be less than the nominal diameters given on the drawings or stated in the schedule.

In addition to withstanding the specified two (or three), edge bearing test-load, the pipes shall be capable of withstanding, without damage during jacking, the maximum longitudinal force to be transmitted by the Contractor's jacks and method of operation.

The design of the pipes shall be determined by the Contractor to suit the proposed method of construction but shall not be less than the class of pipe or type of pipe stated on the drawings or determined by the Engineer. The pipes shall incorporate extended modified Ogee type joints which shall be seated by means of a rubber ring. On longer pipe jacks it may be necessary to use a rebated butt joint to withstand the higher jack forces. However, the decision of type of joint to use is that of the Contractor. Irrespective of joint type used the Contractor must adhere to the joint sealing details given in TS 1.14.1.3 below.

At least one hole shall be formed in the crown of each pipe to allow for the injection of both a lubricant, if required, and a final grout. The final layout of grout holes is the Contractor's responsibility.

***Where the pipeline is located on dolomite, a suitable number of grout holes shall be formed in the pipe to ensure that the annulus around the pipe will be sealed with grout to ensure that no voids shall remain outside of the pipe between the pipe and the excavation face.***

The Contractor must ensure that the pipes shown on the drawings and mentioned in the documents can be jacked the full distance mentioned in the Scope of Work.

#### **TS 1.14.1.2 Intermediate Jacking Pipes**

In circumstances where it is desirable to use jacking pipes intermediate between manholes or junctions the number and type of such intermediate jacking pipes is to be determined by the Contractor. The joint between pairs of intermediate jacking pipes shall be protected externally by a cylindrical mild steel sleeve of wall thickness at least 8mm, which shall overlap the pipes on either side of the joint for a distance of at least 150mm. The joint is to allow a substantial and permanent caulked seal within the joint.

#### **TS 1.14.1.3 Joints and Seals**

It is the Contractor's choice as to type of joint used in the pipes to be jacked. However, applied forces used to jack the pipes must be uniformly distributed

around the joint to avoid damaging the joint. Pipes that are delivered to site with damaged joints must be rejected by the Contractor.

A seal is required at each joint to minimise ingress of water. Ingress of water into the jacked pipes stemming from the joints should not exceed 5 litres per minute in total. The chipboard packing used to distribute stresses on the joints should be raked out to a depth of 25mm on the inside all round and sealed with a durable flexible sealing agent or similar.

***Where the pipeline is located on dolomite, all the joints shall be watertight with zero leakage allowed.***

TS 1.14.2 Construction of Jacking

TS 1.14.2.1 General

TS 1.14.2.1.1 Authority to Jack Pipelines under Roads and Railway Lines

The Employer will obtain permission from the relevant authorities for jacking under roads and railway lines. However, the Contractor is to confirm that such permission has been granted before commencing work.

TS 1.14.2.1.2 Competence

Jacking and excavation shall be supervised and undertaken by persons fully conversant with this work.

***Where the pipeline is located on dolomite, the pipe jacking shall be performed under the guidance and supervision of the competent person (refer to SANS 1936, Part 1 Sections 3.3 and Annex A and Part 3 Section 4.10).***

TS 1.14.2.1.3 Design Calculations by Contractor

The Contractor shall, when so ordered, furnish detailed design calculations, specifications, and working drawings to show his methods of installation and methods of providing temporary support for the road, rail track, or other service or structure and any modifications to structures required before pipe jacking commences.

The design shall be carried out by a civil engineer with adequate experience in this field. Calculations, specifications, and drawings shall be signed by the engineer responsible for their preparation. The Contractor shall not commence any work shown on the said drawings or specified in the said specifications until the Engineer has signified in writing that the Contractor may proceed.

***Where the pipeline is located on dolomite, the proposed design and methodology shall be approved by the competent person (refer to SANS 1936-3, Section 4.10).***

TS 1.14.2.1.4 Contractor Solely Responsible

Any permission to proceed given in terms of TS 1.14.2.1.3 or otherwise shall not indicate acceptance by the Employer or the Engineer of any responsibility for safety or adequacy of jacking structures and methods of working and, in terms of Sub clause 2.5 of SABS 1200 A or SABS 1200 AA, as applicable, shall not limit the obligations and liabilities of the Contractor in regard to such safety or adequacy.

No approval of any material or plant and its operation, or of any construction procedure to be used will imply any relaxation of the requirements governing the quality of the materials or of the finished work or relieve the Contractor of his/her responsibilities under the Contract.

TS 1.14.3 Safety Control Requirements

TS 1.14.3.1 Jacking not to Impair Safety

The pipeline shall be jacked through under the road, railway, or other service or structure, as applicable, without disrupting traffic and without disturbing the alignment or levels of the road surface, the tracks, or other service or structure, as applicable, to an extent that may impair the safety of traffic or of the service or structure.

TS 1.14.3.2 Examination of Structures at Risk

Before commencing work in the vicinity of any structure, the Contractor shall make a detailed examination of the structure, record its condition, and submit a copy of such record to the Engineer.

TS 1.14.3.3 Recording of Movements

TS 1.14.3.3.1 General

The Contractor shall take movement measurements correct to 1,0mm and shall record any change in the line and level of road and railway line before the start of the Contract and at such intervals as directed by the Engineer for a period up to 12 months after the issue of the Completion Certificate. However, no more than 15 sets of reading will be required in this period. A copy of these measurement records shall be made available to the Engineer.

TS 1.14.3.3.2 Working under roadways

Before commencing work under a roadway, the Contractor shall measure levels on the road surface directly over the jacking line and for a distance of at least 5 m on each side of the jacking line. These levels shall be measured at 500 mm intervals along each line of the road paint markings. In cases where the road has no painted shoulder markings, the shoulder levels shall be measured 300 mm from the edges of the surfacing.

Where the road has paved side drains, levels shall also be measured in the invert of the drains.

In order to facilitate control of the measuring of levels, the exact position of each spot height shall be discreetly marked on the road surface before the levels are measured.

After completion of the Works, the Contractor shall re-measure the levels in the same manner as before, and he shall submit to the Engineer the records of levels taken before and after jacking.

The submission of such records shall be a prerequisite for any consideration by the Engineer of the acceptability or otherwise of the Works or the issue of any certificate of completion.



If, within a period of one year after completion of the Works, the road shows any sign of settlement in the vicinity of the jacked pipe, the road authority may re-measure levels on the Site.

The Contractor shall be held responsible for the rectification, to the satisfaction of the road authority, of any deformation that occurs in the road surface in the vicinity of the jacked pipe during the said period of one year.

The Contractor shall bear full responsibility for any consequential damage to persons and property resulting from subsidence.

#### TS 1.14.3.3.3 Working under railway lines

Before jacking under railway lines, the Contractor shall take elevation readings at the top (crest) of the fill embankment and at the toe of the ballast as well as on top of each railway line along the centre line of the pipe jack and at intervals of 1 500 mm apart up to a distance of 9m from the pipe centre line. The profile of the railway embankment must be measured and recorded from toe to toe (of the embankment) before pipe jacking starts.

The intervals at which movement readings are to be taken over a period of 12 months is the same as mentioned above for roads (TS 1.14.3.3.1).

#### TS 1.14.3.3.4 Temporary Supports

Except when such support is provided by others, the Contractor shall provide such temporary support as is necessary to carry road and rail traffic, and in the case of railway tracks, to prevent horizontal or vertical misalignment.

#### TS 1.14.3.3.5 Restriction on Blasting

No blasting shall be carried out without the prior written permission of the Engineer, and without the necessary approval or clearance being obtained from the relevant authority.

#### TS 1.14.3.3.6 Remedial Measures

All remedial measures will be carried out and completed to the standards set by the various controlling authorities.

Roads – Remedial measures plus time related professional costs needed to reinstate roads and fill embankments will be the Contractor's liability. Remedial measures are those relating to the need to put right settlement and movement of road surfaces, formation layers or fill embankments including providing all road safety markers, traffic control, or signs and all associated needs of the road authority to allow remedial work to proceed without danger to workers or traffic. The Contractor must arrange all matters regarding remedial work with the road authority. In most instances these measures will comprise jacking up concrete roads using grout and regrading to original elevation formation layers and premix surfacing as well as mending drainage fixtures where these have been damaged. All the remedial work will be directed by the Engineer to his/her satisfaction and approval.

Railways – Remedial measures plus time related professional costs needed to reinstate railway lines and fill embankments will be the Contractor's liability. Remedial measures are those relating to the cost of realigning railway lines, regrading of ballast, and stabilising fill embankments. All the remedial work will

be directed by the Engineer to his/her satisfaction and approval. A provisional sum is given in the Bill of Quantities to cover the cost of strapping railway lines and provided for a signaller to activate speed deregulation.

#### TS 1.14.4 EXCAVATION

##### TS 1.14.4.1 General

Except as required in terms of 5.2.5 SABS 1200 LG 1983 the provisions of SABS 1200 DA shall apply.

##### TS 1.14.4.2 Thrust Pits

The Contractor shall be responsible for excavation of the thrust and reception pits at each end of the section of pipeline or sleeve that is to be jacked. These pits shall be of dimensions at least equal to the minimum dimensions needed for the Contractor's equipment and for safe and efficient working. The approximate dimensions of the pits that the Contractor intends to excavate shall be agreed upon with the Engineer before work commences. The excavated material shall be stockpiled for later backfilling.

The sides of the pits shall be adequately supported by timbers or other approved means. Where a pit adjoins a railway or a heavily used road, the sides of the pit shall be shored during the entire operation to prevent any movement caused by vibration arising from rail or road traffic. (The Contractor's attention is drawn to the requirements of the "Occupational Health and Safety" latest edition (see Sub clause 5.1 of SABS 1200 D or SABS 1200 DA, as applicable))

The Contractor shall ensure that, at all times each pit is provided with barriers and is a safe place within which to work.

Claims arising out of any accidents or incidents in or adjacent to these access pits will not be considered by the Employer.

Stormwater control measures around these pits are also necessary to prevent water ingress into the pits. Provision must be made by the Contractor to keep both thrust and reception pits free of seepage and stormwater.

***Where the pipeline is located on dolomite, the Contractor shall ensure that no water can pond at the site and that no stormwater runoff can enter the excavation during and after construction is completed.***

Thrust pits will in general only be permitted at positions indicated on the drawings or where manholes or junctions are required. Jacking pits shall be of sufficient size to accommodate the jacking operation and any manhole structure to be constructed upon completion of the jacking. The approximate dimensions of the pits shall be agreed with the Engineer before work commences. The Contractor will be required to design and construct all thrust blocks, bases and other temporary Works required to maintain the stability of the pits and shall demolish and remove these upon completion of the jacking operation and the Contractor shall take into account all such limiting factors when preparing his/her tender.

##### TS 1.14.4.3 Intermediate Jacking Pits (New Sub-Clause)

In circumstances where it is desirable to use jacking pits intermediate between manholes or junctions indicated on the drawings, the number and type of such



intermediate jacking pits is to be determined by the Contractor. Such intermediate jacking pits will only be permitted where conditions of access and working space permit.

Full details of the intermediate jacking pits and the junction box constructed as a closure between the ends of the jacked pipes are to be submitted with the tender.

#### TS 1.14.5 Jacking of Pipeline

##### TS 1.14.5.1 General

Excavation shall be such that overbreak is kept to a minimum. No material shall be removed in advance of the leading edge where the leading edge is in unstable or loose material. If the material at the face starts to slip or run (see TS 1.14.5.2c), excavation shall be stopped immediately and the Contractor shall take such action as is necessary to stabilize the material before excavation is resumed.

A lead pipe with a rebated front end over which the trailing end of the shield is fitted should be the first concrete pipe used. This should minimise overbreak. The extent of the payment line for grouting between the outer face of the sleeve and the excavation face will be limited to 10% of the outside diameter of the sleeve. Therefore, the excavation payment line will be 2500mm dia. for the different sections of sleeves.

No material may be removed in advance of the leading edge of the shield in unstable or loose materials.

As the pipe is advanced, excavation is to take place within the lead pipe under the full time supervision of a responsible foreman to ensure that the end of the shield is always fully plugged with earth at a safe angle of repose within the pipe. The Contractor shall ensure that there is not uncontrolled flow of sand, mud or earth into the pipe which could result in imperilling excavation personnel or the formation of cavities above or around the sleeve pipe. If at any stage during the jacking operation such conditions arise the Contractor shall immediately plug the pipe and stabilise the material before proceeding with further work.

Should it be necessary, the Contractor shall allow for stabilising the soil by dewatering, chemical grouting, or any other approved means. The design of the shield shall be such as to permit the face to be completely or partially closed by boarding or similar to control material flow from the face.

During weekend or holiday stoppages the Contractor must make sure that a plug of soil is left in the shield.

##### TS 1.14.5.2 Prevention of subsidence during jacking

- a) To ensure that overbreak is kept to a minimum, the Contractor shall ensure that the first concrete pipe used is so rebated that there is no substantial difference between the outside diameters of the shield and the pipeline.
- b) The Contractor shall ensure that excavations within the pipe are under continuous expert supervision such that conditions at the front of the shield are always safe.

- c) The Contractor shall take every reasonable precaution to ensure that no slips or runs develop at the face such as will endanger personnel or cause cavities beyond the circumference of the lead pipe.
- d) If necessary, the Contractor shall make provision for suitable dewatering of the material in the vicinity of the leading edge of the pipe.
- e) Should any cavity occur around the outside of a pipe during the jacking process, such cavity shall be filled immediately by the injection of suitable approved process grout through holes drilled in the pipe walls.
- f) Any subsidence occurring above the jacked pipe and arising from any cause related to jacking operations shall be made good to the satisfaction of the Engineer and at the Contractor's expense.
- g) ***Where the pipeline is located on dolomite, the requirements of SANS 1936 shall be strictly applied. Should any cavity, sinkhole or subsidence occur, the requirements of SANS 1936-4, Section 4.2.4 shall be applied. All work shall be stopped immediately, the affected area cordoned off and the competent person informed. The competent person shall investigate the incident and recommend design modifications, rehabilitation, etc. Rand Water shall report the incident to the local authority without delay.***

TS 1.14.5.3 Standard procedure

At the conclusion of each day's work the pipeline being jacked shall be jacked up to the face and boarded up where necessary.

TS 1.14.5.4 Drainage

The Contractor shall ensure that the head of each excavation is drained at all times.

TS 1.14.5.5 Jetting

Under no circumstances will jetting be permitted.

TS 1.14.5.6 Continuous Jacking

In order to minimize problems due to the build-up of skin friction on a static pipe, the pipes are to be jacked continuously unless agreed to otherwise with the Engineer, allowing for overnight stoppage.

TS 1.14.6 Jacking Procedure

TS 1.14.6.1 Procedure

Each pipe shall be advanced by means of one or more hydraulic jacks of adequate capacity that bear(s) against a suitable thrust plate so that the thrust of the jack(s) is distributed adequately over the end face of the pipe.

The rear end of each jack shall bear against a suitably designed structure such that the force is transferred to the surrounding material and evenly distributed over an area sufficient to ensure that the bearing capacity of the soil is not exceeded and that no structure in the vicinity of the thrust pit is disturbed.

Each jack shall be fitted with a pressure gauge suitable calibrated such that the actual jacking forces can be read at any time.

Suitable packing of hard materials shall be inserted between the abutting vertical ends of the pipes in order to transfer the jacking force. The packing shall constitute a complete circle and be sufficiently wide to transfer the applied load.

A suitable adjustable shield is to be fitted to the front of the lead pipe. The shield is to incorporate cutting edges which can be varied by control jacks to maintain the pipe on line and level.

Pipe jacking may generally be carried out either up-grade or down-grade to suit the Contractors requirements subject to the approval of the Engineer, and provided that provision is made by the Contractor for the necessary drainage required.

#### TS 1.14.6.2 Lubrication of Structure during Jacking

The Contractor may, with the written permission of the Engineer, inject a suitable lubricant through preformed holes in the structure or at the cutting edge of the shield.

To ease pipe friction, the Contractor shall make provision for the injection of bentonite or other approved lubricant.

#### TS 1.14.7 Backfilling

Both thrust and reception pits must be backfilled using the removed material. Backfill compaction rates must not be less than 90 percent Modified AASHTO with the top 1,5m of backfill being compacted to a minimum 92% Modified AASHTO. The backfill must be built up to at least 500mm above the natural ground level to prevent stormwater pounding around the excavation pits.

***Where the pipeline is located on dolomite, backfilling of the thrust and reception pits shall be performed with materials and compaction as specified for pipe trenches in TS 1.10.2.3. No ponding of stormwater shall be allowed at these sites after completion of the backfilling.***

#### TS 1.14.8 Grouting and Plugging

When the jacked pipeline is in its final position a stabilized sand/cement grout shall be injected to fill all voids between the jacked pipeline and the surrounding material. The grout shall have a strength equal to or better than a grout consisting of one-part cement and two parts sand and shall have a slump of 120mm.

All holes in the pipeline shall be sealed with an approved epoxy sealant.

The grout shall consist of cement/sand grout with mix ratio of 1:2 and approved plasticiser.

***Where the pipeline is located on dolomite, the grouting shall be performed under the direction of the competent person (SANS 1936) and the Contractor shall ensure that no voids are left around the pipe after completion. The grout shall be suitably designed to ensure flowability and zero shrinkage after drying.***

#### TS 1.14.9 Markers

On completion of the pipe jacking activities the Contractor shall place standard Rand Water marker concrete posts at the start and end of each pipe jacking section. The marker posts shall be collected at the Rand Water Central Depot (located 10km south of the head office of Rand Water opposite Zwartkopies Pump Station), transported to site, offloaded, stored, and installed.

#### TS 1.14.10 Recording Jacking Parameters

Throughout the jacking operation the Contractor is requested to take and record the following measurements.

- a) A plot of pressure (kN/m<sup>2</sup>) and total force (kN) originating from the combined force of all hydraulic jacks used to move pipes versus accumulative length of jacked pipe. As soon as a lubricant is used it must be recorded on the plot. If heavy ground water seepage is noted this must also be recorded on the plot. A time scale in days should also be used in conjunction with jacked length of pipe. It is also important to record start up force required to move pipes after a delay, i.e. after weekend.
- b) The dimensions of the thrust block used must be recorded as well as the accumulative thrust force on the block (kN) together with lateral movement of the thrust block (mm).

A copy of these measurement records shall be made available to the Engineer.

#### TS 1.14.11 AS-BUILT DRAWINGS

If an alternative design by the Contractor has been accepted or if the structure shown on the tender drawings has been modified to suit the jacking method, the Contractor shall, on completion of the work and before the final payment is made, supply to the Engineer transparencies showing details of the completed structure. Each such transparency shall be certified by the Contractor to be an accurate reflection of the details of the work as constructed.

#### TS 1.14.12 TOLERANCES AND MEASUREMENT

##### TS 1.14.12.1 General

Subject to any requirements of the project specification imposed because of the gradient(s) of the pipeline or the purpose for which it is required, the pipes shall be jacked into position within the tolerances given in TS 1.14.12.2.

Should the difference between the actual and the specified position or alignment of the finished pipeline exceed the value of the said tolerance to an extent that additional costs are incurred in locating, installing, supporting, or maintaining any service that has been designed to be laid through the finished pipeline, the Contractor shall bear such additional costs provided that the details of the work to be done to relocate, install, or support the said service, and the order for the work to be done (by the Contractor or by others) have been given by the Engineer within 30 working days after the completion of the jacking operation.

##### TS 1.14.12.2 Permissible Deviations

The position of any point of the finished pipeline shall be within 50mm horizontally and 50mm vertically of the designed position. Adjustment to line

or level, or both, shall be gradual and the pipe manufacturer's stated maximum permissible draw or angular deflection shall not be exceeded at any point. Misalignment between pipe units shall not exceed 10mm

Steel pipe through the jacking sleeve shall be bare. Where pipe is coated the pipe coating protection required shall be two layers of Bidim-Grade A6 underneath the straps of the wheels and/or skid for the positioning of the pipes within the reinforced concrete sleeves. Also refer to TS 1.10.9.

#### **TS 1.15 PROTECTION OF RAND WATER PRE STRESSED CONCRETE PIPE (PCP)**

The pipeline will run parallel to and or cross existing Rand Water pipelines constructed from pre stressed concrete pipes (PCP) or steel pipe or lead caulk jointed pipes.

##### **TS 1.15.1 Requirements and restrictions on work adjacent to existing PCP:**

The Contractor will locate the centerline of the existing PCP by approved methods and demarcate the centerline with 60mm by 6m thick rolled steel angle stakes 1,5m long not more than 200m between stakes. Before excavation of the pipe trench commences the Contractor shall erect temporary fences either side of the PCP to demarcate 'keep clear' areas in accordance with the servitude cross section drawings where no vehicle shall travel or dump spoil from the excavations or borrow pits.

##### **TS 1.15.2 The following restrictions shall apply to vehicles crossing the demarcated 'keep clear' areas:**

Transverse crossing joints of the demarcated PCP areas shall be limited to existing roads and tracks or to points authorised in writing by the Engineer. At authorised transverse crossings, other than existing roads and tracks, the Contractor shall provide an approved vehicle-bridge to transmit vehicle wheel loads to undisturbed soil along both edges of the PCP backfilled trench. The vehicle bridge may comprise a steel structure that can be re-used for future crossings or a reinforced concrete slab laid over compressible fill that will not transmit appreciable loads to the PCP. Detailed calculations shall be submitted by the Contractor for approval giving the expected wheel loads of loaded vehicles that will use the crossing and the calculated resulting soil pressures due to vehicle and soil loads at the crossing and sides of the PCP.

Where the pipeline trench is to be excavated adjacent to the outside of a horizontal bend of a Rand Water PCP, the Contractor shall submit proposals and calculations to the Engineer for approval verifying that the excavation of the pipe trench in accordance with the longitudinal plan and sectional drawings will not lead to a loss of support and subsequent movement of the PCP horizontal bend and adjacent pipe joints. If the calculations show that the PCP horizontal bend and joints will be affected by the excavation of the pipe trench, the Contractor shall submit proposals for approval by the Engineer whereby the excavation can be carried out without compromising the safety of the PCP.

The Contractor shall employ the services of a suitably qualified and experienced geotechnical, pipeline and/or structural Engineer to conduct and certify the basis and correctness of the calculations required to be submitted in terms of TS 1.15.

## **TS 1.16 CROSSING RAND WATER AND OTHER PIPELINES**

- TS 1.16.1 Construction of new Rand Water pipelines may necessitate the transverse crossing underneath the existing pipelines. The method of construction of the pipe crossings shall be safe and utilize appropriate design and construction procedures based upon the condition, type and construction of the existing pipeline to be crossed. The Contractor shall employ the services of a suitably qualified and experienced geotechnical, pipeline, and/or Structural Engineer to conduct and certify the basis and correctness of calculations required to be submitted to the Engineer for approval in writing before any pipeline crossing work is carried out on site.
- TS 1.16.2 Pipelines to be crossed may comprise rubber gasket jointed PCP, lead caulked or rubber gasket jointed steel pipes or continuously welded steel pipes. In all cases the Contractor shall employ careful hand excavation of the final soil layer next to the pipe in order to avoid damage to pipe coatings and in the case of PCP, damage to the copper cables providing a faraday cage around the PCP for lightning protection.
- TS 1.16.3 A typical method of crossing a lead caulked jointed steel pipeline for which approval would be required to be submitted to Rand Water in terms of Clause TS 1.16.1 could be as follows :
- Demarcate the top width of the trench to be excavated underneath the lead caulked jointed pipe
  - Excavate the pipeline to be crossed to expose the crown of the pipeline and locate any joints for a distance at least equal to 1,5m either side of the top width of the trench to be excavated for the new pipeline
  - Deepen and extend the trench to expose the pipe to be supported and crossed down to the spring line or sides and for a distance on each side of half a pipe length beyond the first pipe joint outside the trench width to be excavated for the new pipeline
  - Open up the excavation around the joints of the pipe to be supported and measure accurately the slope of the lead caulked joints. Arrange for split double tapers to be fabricated for each joint
  - After approval from Rand Water weld the double tapers over the lead caulked joints to prevent any pipe movement and leaks of the joints
  - Provide and fit suitable steel reinforcing with sufficient lap length and stop ends underneath the pipe joints up to 300mm above the crown of the pipe and encase the joints in 30MPa concrete
  - After the concrete around the joints has gained sufficient strength, remove the stop ends and excavate the remainder of the pipe to be supported between the concrete joint blocks to a depth of at least 300mm beneath the pipe invert
  - Provide, fit and fix sufficient steel reinforcement to that already extending from the concrete joint blocks, ensuring that there is adequate lap length to develop full tension



- Encase the remainder of the pipe to be supported in 30 MPa concrete so that the jointed pipeline is fully encased in reinforced concrete over the required length
- When the concrete has gained sufficient strength, proceed with the trench excavation for the new pipeline underneath the encased jointed pipeline

TS 1.16.4 The Contractor shall attend to and provide assistance to Rand Water employees, or their Consultants or Sub-contractors responsible for the installation of cathodic protection systems, whether temporary or permanent, for the new pipeline being laid and the pipelines being crossed.

## **TS 1.17 CROSSING STREAMS, WATER COURSES AND FURROWS**

TS 1.17.1 Where the trench crosses a stream, water course or furrow the Contractor shall take all measures necessary to control the entry of water into the trench and shall design and construct any temporary embankments, diversion channel or overpass and supply and operate such pumping plant as may be necessary for this purpose. The proposed plan of the dewatering system shall be submitted to the Engineer for approval prior to the installation of the system.

TS 1.17.2 At all river and stream crossings the Contractor shall estimate the flood that can be expected in the river or stream and design, provide and maintain a suitable diversion channel or overpass with adequate capacity to convey the estimated flood past the excavations. Each embankment shall be of adequate height and strength and shall be arranged to train the stream flow into the channel or overpass.

TS 1.17.3 The Contractor shall make all necessary arrangements and obtain permission from the property owners to construct the necessary diversion channel and on completion of the crossing shall refill the channel, remove embankments and clean up and reinstate the working area to the satisfaction of the owner and the Engineer.

***Where the pipeline is located on dolomite, the backfilling of the diversion channel shall be such that the backfilled channel shall be denser and less permeable than the surrounding in situ materials. The backfilled surface shall be higher than the surrounding area and there shall be no ponding of stormwater.***

TS 1.17.4 The Contractor shall construct all necessary embankments, causeways, fords or bridges from which the pipe installation can be undertaken across the water course and associated low lying wet marshy areas, reinstate temporary works in the event of flooding or washaways, clear all temporary works after the crossing has been completed.

TS 1.17.5 Except for shutdowns for maintenance of dewatering equipment, or other shutdowns approved by the Engineer, no interruptions in the approved dewatering system procedures will be permitted during excavation operations and pipe installation. Full time surveillance, 24 hours per day, and maintenance shall be provided to avoid breakdowns.

## **TS 1.18 FENCES**

TS 1.18.1 Where instructed by the Engineer, the Contractor shall provide all materials and erect temporary fences to demarcate the boundaries of the site and approved

working strips, to protect PCP and to protect the excavations. A temporary fence shall remain in position until its removal has been authorized by the Engineer. Material recovered from a temporary fence may be used in a subsequent position.

## **TS 1.19 SAFETY OF TRENCH AND OTHER EXCAVATIONS**

- TS 1.19.1 The Contractor shall provide all the necessary timbering and shoring of the sides of the trench. Such timbering shall consist of open planking, walings and substantial struts and shall be carried out in a workmanlike manner to the satisfaction of the Engineer.
- TS 1.19.2 The shoring method adopted shall be compatible with the excavating, backfilling and pipe laying method and shall cause minimum restrictions to the laying of the pipes. Shores shall be designed to withstand the earth pressures exerted upon them from the trench side which shall include the superimposed loading of pipe laying equipment with pipes working at the side of the trench.
- TS 1.19.3 The length of steel pipes to be laid shall be approximately 19m.
- TS 1.19.4 The Engineer may call upon the Contractor to timber the sides of the trench at any point that he may consider in any way dangerous. Such timbering shall be left in place until after the completion of the pipe laying at the point affected.
- TS 1.19.5 The Contractor shall carry out the removal of timbering immediately prior to backfilling or on the instructions of the Engineer.
- TS 1.19.6 As an alternative to timbering the Contractor may prefer to batter the sides of the trench in accordance with the regulations promulgated under the Occupational and Safety Act (latest edition).
- TS 1.19.7 All battering of trench sides and forming of suitable steps to ensure the safety of the excavations are to be undertaken as a safety precaution on the part of the Contractor to comply with the requirements of the Occupational and Safety Act (latest edition).
- TS 1.19.8 Maintaining the sides of the trench in a safe condition during excavations, preparation of trench floor, delivery of pipes to site, placing of pipe bed, laying of pipe, and backfilling and the protection of the trench together with preventing general access to the trench by unauthorized persons, by children and by animals shall be the sole responsibility of the contractor. No undercutting of the sides of the trench will be allowed.
- TS 1.19.9 The Contractor shall take every precaution to prevent water from any source entering the excavations and shall keep the pipe trench free from water while carrying out excavation, preparation of the trench floor and pipe bed, and until the excavations are backfilled. The Engineer may order additional precautions to be taken where he is not satisfied with the Contractor's arrangements. Any water, including seepage, entering the trench shall be removed immediately if directed by the Engineer.
- TS 1.19.10 If required by the Engineer, the Contractor shall leave unexcavated blocks in the trench to prevent the flow of stormwater down the trench. These blocks shall be at least 1m thick and spaced as directed by the Engineer.
- TS 1.19.11 *Where the pipeline is located on dolomite, the Contractor shall ensure that no stormwater will enter the pipe trench and that no ponding of water will***



***occur in the vicinity of the trench. The trench shall be inspected daily for the presence of cracks and subsidence in and/or within 10m of the trench. Such cracks and subsidence shall be immediately reported to the competent person and nobody allowed to work in the area where the cracks or subsidence was noticed until the competent person has declared the area safe or recommended rehabilitation measures to improve the safety of workers.***

## **TS 1.20 MAINTENANCE OF OPEN TRENCH**

After excavation, the trench floor, joint holes and pipe bed (if applicable) shall be maintained until the pipe is installed. Should the sides fall in or any debris or water accumulate in the trench due to any cause the trench shall be cleared and the floor, joint holes and/or pipe bed, made good when so directed by the Engineer. After the installation of the pipes and making good of the external coating at field joints has been completed the trench shall be maintained until its backfilling is instructed by the Engineer.

***Where the pipeline is located on dolomite, no water shall be allowed to enter the pipe trench. Should water still accumulate in the trench, such water shall be immediately pumped from the trench and the water directed away from the trench without ponding.***

## **TS 1.21 LAYING AND JOINTING OF PIPES**

TS 1.21.1 The Contractor appointed to carry out the work under TS 2 of the contract will receive, unload and string the pipes alongside the trench and will then install the pipes in the trench and make the joints.

TS 1.21.2 Prevention of pipe flotation

TS 1.21.2.1 The Contractor shall prevent the flotation of pipework due to stormwater or groundwater entering the trench before backfilling has been completed.

TS 1.21.2.2 Methods adopted to prevent flotation shall not damage coatings or linings and shall be approved by the Engineer. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it

TS 1.21.3 Pipeline trench excavations shall be maintained in a safe condition by the excavation Contractor, in compliance with the requirements of the regulations promulgated under the Occupational and Safety Act (latest edition). The responsible person for the installation of the pipes shall ensure that trenches are in a safe condition before committing workmen and commencing pipe laying in a section of trench. Trenches deemed to be unsafe shall be notified to the Engineer and the excavation Contractor. The excavation Contractor shall then cause the section of trench to be made safe.

***Where pipelines are located on dolomite, the requirements of TS 1.19.11 shall be applicable (also refer to SANS 1936).***

TS 1.21.4 Sandbags for pipe support

TS 1.21.4.1 The pipes shall be off-loaded and placed on approved sandbag supports timeously provided at the pipe storage strip which has been cleared of all vegetation and treated with an effective weed killer. The sandbag supports shall

be arranged so that the bearing area is adequate to prevent damage to the external coating and no portion of the coated pipe is in contact with the ground.

- TS 1.21.4.2 Approved sandbags are constructed from durable woven material of sufficient strength to maintain proper pipe support. They shall be filled with sand for concrete complying with the requirements of Clause TS 2.9.5.1.2. The volume of each sand bag shall be approximately 25 litres.
- TS 1.21.4.3 In the pipe trench, each pipe shall be laid on two rows of sandbags spaced sufficiently far apart to maintain a clearance under the pipe barrel of at least 200mm and to provide stable support while working on the pipe.

## **TS 1.22 FILLING OF TRENCHES**

- TS 1.22.1 As the pipe is laid, valve chambers, thrust anchors and other structures are completed the Contractor shall fill in the trench without delay either to the full extent or partially as and when directed by the Engineer in accordance with the details shown on Drawing No. R0 27141. Where the Contractor has completed backfilling of the trench and tidying up of the site prior to the completion of the valve chambers, jacked pipe crossings or culvert brickwork the Contractor shall return to site to complete the reinstatement of the trenches around the chambers and brickwork.
- TS 1.22.2 Except in roadways, wet conditions with high water table or water course crossings, the back filling around and over the pipe up to 300mm above the pipe (Stage 1) shall be selected granular material in accordance with TS 1.10.1 and Drawing No. R0 27141 compacted by vibratory roller, power rammers or other approved equipment in 200mm finished thickness layers to 90 per cent of modified AASHTO (T-180) density.

***Where the pipeline is located on dolomite, all backfilling shall conform to the requirements of TS 1.10.2.3.***

- TS 1.22.3 Except in roadways and water course crossings, the remainder of the back filling (Stage 2), to underside of topsoil layer or to ground level, shall be selected fill material in accordance with TS 1.10.2 and Drawing No. R0 27141 compacted by vibratory roller, power rammers or other approved equipment in 300mm finished thickness layers to 85 per cent of modified AASHTO (T-180) density or as instructed by the Engineer.

***Where the pipeline is located on dolomite, all backfilling shall conform to the requirements of TS 1.10.2.3.***

- TS 1.22.4 Prior to the refilling of a section of the trench the Contractor shall measure with an approved measuring device and record the horizontal and vertical diameters at six equally spaced intervals along each pipe recording the number of the pipe and the chainage at which it was installed. When the backfilling has been completed to ground level the Contractor shall re-measure the horizontal and vertical diameter at each point. If the difference in the measurements taken before and after the backfilling shows that the pipe deflection exceeds 2 per cent of the diameter the Contractor shall remove, replace and re-compact the full depth of backfilling over the length of pipe that has suffered excessive deflection. Measurements shall be taken with an accuracy of 1mm and the Contractor shall provide approved equipment and adequately trained labour to carry out the measurements. The recorded measurements shall be submitted

to the Engineer's Representative within 24 hours of the time that any measurement was taken.

TS 1.22.5 During placement and compaction of Stage 1 material the maximum difference in backfill surface elevation on each side of the pipe shall not exceed 400mm.

TS 1.22.6 Filling of trenches at road crossings

TS 1.22.6.1 Major roads

TS 1.22.6.1.1 The filling of the trench at major road crossings shall be limited to grouting up the annulus between the jacked pipe crossing sleeve and the inserted Rand Water steel pipeline with foamed cement mortar complying with the requirements of TS 1.10.6.

TS 1.22.6.2 Minor roads or Farm tracks

TS 1.22.6.2.1 The back filling of the trench at minor roads or farm track crossings shall be flowable fill in accordance with the requirements shown on Drawing No. R0 27141 or as directed by the Engineer.

TS 1.22.7 General

TS 1.22.7.1 Where required by the Engineer the degree of compaction of the Stage 1 backfill shall be increased from 90 per cent to 95 per cent of modified AASHTO density at optimum moisture content. Similarly, the Engineer may instruct that the degree of compaction of the Stage 1 backfill be increased from 85 per cent to 90 per cent of modified AASHTO density at optimum moisture content.

***Where the pipeline is located on dolomite, only the requirements of TS 1.10.2.3 shall be acceptable.***

TS 1.22.7.2 No rock with any dimensions greater than 150mm shall be returned to the trench.

***Where the pipeline is located on dolomite, the maximum layer thickness for backfilling is 150mm and maximum particle size allowed is 100mm.***

TS 1.22.7.3 An adequate mound shall be formed over the backfilled trench to allow for settlement and suitable gaps at approximately 60m intervals shall be left in the raised backfill to allow for stormwater drainage.

## **TS 1.23 MAINTENANCE OF BACKFILLED TRENCHES**

TS 1.23.1 After completion of backfilling of each trench the Contractor shall maintain the trench and for this purpose shall patrol the trench daily for 30 days, and thereafter fortnightly for the remainder of the maintenance period. In addition, the entire length of the trench shall be patrolled after each rainfall exceeding 10mm.

TS 1.23.2 During the maintenance period, the Contractor shall submit monthly patrol reports to the Engineer.

TS 1.23.3 The period of maintenance shall extend until twelve months after the date of the Certificate of the Engineer that the whole of the work has been satisfactorily completed. Any settlement shall be filled in and made good immediately.

***Where the pipeline is located on dolomite, no ponding of water shall be allowed on or adjacent to the trench. Where settlement has occurred, such settlement shall be backfilled to above natural ground surface to prevent ponding of stormwater.***

TS 1.23.4 If instructions are issued by the Engineer for any repairs and if a delay occurs in the making good of any portion of the trench, the Board will repair the trench at the expense of the Contractor.

TS 1.23.5 The Contractor shall be liable for all claims arising out of any accidents that may occur during the whole period of maintenance.

#### **TS 1.24 FIRE BREAKS**

TS 1.24.1 Where directed by the Engineer, the Contractor shall clear an area around the pipes, which will be placed temporarily alongside the pipe trench, of all vegetation so that no damage can be caused to the pipes by grass or veld fires. The Contractor shall maintain the fire breaks until the backfill of the trench is completed.

TS 1.24.2 On receiving an instruction to form a fire break the Contractor shall put this work in hand immediately.

#### **TS 1.25 DISPOSAL OF SURPLUS SPOIL AND UNDESIRABLE MATERIAL**

TS 1.25.1 All surplus spoil from the excavations shall be loaded up, transported, dumped and levelled on suitable sites to be negotiated by the Contractor and the finished surface of the working strip as instructed by the Engineer. The Contractor may decide to remove the surplus spoil either as the excavation proceeds or after the backfilling of the trench has been completed.

TS 1.25.2 If the Contractor elects to remove the surplus spoil to permanent disposal sites as the excavation proceeds then the assessment of the quantity of spoil to be removed shall be his responsibility entirely, and any deficit shall be made good by the Contractor without further cost to Rand Water.

TS 1.25.3 The undesirable material described in TS 1.9.4 shall be loaded, transported, deposited on suitable sites and levelled off as it is excavated from the trench and other excavations. No undesirable material shall be disposed of within 50m of the trench.

TS 1.25.4 No material or surplus spoil shall be disposed of either temporarily or permanently, on privately or publicly owned property unless the Contractor shall first obtain permission therefore. The Contractor shall furnish satisfactory evidence to the Engineer that such consent has been obtained.

#### **TS 1.26 FINAL REINSTATEMENT OF WORKING AREA**

TS 1.26.1 The Contractor shall restore the surface of the ground for the full width of the working area to a condition as near as may be equivalent to that which existed at the time of beginning construction operations on each such area.

TS 1.26.2 In all areas of the working strip the surface area shall be free of bumps and hollows caused by the construction activities and, where required by the Engineer, bumps shall be cut away and hollows filled and lightly compacted to leave the surface of the site in a smooth, even and tidy condition.

- TS 1.26.3 The surface of access tracks and access ways to residential properties shall be reinstated to the owners' satisfaction and any stones, gravel or other deleterious material left from spoil piles shall be removed and disposed of as in TS 1.25.1. All stormwater channels and drains shall be cleaned.
- TS 1.26.4 The grassed surfaces of parks, road pavements and median islands between carriageways shall be cleared, as far as is practicable, of all spoil spread over the working strip during the course of excavation and pipelaying operations, and the grassed areas shall be loosened by means of spiked rollers or other approved equipment, in order to ensure that the top soil compacted during the construction of the pipeline is rendered suitable for sustaining the growth of grasses.
- TS 1.26.5 Veld grass areas shall be cleared of surplus spoil, where required, but clearing operations shall be carried out by methods that will cause as little disturbance as possible to the grass root systems.
- TS 1.26.6 Across agricultural lands the soil shall be loosened with subsoiling equipment, disked and levelled to leave the surface free of bumps and hollows.

## **TS 2. PIPE LAYING, SPECIALS AND TESTING OF STEEL PIPES**

### **TS 2.1 GENERAL REQUIREMENTS**

Under this Section of the Contract the Contractor shall:

- (i) Identify and check the conditions of the steel pipes delivered and stored at the laydown areas and along the pipe. Pipes that are defective are to be reported to the Engineer. Agreement is then to be reached as to how these defective pipes are to be repaired and the price of the repair, or
- (ii) Identify and check the conditions of the steel pipes as they are delivered to site from the manufacturers. Pipes that are defective are to be reported to the Engineer. Agreement is then to be reached as to how these defective pipes are to be repaired and the price of the repair.
- (iii) Identify, establish and prepare to the satisfaction of the Engineer, temporary lay-down areas for the pipes next to the pipeline. These laydown areas do not include the working strip next to the pipeline route.
- (iv) Arrange for the supply, loading, transport and unloading of fabricated pipe bends, pipe specials, valves and applicable instrumentation from suppliers/ manufacturers to alongside the trench for the pipeline and temporary lay-down areas.
- (v) Arrange for the loading, transport and unloading of pipe from the pipe storage area or from temporary laydown areas next to the pipeline (See (iii) above) to alongside the trench for the pipeline.
- (vi) Install the pipes in the trenches and make the necessary joints including the flanged joints at isolating valves.
- (vii) Install fabricated pipe bends to form horizontal and vertical changes in pipeline direction where shown on the drawings. The Contractor will install them according to the drawings.
- (viii) Install special steel pipe sections as scheduled. This will include (not limited to):
  - Tees for air-valves;

- Reducers for the valve chambers;
  - Tees for the cross connections;
  - Tee for a future off-take;
  - Including supply of all flanges
- (ix) Allow specialist (to be nominated by the Engineer) to carry out radiographic examination of welded joints as per Engineer's instruction.
- (x) Install all isolating, by-pass, scour and air valves.
- (xi) Make good the external coating and internal lining at joints and clean out the pipeline.
- (xii) Rectify defects in the pipeline during construction and for a period of 12 months after the final date of the acceptance of the contract.

## **TS 2.2 PIPE CHARACTERISTICS**

The pipes shall have a grade and dimensions as specified in Project Specification and Bill of Quantities (BOQ). The minimum pipe wall thickness that will be allowed is 6mm.

## **TS 2.3 LOADING, TRANSPORTING AND UNLOADING OF PIPES**

- TS 2.3.1 The steel pipes will be delivered to a storage yard or on site, or designated lay down areas or along the trench. It is the Contractor's responsibility to check and inspect the pipes on delivery to ensure that they are in acceptable condition. Should any defects be found, they are to be reported to the Engineer. Agreement is then to be reached as to how these defective pipes are to be repaired or send back to the manufacturers.
- TS 2.3.2 The Contractor shall examine visually and by means of the appropriate detectors, the external coating and internal lining of all pipes at or near the storage area within the storage site as well as along the trench, in the presence of a Rand Water representative. Should any defects be found, they are to be reported to the Engineer. Agreement is then to be reached as to how these defective pipes are to be repaired or send back to the manufacturers
- TS 2.3.3 The Contractor shall upload and transport the pipes from storage site or laydown areas and lay them down in temporary laydown areas along the pipeline route and/or at certain positions along the pipeline route.
- TS 2.3.4 The Contractor shall load the pipes from the temporary lay-down areas, move them to the excavated trench and string them along the trench until required for installation. The pipes shall be adequately supported on sand bag supports (Sawdust filled bags shall not be used).
- TS 2.3.5 The pipes at all stages, shall be protected against damage, and shall be lifted by means of approved broad-band slings and spreader beams
- TS 2.3.6 The use of chains, wire ropes, etc, will not be permitted and the pipes shall be supported on sand bag supports provided by the Contractor while in the temporary laydown areas or when placed alongside the trench. (Sawdust filled bags shall not be used).
- TS 2.3.7 Also refer to Rand Water's Specification for Pipe Handling and Storage SAM SHERQ 01008 F.



## **TS 2.4 HANDLING OF PIPES**

- TS 2.4.1 The Tenderer shall state in Returnable Schedule the plant he proposes to use for loading, unloading, bracing and placing the pipes in the trench. All plant shall be subject to the approval of the Engineer. The plant and bracing shall be designed so as not to damage the pipes, the lining and sheeting or disturb existing pipelines.

Examinations and testing of welds shall comprise the following:

- TS 2.4.2 Before placing the pipes in the trench, the measures taken to ensure the safety of the operations, the material and compaction of the trench floor and the finished line and grade of the pipe bed shall be carefully checked between survey pegs by the Contractor. The Contractor shall check the joint holes for each pipe length and permission to lay obtained from the Engineer's Representative. The pipes shall then be placed in the trench, installed and jointed in accordance with the specification.

The Contractor shall keep the pipe trench and excavations free from water at all times during the pipe laying operations.

- TS 2.4.3 Also refer to Rand Water's Specification for Pipe Handling and Storage SAM SHERQ 01008 F.

## **TS 2.5 INSTALLATION OF STEEL PIPES**

- TS 2.5.1 Preparation

- TS 2.5.1.1 Before a pipe or special pipe section is placed in the trench the internal and external protective coatings shall be examined visually and by means of a holiday detector of the correct type and rating for the particular coating system. No pipe shall be laid without the permission of the Engineer's Representative. The Tenderer shall state in Returnable Schedule details of the equipment that will be provided to carry out holiday detection on the site.

- TS 2.5.1.2 Any manufacturing defects located in the coatings shall be reported immediately to the Engineer who will make arrangements for the repair of the defects.

- TS 2.5.1.3 Any damage to the sheathing caused during unloading or while the pipes are stored on the site the Contractor shall make the site good.

- TS 2.5.1.4 When making joints or doing any other work inside the pipe, every care shall be taken to avoid damage to protective lining or coatings. Rubber matting or timber duck-boards at least 400mm wide shall protect the invert surfaces of the pipe when working inside the pipe. The coatings shall be protected during welding from weld spatter, hot slag, etc. using rubber matting.

- TS 2.5.2 Cleaning of Joints

Immediately prior to the installation of any section of pipe, all foreign matter of any nature and all protective material shall be removed from the surfaces that are to be in contact at joints, so as to leave thoroughly clean surfaces for metal-to-metal contact in the field joints.

- TS 2.5.3 Laying Pipe

Each pipe shall be accurately laid on the prepared bed to the required line and grade. In placing pipe in the trench, the pipe shall be held by an approved sling, at least 0.4m wide, and the pipe shall not be dragged on the bottom of the trench but shall be supported by the sling while being fitted to the adjacent pipe section.

After each pipe has been set into position it shall be attached to the adjoining pipe by means of an arc-welded joint. The use of dogs, clips, lugs or equivalent devices welded to the pipe for the purpose of forcing it into position will not be permitted.

- TS 2.5.3.1 The Contractor shall remove any dents, which appear in the wall of the pipe, General: The pipes and specials shall be manufactured exclusively at the works of the Contractor or on site or by such makers as may be approved by the Engineer and at only one works unless otherwise agreed to by the Engineer in writing.

Pipe sections and specials shall be consecutively numbered from the commencement of fabrication. Each pipe section number shall be punched on the inside of the pipe at each end of the pipe and each circumferential weld made at the Contractor's works, to joint pipes, shall be marked with the welder's identifying stamp.

The method of manufacture of the pipes shall be detailed in Returnable Schedules for evaluation. All welding procedures shall be described in Returnable Schedules and approved by the Engineer and all welders and welding operators employed on the work shall have passed an approved qualification test. The Contractor shall maintain a record of the procedure, performance and qualification tests.

Full details of welding electrodes and fluxes, where applicable, shall be given in Returnable Schedules.

- TS 2.5.3.2 Forming

The Line Pipe Specification (API 5L) allows for helical and longitudinal seam welds for fabrication of the pipe. The welding method and process of fabrication shall be given by the Contractor in the Returnable Schedules.

- TS 2.5.3.2.1 Spiral/helical seams

Pipe coils shall be fabricated from strip formed to a cylindrical form with a helical seam. Coil jointing welds in the strip used in the forming of spiral welded pipes shall be not less than 300 mm from a pipe end.

The radial offset (misalignment) of the plate edges in the weld seams shall not exceed 1.5 mm.

This shall apply to all pipe sizes.

- TS 2.5.3.2.2 Longitudinal seams

Pipe coils/plate shall be fabricated from strip formed to a cylindrical form with a longitudinal seam. The coil/strip jointing end welds shall not be present in the finished longitudinal seam pipe.



Mechanical testing of the longitudinal seam shall be in accordance to API 5L. For double-seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

The radial offset (misalignment) of the plate edges in the weld seams shall not exceed 1.5 mm.

This shall only apply to pipes up to 600mm. Pipe larger than 600mm must be discussed with the RW Design Engineers after the cause or the object causing the dent has been located and removed. The cost of removing the dent and making good the lining, wrapping and backfilling shall be borne by the Contractor.

Any damage to the pipe during or after laying shall be made good and for this purpose the Inspector may require the pipe or section thereof to be removed from the trench and replaced with pipe which is free from defects.

#### TS 2.5.4 Surface Preparation

As soon as the field joints have been welded the coating at such field joints shall be completed in accordance with the following procedures:

##### TS 2.5.4.1 External Priming

After welding and the necessary examination have been carried out, the surface of the pipe to be made good shall be wire brushed, using mechanically operated tools, to remove loose rust and slag from the weld. The surface roughness shall be minimum 50 µm. The cleaned area has to be primed through spraying or brush applying.

Application of the primer or equivalent membrane shall be performed by either manual or semi-automatic application techniques. The membrane has to be pressed firmly against the pipeline steel until whilst being heated by a propane torch. The membrane is progressively unrolled around the pipeline circumference, keeping a thin bead of molten adhesive between the steel and membrane. This technique ensures that all air is expelled.

Wet Sponge holiday detection 90 volts 5 mega ohms 100% pinhole free. Completion of external coating will be executed as per the supplier's requirements and specifications.

##### TS 2.5.4.2 Internal coating (Epoxy Lining)

- a) Abrasive strip blast to SA3 a strip that includes all the unpainted section and overlaps the epoxy coated section by 50mm. This section is to have a minimum surface profile of 60 to 85 microns.
- b) Check surface cleanliness to SANS 769 – 0.2% Dust and Debris max.
- c) Apply equivalent coating product that has been approved by the Engineer by brush or roller to achieve a min DFT of 600 microns.
- d) Wet Sponge holiday detection 90 volts 5 mega ohms 100% pinhole free. Completion of epoxy linings will be executed as per the supplier's requirements and specifications.

#### TS 2.5.5 Payment on completion of sections not hydraulically pressure tested

A maximum payment of 80% of the tendered rate shall be made for the completed section of pipeline which has not been hydraulically pressure tested and disinfected. A further payment of 15% of the tendered rate will be made upon successful completion of the pressure testing for the relevant section of pipeline. The final 5% of the tendered rate will be made upon completion of disinfection of the pipeline.

Notwithstanding the above, the rate for “supply, lay and bed pipes” excludes the cost associated with pressure testing and disinfection of the pipeline. Separate items have been included in the Bill of Quantities for the cost associated with pressure testing and disinfection of the pipeline.

## **TS 2.6      WELDING**

Jointing shall be by butt and/or fillet welding laid down in accordance with the details on Drawing No RA23557.

Welding joints shall be made in accordance with approved welding techniques and to the standard specified in TS 2.6.2 and TS 2.6.3. All welding shall be electric fusion welding and be acceptable to the Engineer.

### **TS 2.6.1      Butt welding of pipe joints**

All welding shall be electric fusion welding, be acceptable to the Engineer and shall comply with the following requirements:

- (a) Uniformity of appearance: All welds shall be substantially uniform in appearance and shall show full fusion and penetration throughout their lengths.
- (b) Undercut: Welds shall be substantially free from undercut and, if present,
  - (i) the depth of the undercut shall not exceed 12½ per cent of the nominal wall thickness or 1 mm, whichever is the lesser in depth and,
  - (ii) the aggregate length of undercut in any 1m length of welding shall not exceed 50mm.
- (c) Weld bead tolerances: The outer weld bead shall not exceed a height of 3 mm for nominal wall thickness of 10 mm and under, and shall not exceed a height of 5 mm in pipes having thicker walls. The inner weld bead shall not project more than 1 mm and all excess weld metal shall be removed by grinding to the satisfaction of the Engineer.

For butt welds made from one side only a root groove may be present provided that it has a rounded outline and does not penetrate below the level of the adjacent surfaces of the parent plate.
- (d) Freedom from defects: The weld, heat affected zone and surrounding parent metal shall be free from cracks, porosity cavities and trapped slag and other defects described in API Specification 5L.
- (e) Transverse tensile strength of welded joint: The welded joint shall have an ultimate tensile strength at least equal to 95 per cent of the minimum tensile strength of the parent plate.
- (f) Resistance to bending: Test specimens prepared and tested in accordance with Clause 5 shall show no crack (on the outer surface) greater in length than 5 mm in any direction.

### **TS 2.6.2      Fillet welding of pipe joints**

Fillet welding shall comply with the following requirements and the details shown on Drawing No. RA23557.

A visual inspection shall be carried out after cleaning the slag off every fillet weld before completion of the external coatings

Welds shall not have a concave surface. There shall be no undercutting of adjacent plate. Welds shall be free from cracks, slag intrusions and porosity.

**TS 2.6.3**      Welding tests on butt welds only

**TS 2.6.3.1**      The Contractor shall allow a specialist (to be nominated by the Engineer) to carry out radiographic examination, in accordance with American Petroleum Institute Standard 1104, of the full length of 10% of the circumferential welds made during installation of the pipeline, after 100% x-rays results have been accepted on the first 10 sequential joints. Should 100% pass rate not be achieved on these initial joints, x-rays shall continue to be taken until 10 sequential joints results are achieved.

**TS 2.6.3.2**      Cracks, lack of complete penetration, or lack of complete fusion shall be considered injurious defects. The standard for acceptance of minor imperfections such as slag inclusions or gas pockets shall be that laid down in Clause 9.3.8 of American Petroleum Institute Standard 1104

**TS 2.6.3.3**      Any weld rejected as a result of radiographic examination shall be repaired by the Contractor and such repair shall be carried out in accordance with TS 2.6.4. The repaired weld shall be re-examined radio graphically and re-examination shall extend for the full length of the weld in which the repair has been carried out.

**TS 2.6.4**      Repairs

**TS 2.6.4.1**      Repairs of welded joints shall be permitted in accordance with approved repair procedures. Repairs shall be re-examined using the relevant non-destructive testing method. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding and re-welded to the satisfaction of the Engineer. All costs associated with the repair of defective welds will be borne by the Contractor

**TS 2.6.4.2**      The repairs procedure and performance, and welders employed on repairs shall be qualified in accordance with Appendix B of American Petroleum Institute Standard 5L. Each repair weld shall be marked with the welder's identifying stamp.

**TS 2.6.4.3**      On discovery of rejected welds the Engineer may, at his discretion, call for additional radiographic examination at the Contractor's cost until it is shown that the necessary standard is being maintained.

**TS 2.7**            **SPECIALS AND PIPES**

**TS 2.7.1**      Fabrication

- TS 2.7.1.1      Material and Manufacture
- TS 2.7.1.2      The special pipe sections that are required to be installed under this contract are to be supplied by the Contractor. Rand Water reserves the right to free issue these items.
- TS 2.7.1.3      All pipes and pipe specials shall be manufactured from grade S355JR and steel grade X42 (API 5L) in accordance API 5L as a minimum.
- TS 2.7.1.4      All pipes of nominal diameter larger than 600 mm shall be manufactured from steel grade S355JR (SANS 50025-2) and steel grade X42 (API 5L) in accordance API 5L.
- TS 2.7.1.5      Steel for flanges of pipe specials shall be Grade 43A (minimum) of BS4360 or Grade S275JR (minimum) of SANS 50025 as per Rand Water Specifications (Refer to Drawing No. A11791).
- TS 2.7.1.6      The steel plate and/or coil shall be free from seams, cracks, laminations and other injurious defects. The external diameter shall conform to the relevant dimensions given in the schedules and the outside diameter and circumference of specials with a diameter exceeding 400mm shall be subject to tolerances of + 300mm and  $\pm 6$ mm respectively.
- TS 2.7.1.7      Ends of specials shall be cleanly cut and be free from burrs. The ends shall not deviate more than 3mm at any point from a true plane at right angles to the axis of the pipe.
- TS 2.7.1.8      Where pipes are to be joined by butt welding the ends shall be bevelled to an angle of  $30 \pm 5$  degrees measured from a plane perpendicular to the axis of the pipe, and shall include a root face of  $2\text{mm} \pm 1\text{mm}$  (Refer to Drawing No. RA23557).
- TS 2.7.1.9      All valves shall be supported by permanent valve supports to be supplied and installed by the Contractor (Refer to A12210).
- TS 2.7.2          Welding
- Welding shall be in accordance with TS 2.6
- TS 2.7.3          Welding Tests
- TS 2.7.3.1        Examinations and testing of welds
- Examinations and testing of welds shall comprise the following:
- (a) Mechanical tests (destructive tests): Transverse tensile and guided bend tests carried out on test pieces cut from the welded seam. The tests shall be carried out in accordance with Section 4 of American Petroleum Institute Specification 5L (latest edition). Should one of these test samples fail to comply with the relevant requirements, two further specimens of the same type shall be prepared and subjected to the relevant test. If one or both of the retest specimens fail to comply with the relevant requirements further re-tests shall be carried out until 10 consecutive specimens comply with the relevant requirements.
  - (b) Radiographic examination of helical and circumferential welds. Cracks, lack of complete penetration, or lack of complete fusion shall be considered injurious defects. The standard for acceptance of minor

imperfections such as slag inclusions or gas pockets shall be in accordance with Clauses 9.2 through 9.13 of American Petroleum Institute Specification 5 L (latest edition). Any weld rejected as a result of radiographic examination may be repaired at the option of the Contractor, and such repair shall be carried out in accordance with Clause 7 of American Petroleum Institute Specification 5L (latest edition).

- (c) Ultrasonic inspection with equipment capable of continuous and uninterrupted inspection of the weld seam. The examination procedure, reference standard and rejection limits shall be those set out in Clauses 9.14 to 9.18 of American Petroleum Institute Specification 5L (latest edition). An imperfection that produces an indication which would lead to rejection in terms of Clause 9.16 of Specification 5L (latest edition) shall be investigated by radiographic examination.

#### TS 2.7.3.2 General

The Tenderer shall state what facilities and equipment for testing and examining welds are available at his works. The cost of all tests and repairs to a pipe cut to obtain test strips shall be borne by the Contractor.

#### TS 2.7.4 Repair of Injurious Defects

TS 2.7.4.1 Repairs of a welded seam shall be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding and re-welded to the satisfaction of the Engineer.

TS 2.7.4.2 The repair procedure and performance, and welders employed on repairs shall be qualified as stated in Appendix B of the American Petroleum Institute Standard 5 L (latest edition). Each repair weld shall be marked with the welder's identifying stamp.

TS 2.7.4.3 When a repair is made in a weld, the weld shall be radio graphically examined for the full length of the repaired section and for an additional length of 400 mm on each side of the repaired section.

TS 2.7.4.4 On discovery of reject welds, the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

TS 2.7.4.5 Should a weld repair be required on a pipe subsequent to hydraulic testing; the pipe shall be retested to the test pressure specified.

### TS 2.8 HYDROSTATIC TESTING OF PIPES AND SPECIALS

TS 2.8.1 Pipes and specials shall be subject to an approved hydrostatic test to a test pressure determined as follows:

$$P = \frac{2\,000\,tf}{D}$$

Where,

P = the test pressure in kPa.

F = 85 per cent of the guaranteed minimum yield strength in MPa for the steel plate.

D = the outside diameter of the pipe in mm  
T = wall thickness in mm.

- TS 2.8.2 Hydrostatic testing shall not be carried out until all aspects of fabrication have been completed. Documentation of the hydrostatic testing is to be submitted to the Engineer.
- TS 2.8.3 Instruments and testing equipment used for measurement of pressure, volume and temperature should be certified for accuracy, repeatability and sensitivity. Gauges and recorders should be checked prior to testing and calibration certificate not older than 6 months must be submitted for every test.
- TS 2.8.4 The pressure shall be applied steadily by approved means and maintained without variation sufficiently long for proof and inspection. The description of the testing apparatus and parameters shall be given in Returnable Schedules.
- TS 2.8.5 Should water sweat or ooze from any part or any defects of any nature be discovered the pipe shall be emptied and the defects made good. The pipe shall then be tested again. Should a pipe, after repair, fail to pass the second hydraulic test the Engineer may order its rejection.
- TS 2.8.6 The fact that any pipe may have passed the hydraulic test at the works shall not exempt the Contractor from his liability under the General Conditions of Contract.
- TS 2.8.7 If a pipe fails to pass any of the above tests it shall be rejected but the Engineer may permit repairs or alterations to be made to enable the pipe to pass the test.
- TS 2.8.8 The Engineer may require one or more pipes to be tested to destruction. If practicable the Engineer may require the Contractor to repair the pipes and retest them.
- TS 2.8.9 A Hydrostatic testing plan and method statement shall be submitted for approval prior to testing.

## **TS 2.9 PROTECTIVE LINING AND COATING**

The protective lining and coating shall comprise a coherent internal lining and external coating bonded to the inside and outside surface of each pipe in order to prevent corrosion of the inside and outer pipe surface. The acceptable alternatives to be considered by Rand Water are Modified Bitumen, Polyurethane external protective coating, and CML and Epoxy for internal protective coating. The Tenderer must supply full details of the coating proposed.

The Tenderer must supply the brand of coating, the analysis of the coating and the mix ratios of the coating manufacture, if applicable, to the Engineer. The results of the control standards for the coating from the manufacturer need to be presented. Proof of testing of the coating at SABS, CSIR is required and must be presented.

Protective coating shall only be applied to bare steel pipe that complies with all the technical requirements and has passed the tests and hold points of the quality control plan. For all inspections in the quality control plan that are required to be witnessed by the Engineer's Representative, at least 24 hours' notice shall be given by the Contractor.



TS 2.9.1 Materials and Application Requirements

TS 2.9.1.1 Bitumen External Coating

TS 2.9.1.1.1 Bitumen shall be an approved bitumen pipe coating enamel of the quality required by and applied in accordance with EN10300 (latest) and SANS 1178 (latest) which shall comply generally with the following requirements:

- (a) Softening point (ring and ball) to ASTM D36: 105 -120°C.
- (b) Penetration value at 25°C to ASTM D5 IP.49: 10 - 22.
- (c) Flash point (Cleveland Open Cup) to ASTM D92: 200°C minimum.

TS 2.9.1.2 Bitumen shall be in the form that it is received from the supplier and no adulteration will be permitted. The material data sheet must be provided, see TS 2.9 above (Protective Coating - Guidelines).

TS 2.9.1.3 Unless agreed to by the Engineer, temperatures shall not exceed the following:

Bulk Storage	180°C
Hot Priming	235°C
Coating and wrapping	235°C

Bitumen which has been heated to a temperature in excess of 250°C shall be discarded. The Contractor shall provide approved means of recording the temperatures during the operation. The temperature recordings must be documented in a table and submitted to the Engineer for each pipeline coated.

TS 2.9.1.4 Priming pipe and stiffeners:

Within four hours after the pipes and stiffeners have been cleaned and inspected in accordance with clause 10 the surface to be coated shall be primed with an approved synthetic primer complying with EN 10300: 2005 (or bitumen solution primer complying with SANS 1178 (cold applied) (latest edition).

The cleaned pipe shall be completely dry before being coated with the primer and the application shall be by brush, roller or spray application and shall be allowed to dry completely.

TS 2.9.1.5 Surface Preparation:

Each steel special shall be thoroughly cleaned and freed from all mill scale, foreign matter or rust especially along the weld and shall be approved by the Inspector immediately before coating. The exterior and interior of the special shall be cleaned by steel shot blasting and will not be accepted unless the operation provides a roughened surface equivalent to SA 2½ as table below.

**Table 2.9.1.5: Preparation**

ISO	8501-1	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO	8501-2	Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness -- Part 2: Preparation grades of previously coated steel substrates after localized removal of previous coatings

ISO	8501-3	Preparation grades of welds, edges and other areas with surface imperfections
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TS 2.9.1.5.1 Tubes and components shall be maintained at least 3 °C above the dew point temperature at all times during the cleaning and coating process.

NOTE: At the time of application, particularly when the weather is damp and cold, it may be necessary to pre-heat the tubes and components, and this operation should not be prejudicial to the cleanliness of the surface or to the conditions required for the application of the primer.

TS 2.9.1.5.2 Pre-blast requirements

Immediately prior to blast cleaning, the tubes shall be inspected for surface contamination (oil grease, temporary corrosion protection, etc.). Where oil, grease or other surface contaminants are present they shall be removed (without spreading over the surface) with a suitable solvent (e.g. Xylene) or a biodegradable emulsifier.

All surface defects (slivers, laminations, etc.) detrimental to the surface or to the adhesion of the coating shall be removed.

When necessary tubes shall be washed with fresh potable water before blast cleaning to remove surface contaminants including mud, salts and other loosely adhering mineral matter. The tubes and components shall then be preheated to a minimum of 30 °C in order to remove moisture and to prevent contamination of the abrasive media.

TS 2.9.1.5.3 Blast Cleaning

Tubes and components shall be blast cleaned; the grade of abrasive shall give a blast peak to trough surface profile of 50 µm - 100 µm. The degree of cleanliness shall be to SA 2½ in accordance with EN ISO 8501-1

Only dry abrasive techniques shall be employed. The abrasive shall be reusable chilled iron grit or steel grit or a mixture of grit and shot, the abrasive shall be kept free from dust, salts and other impurities.

Sand shall not be used.

TS 2.9.1.6 Protection required:

The external coating for pipes shall have a minimum thickness of 5mm and be reinforced with two layers of a Type I glass fibre mat in accordance with SANS 1130 – 2009 or latest applied at a controlled speed and tension to form a helix having an overlap of at least 30mm.

TS 2.9.1.7 Application:

The primed surface shall be completely dry before the bitumen coating is applied. The coating shall be evenly applied and shall be tough, impervious, free from pin holes and its adhesion to the steel be such that it will not peel, flake, erode nor be readily prized off.

The coating shall be evenly applied and shall be tough, smooth, glossy and free from ripples or runs; Care shall be taken to ensure that there are no air gaps between the coating and the pipe at welds and in particular where the stiffener

is attached to the pipe wall. If necessary, an approved bitumen based mastic filler shall be smoothed over the welds before the bitumen coating is applied.

**TS 2.9.1.8 Generally:**

Details of the material, primer and methods to be used to heat and mix the material and steps to be taken to maintain a uniform and consistent material shall be stated in the relevant Returnable Schedule.

**TS 2.9.1.9 Repair of coating:**

A bitumen external coating may be repaired at the maker's works providing the area requiring repair does not exceed 5.0 per cent of the wrapped area. If the area to be repaired exceeds this figure the entire damaged protective coating shall be stripped and the pipe recoated. Where wrapping is repaired an entire circumferential band the width of the damaged section shall be removed from the pipe and the repair made with full wrapping bands or reinforcing mat.

**TS 2.9.2 Modified Bitumen External Coating**

**TS 2.9.2.1 Modified bitumen shall comply with the requirements of category 2 coating enamel, grade b (Table TS9.2.1) as required by and applied in accordance with SANS 1178**

**Table TS2.9.2.1**

Characteristics	Grade b	Method of test
Filler content by ignition, % by mass	25 to 35	EN 10300 Annex K
Density at 25 °C, g/cm <sup>3</sup>	1.2 to 1.4	EN 10300 Annex L
Softening point (ring and ball), °C	130 to 160	EN 1427
Penetration at 25 °C, 0.1 mm	10 to 30	EN 1426
Flash point (Cleveland open cup) minimum °C	260	ISO 2592

Property		Grade b	Method of test
Sag, maximum mm	80 °C , 24 h 90 °C , 24 h	1.5	Annex D
Impact disbonded area, maximum mm <sup>2</sup>	0 °C - 10 °C	6 500	Annex E
Peel initial and delayed, minimum N/20 mm	30 °C 40 °C 50 °C	80 50 30	Annex F, F.4.2
Bend at - 10 °C, minimum mm		15	Annex G

Cathodic disbonding, disbonded radius after 28 d, maximum, mm	7	Annex I
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The minimum thickness of the enamel shall be 4mm with an average of 5mm.

TS 2.9.2.2 Modified Bitumen shall be in the form that it is received from the supplier and no adulteration will be permitted. The material data sheet must be provided, see TS 2.9 above (Protective Lining and Coating).

TS 2.9.2.3 Unless agreed to by the Engineer temperatures shall not exceed the following:

Bulk storage temperature	180°C
Hot priming	235°C
Coating and wrapping	235°C

TS 2.9.2.4 Modified bitumen which has been heated to a temperature in excess of 235°C shall be discarded. The Contractor shall provide approved means of recording the temperatures during the operation. The temperature recordings must be documented in a table and submitted to the Engineer for each pipeline coated.

TS 2.9.2.5 Protection required:

The Bitumen Fibre Wrapping external coating for pipes shall have a minimum thickness of 5mm and an average thickness of 5mm. The coating shall be reinforced with two layers of a Type I glass fibre mat in accordance with SANS 1130 (latest version) and BS EN 10300:2005 applied at a controlled speed and tension to form a helix having an overlap of at least 30 mm.

TS 2.9.2.6 Surface Preparation:

Each steel special shall be thoroughly cleaned and freed from all mill scale, foreign matter or rust especially along the weld and shall be approved by the Inspector immediately before coating. The exterior and interior of the special shall be cleaned by steel shot blasting and will not be accepted unless the operation provides a roughened surface equivalent to SA 2½ as table below.

**Table 2.9.2.6: Preparation**

ISO	8501-1	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO	8501-2	Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness -- Part 2: Preparation grades of previously coated steel substrates after localized removal of previous coatings
ISO	8501-3	Preparation grades of welds, edges and other areas with surface imperfections

TS 2.9.2.6.1 Tubes and components shall be maintained at least 3 °C above the dew point temperature at all times during the cleaning and coating process.

NOTE: At the time of application, particularly when the weather is damp and cold, it may be necessary to pre-heat the tubes and components, and this

operation should not be prejudicial to the cleanliness of the surface or to the conditions required for the application of the primer.

#### TS 2.9.2.6.2 Pre-blast requirements

Immediately prior to blast cleaning, the tubes shall be inspected for surface contamination (oil grease, temporary corrosion protection, etc.). Where oil, grease or other surface contaminants are present they shall be removed (without spreading over the surface) with a suitable solvent (e.g. Xylene) or a biodegradable emulsifier.

All surface defects (slivers, laminations, etc.) detrimental to the surface or to the adhesion of the coating shall be removed.

When necessary tubes shall be washed with fresh potable water before blast cleaning to remove surface contaminants including mud, salts and other loosely adhering mineral matter. The tubes and components shall then be preheated to a minimum of 30 °C in order to remove moisture and to prevent contamination of the abrasive media.

#### TS 2.9.2.6.3 Blast Cleaning

Tubes and components shall be blast cleaned; the grade of abrasive shall give a blast peak to trough surface profile of 50 µm - 100 µm. The degree of cleanliness shall be to SA 2½ in accordance with EN ISO 8501-1

Only dry abrasive techniques shall be employed. The abrasive shall be reusable chilled iron grit or steel grit or a mixture of grit and shot, the abrasive shall be kept free from dust, salts and other impurities.

Sand shall not be used.

#### TS 2.9.2.6.4 Priming pipe

The primer shall be applied to a dust free, clean, dry, prepared surface. The primer shall be applied in accordance with the primer manufacturer's recommendations. The primer manufacturer must supply the Material Data Sheet and the method to be utilised.

The primer film applied at the thickness specified by the primer manufacturer shall be uniform and continuous. The dry film thickness shall be measured at least once per shift. The primer shall be free from runs drips, sags, misses, holidays and bare areas. Tubes not primed correctly shall be re-cleaned and re-primed.

Tubes on which the primer has deteriorated, or become contaminated shall be rejected and shall be re-cleaned and re-primed.

#### TS 2.9.2.6.5 Application

Coat and wrap application shall follow priming within 2 hours of priming, and the primed surface shall be dry and free from surface contamination prior to enamel application.

The enamel shall be applied by an extrusion process.

Equipment shall be used for spirally wrapping the outer-wrap under controlled tension using trained operators.

The extruded enamel shall have the outer-wrap pulled on immediately following enamel application. The outer-wrap shall be pulled onto the enamel and be well bonded with some bleed through of enamel occurring.

All wraps shall be wrinkle-free with minimum overlap of 12 mm. The enamel shall be applied at a temperature in accordance with the manufacturer's recommendations. The enamel shall flow evenly onto the pipe and be free from any solid particles which may cause irregularities in flow.

The coating shall be cut-back where necessary to meet the specification. The method of removal of cut-back shall be approved prior to commencement of coating.

#### TS 2.9.2.6.6 Testing of Bitumen Coating:

On one pipe in each batch of 20 pipes the Contractor shall carry out, in the presence of the Engineer's Representative, the following tests in accordance with the test methods set out in BS EN 10300:2005:

##### TS 2.9.2.6.6.1. Visual

The general appearance of the coating shall be evaluated visually. The coating shall be of uniform appearance free from wrinkle, pinholes, voids, laminations, holiday, dry wrap and contamination. The coating shall be completely bonded to the surface. Visual inspection notes must be presented and representatives from the client and the tenderer must co-sign in agreement of the inspection.

##### TS 2.9.2.6.6.2. Holiday detection

Holiday detection shall be carried out on every coated pipe as in Annex R of BS EN10300:2005. Holiday detection documentation must be presented.

The coating shall be free from holiday.

##### TS 2.9.2.6.6.3. Adhesion

A field bond test shall be conducted on the coated pipes 24 hours after coating on one pipe in every 20 pipes. Three tests shall be conducted on each selected pipe.

The coating shall adhere to the steel in accordance with the specified limits in Annex S of BS EN10300:2005. The adhesion tests documentation must be presented.

##### TS 2.9.2.6.6.4. Enamel coating thickness

A film thickness gauge of magnetic or electro- magnetic type shall be used to measure the coating thickness of each pipe (including coating over the weld where applicable) in accordance with Annex T of BS EN 10300:2005. The instrument shall be calibrated at least twice daily. The thickness readings made on every twentieth pipe shall be recorded.

The thickness of the coating shall conform to the requirements of the order and it is recommended that the thickness should in accordance with Annex J of EN 10300:2005.

The Engineer's representative must be present and co-sign on the presented documentation.



#### TS 2.9.2.6.7 Non-conformance procedure

During production quality control, if the coated pipe selected for tests specified in above mentioned tests, i.e. visual, holiday, adhesion and thickness shows defects/ failures that gives cause for rejection, then three pipes preceding and two pipes following this pipe shall also be tested. These five pipes shall be subjected to the test specified for visual, holiday adhesion and thickness.

If the results of these pipes are satisfactory, the coating shall be considered acceptable. If not, the coating shall be considered unacceptable.

If further defects / failures are detected, then the entire production for that shift shall be checked and examined. If the coating is rejected, the coater shall re-coat pipes and components and present the re-coated pipe for acceptance again.

If in any total production batch, the rejection rate is higher than 10%, the whole batch shall be rejected and the cause if the failures ascertained. Production shall not recommence until the cause of the failure has been satisfactorily established.

#### TS 2.9.2.6.8 Cathodic disbonding

Cathodic disbonding test on coated pipes shall be undertaken in accordance with method given in Annex I of BS EN 10300:2005. Documentation of tests performed to be presented to the Engineer

#### TS 2.9.2.6.9 General:

Details of the material, primer and methods to be used to heat and mix the material and steps to be taken to maintain a uniform and consistent material shall be stated in Returnable Schedules.

The coating shall be evenly applied and shall be tough, smooth, glossy and free from ripples or runs. Care shall be taken to ensure that there are no air gaps between the coating and the pipe at welds and in particular where the stiffener is attached to the pipe wall. If necessary an approved, bitumen based mastic filler shall be smoothed over the welds before the bitumen coating is applied.

#### TS 2.9.2.6.10 Repair of coating:

Pipe external coating may be repaired at the maker's works providing the area requiring repair does not exceed 5.0 per cent of the wrapped area. If the area to be repaired exceeds this figure the entire damaged protective coating shall be stripped and the pipe recoated. Where wrapping is repaired an entire circumferential band the width of the damaged section shall be removed from the pipe and the repair made with full wrapping bands or reinforcing mat.

Pipes with localized defects (e.g. porosity, surface defects) as well as those which have been subjected to control tests may be repaired.

The coating materials that can be used for the repairing of defects shall satisfy two conditions:

- Be suitable for protective the pipe in the required service conditions (e.g. working temperature)

- Be compatible with and adhere to the bitumen based coating applied previously.

The application conditions for repair materials shall be approved prior to commencement of coating.

After application, the repair shall be subject to holiday detection. The repair shall be free of holiday.

### TS 2.9.3 Rigid Polyurethane External Coating

TS 2.9.3.1 The material used for coating of steel pipes shall be of the following types:

- a) Type 1: a multi-pack liquid coating material, curing at ambient temperatures within the range recommended by the manufacturer and consisting of one of the followings:
  - 1) Type 1A: solvent-borne chemically cured polyurethane resin,
  - 2) Type 1B: solvent-borne epoxy or a polyurethane tar or
  - 3) Type 1C: solvent-free chemically cured polyurethane.

TS 2.9.3.2 Physical and performance requirements:

Coating material shall comply with the appropriate requirements given in Table 1 of SANS 1217 (presented below as Table TS2.9.3.2) and the will be done at the request of the client's QCP and this test shall be deemed to be included in your price.

**Table TS2.9.3.2: Physical and performance requirements of coating material**

Property	Type 1 C Solvent-free chemically cured rigid polyurethane <sup>a</sup> coating material requirement	Test method or clause
Adhesion, MPa, min. (laboratory)	15	ASTM D 4541 (tester type III, IV, or V)
Impact resistance, Kg.m, min.	0,6	ASTM D 2794 intrusion
Water absorption, %, max.	3	ASTM D 570 long term
Dielectric strength, kV/mm thickness, min.	15	ASTM D 149-97a
Resistance to abrasion, g, max.	0,080	ASTM D 4060, CS 17, 1kg, 1000 cycles
Cathodic disbonding, disbonded area, mm ECD <sup>b</sup> , max. 28 d test period at 23°C 90 d test period at 23°C	18 24	ASTM G 8 ASTM G 95
Flexibility of material	pass	ASTM D 522-93a, 180°, 75 mm mandrel, clause 13.1.1
ECD = Equivalent circle diameter		
<sup>a</sup> Requirements for type 1C coating of other materials to be agreed between the purchaser and supplier <sup>b</sup> Calculation of ECD: $ECD = [(A \times 4) \div \pi]^{1/2}$ where A = disbonded area less the initial holiday area		

The coating repair material's properties shall be as good as or better than the original production coating material when tested.

#### TS 2.9.3.3 Requirements for coating pipe:

A coating on a pipe shall comply with the appropriate requirements for film thickness of 2000 microns and electrical insulation defects given in Table 2.9.3.3, after application and curing for at least a period and temperature specified by the manufacturer of the coating material (Refer to TS 2.9).

**Table TS2.9.3.3: Test properties of applied coating**

Property	Type 1 C Solvent-free chemically cured rigid polyurethane <sup>a</sup> coating material requirement	Test method or clause
Total dry film thickness, microns, min.	2000	SANS 2808
Adhesion, MPa, min. (pipe)	10	ASTM D 4541
Electrical discontinuity.	ND	ASTM D 5162
ND = No defects		
<sup>a</sup> Requirements for type 1C coating of other materials to be agreed between the purchaser and supplier		

If in the determination of the total dry film thickness, any reading is below the minimum value, a further series of at least 10 readings shall be taken. In both series of readings shall be less the minimum specified and it shall not in any case be less than 80% of the minimum specified. If the coating fails to comply with the relevant requirements for film thickness, a further coat may be applied over the whole surface, if approved by the client and if acceptable, and after suitable surface preparation.

#### TS 2.9.3.4 Adhesion:

Use SANS 2409: 2008 but, instead of the spacer, use a cutting jug of suitable flexible material and having 2mm spacing. Where test panels or control specimens are used for the test, prepare and coat three test panels per pipe and carry out three tests on different part of the same test panel or control specimen and calculate the mean value.

Use SANS 5776 / ASTM D4541 but use bobbin-type test pieces of diameter 25mm and operate the pull-off tester at a constant rate of extension of 1mm/min.

#### TS 2.9.3.5 Impact resistance:

Use the method describe in ASTM G14, but us a mass piece or up of mass 1.36 kg and having a hemispherical nose of diameter 16,0mm and use a 2m long guide tube of the type specified in SANS 5176.

Calculate the impact resistance of the coating as follows:

Impact resistance, J = 9,806 6 mh

Where

m = mass of the tup, kg (1.36 kg)

h = height from which the tup is dropped, m

**TS 2.9.3.6 Inspection and adhesion test:**

Examine the coating for any defects including blistering, softening, wrinkling and whitening, and test for loss of adhesion. Deem an adhesion test result below 10, as per Table 2.9.3.6 above, to be a defect. Note and report blistering (if any) in accordance with ASTM D714. Where the size of blisters exceeds those represented by blister size No. 2, record the average blister diameter in millimeter and the frequency of blisters as in ASTM D714.

**TS 2.9.3.7 Surface Preparation:**

Each steel special shall be thoroughly cleaned and freed from all mill scale, foreign matter or rust especially along the weld and shall be approved by the Inspector immediately before coating. The exterior and interior of the special shall be cleaned by steel shot blasting and will not be accepted unless the operation provides a roughened surface equivalent to SA 2½ as table below.

**Table 2.9.3.7: Preparation**

ISO	8501-1	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO	8501-2	Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness -- Part 2: Preparation grades of previously coated steel substrates after localized removal of previous coatings
ISO	8501-3	Preparation grades of welds, edges and other areas with surface imperfections

**TS 2.9.3.8 Generally:**

Details of the material, primer and methods to be used to heat and mix the material and steps to be taken to maintain a uniform and consistent material shall be stated in the Relevant Schedule. The coating shall be evenly applied and shall be tough, smooth, glossy and free from ripples or runs; Care shall be taken to ensure that there are no air gaps between the coating and the pipe at welds and in particular where the stiffener is attached to the pipe wall. If necessary, an approved polyurethane based mastic filler shall be smoothed over the welds before the polyurethane coating is applied.

**TS 2.9.4 Epoxy Internal Lining**

**TS 2.9.4.1 Material:**

The internal protective lining for the pipeline shall comprise of a type 1B solvent-free chemically cured epoxy material that complies with the requirements of the draft South African Standard 1217 ED2 Guidelines for internal and external organic coating protection for buried steel pipelines. The coherent lining shall

be bonded to the inside surface of each pipe in order to prevent corrosion of the inner steel pipe surface, and to provide low hydraulic wall friction.

The internal protective lining for the pipeline shall comply with all the requirements for external coating that are also relevant and applicable to internal lining except where they are amended in the following clauses.

The lining material shall meet all the physical and performance requirements shown in Table 2.9.4.1.

The Tenderer must supply the brand of the epoxy internal lining, the analysis of the internal lining and the mix ratio of the manufacture, if applicable, to the Engineer. The results of the control standards for the epoxy internal lining from the manufacturer need to be presented to the Engineer.

Full details of the protective lining including the precautions proposed to ensure an adequate bond with the steel and the prevention of cracking and flaking of the coating shall be submitted with the tender in the relevant returnable schedule

If, during the course of the contract, any material deteriorates or fails to conform to the specification, all such material shall be rejected.

**Table TS10.4.1: Physical and performance requirements of lining material**

Property	Type 1 B Solvent-free chemically cured epoxy lining material requirement	Test method or clause
Adhesion, MPa, min. (laboratory)	10	ASTM D 4541 (tester type III, IV, or V)
Impact resistance, J, min.	4	ASTM G 14
Water absorption, g/m <sup>2</sup> , max	10	Draft SANS 1217 ED2
Dielectric strength, kV/mm thickness, min.	105	ASTM D 149-97a, draft SANS 1217 ED2
Resistance to abrasion, g, max.	0,180	ASTM D 4060, CS 17, 1kg, 1000 cycles
Cathodic disbonding, disbonded area, mm ECD <sup>b</sup> , max. 28 d test period at 23°C 90 d test period at 23°C	25 35	ASTM G 8 ASTM G 95
Flexibility of material	pass	ASTM D 522-93a, 180°, 75 mm mandrel
ECD = Equivalent circle diameter		
<sup>a</sup> Requirements for type 1C coating of other materials to be agreed between the purchaser and supplier <sup>b</sup> Calculation of ECD: $ECD = [(A \times 4) \div \pi]^{1/2}$ , where A = disbonded area less the initial holiday area		

#### TS 2.9.4.2 Surface Preparation:

Each steel special shall be thoroughly cleaned and freed from all mill scale, foreign matter or rust especially along the weld and shall be approved by the Inspector immediately before coating. The exterior and interior of the special shall be cleaned by steel shot blasting and will not be accepted unless the operation provides a roughened surface equivalent to SA 2½ as table below. The surface profile amplitude shall have an average which does not exceed 100 microns and no individual reading shall exceed 150 microns.

**Table 2.9.4.2: Preparation**

ISO	8501-1	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO	8501-2	Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness -- Part 2: Preparation grades of previously coated steel substrates after localized removal of previous coatings
ISO	8501-3	Preparation grades of welds, edges and other areas with surface imperfections

#### TS 2.9.4.3 Application:

Within four hours after cleaning and inspection in accordance with TS10 the internal surface shall be coated with hot applied, solvent-free two component epoxy coating applied by a machine designed for the hot application of such material, in accordance with the manufacturer's specification. The machine shall be equipped to heat the two components to the temperature recommended by the epoxy manufacturer and control the temperature thermostatically within 5°C or better and to meter the components to the mixing head accurately in the prescribed proportions. The components shall be completely mixed and sprayed on to the surface by airless spray. The design shall be such as to prevent gelation of the material in the equipment. The dry film thickness shall have an average of not less than 600 microns and the minimum thickness at any point shall be 600 microns. Particular care shall be taken to coat weld seams and edges adequately.

#### TS 2.9.4.4 Internal Lining Requirements and Testing:

Once the pipe internal lining has reached sufficient cure (elapsed time and temperature) according to the lining materials manufacturer, the lining shall be inspected and the following tests carried out to check that its properties comply with the requirements given in Table 2.9.4.4. Lining material shall comply with the appropriate requirements given in Table 1 of SANS 1217 (presented below as Table and the will be done at the request of the client's QCP and this test shall be deemed to be included in your price.



**Table TS2.9.4.4: Test properties of applied lining**

Property	Type 1 B Solvent-free chemically cured epoxy lining material requirement	Test method or clause
Total dry film thickness, microns, min.	600	SANS 2808
Adhesion, MPa, min. (pipe)	10	ASTM D 4541
Electrical discontinuity.	ND	ASTM D 5162
ND = No defects		

**TS 2.9.5 Cement Mortar Internal Lining**

The internal surface to be lined shall be free from objects that can adversely affect the lining or impair its application. Loose rust, loose mill scale, dirt, debris, oil, grease, paint and other material that may have originated from an external coating process, scattered weld beads as well as blasting residues and/or chemical cleaning process residues shall be removed. However, the presence of a light adhesive rust layer does not impair the performance of a cement mortar lining and may be left.

The mortar shall be a homogeneous mixture of cement, sand and water of a suitable consistency for producing a uniform lining on the internal surface of the tubes and fittings. The mortar shall be free from foreign bodies, in particular lumps of hardened mortar.

In the case of drinking water transportation lines, the organic impurities content shall not exceed the amount equivalent to 0.1 g KMnO<sub>4</sub> / kg sand when determined as an extract in de-ionized water and to 0.3 g KMnO<sub>4</sub> / kg sand when determined as an extract in 0.1 mol NaOH.

**TS 2.9.5.1 Materials for mortar lining****TS 2.9.5.1.1 CEMENT:**

The cement shall comply with SANS 50197-1:2000/EN 197-1:2000. The following general provisions shall apply:

- Cement shall be Portland Cement (Cem I). Early strength class N or R or a combination of these classes may be used.
- Pozzolanic material, fly ash, or silica fume, shall not be used in addition to or to replace a portion of the cement.
- Cement used for the trial mortar mix to be specified by the Tenderer in Annexure 3 of the commercial tender document and all cement used for this contract shall be procured from the same factory unless otherwise permitted by the Engineer in writing. The name of the factory shall be stated by the Tenderer in Annexure 3 of the commercial tender document.
- Cement shall be delivered to the site in a dry condition undamaged by exposure to the weather.

- e) Cement shall be stored on the site in approved weather and damp-proof conditions.
- f) All cement spilled from broken pockets on working surfaces or storage floors shall not be used on the work. It shall be swept up each day and removed from the work together with all broken pockets of cement.

#### TS 2.9.5.1.2 SAND:

Sand for cement mortar shall be river sand, natural pit sand, crusher sand or a blend of the sands provided it is clean and the grains are inert, hard, durable and uncoated. The supplier and type of sand and its typical grading envelope shall be stated by the Tenderer in the schedules.

Sand shall be well graded and a sieve analysis of a representative sample carried out in accordance with SANS 3001-AG1:2009 shall show that it complies with the following grading requirements (Table 2.9.5.1.2):

**Table 2.9.5.1.2: Grading requirement for cement mortar sand.**

Sieve size (mm)	Percentage passing by mass
1,000	100%
0,075	1 to 10%

Deleterious substances	Percentage by mass
Shale	1%
Clay lumps	1%
Mica and other deleterious substances	2%
Sum of all deleterious substances	3%

Sand shall be free from injurious amounts of dust, clay lumps, shale, soft or flaky particles, mica, loam, oil, alkali, and other deleterious substances. The maximum percentage by mass of deleterious substances shall not exceed the following limits:

The following general provisions shall apply:

- a) The water demand of the sand is defined as the quantity of water in litres required to make one cubic metre of a mortar which having a sand to cement ratio by mass of 1,0 has a consistency of 8.5 mm DB penetration when tested in accordance with BS 4551 latest. The water demand of the sand shall not exceed 340 l/m<sup>3</sup>.
- b) The water demand of the sand shall be determined from at least three trial cement mortar mixes each of a different water content and shall be stated by the Tenderer.
- c) Sand tested for organic impurities in accordance with SANS 5832: 2006 shall yield a test solution not darker in colour than the reference solution.
- d) The chloride content of the sand determined by SANS Method 5831 shall not be greater than 0.01 per cent.
- e) The Contractor shall submit samples of the sand to the Engineer for his approval before use. Prior to commencing the work, the Contractor shall

submit a report in detail from an approved testing laboratory showing that the sand complies with the specification.

- f) Sand shall be stored on site on an impermeable surface, protected from the weather, and washed sand shall be allowed to drain freely for at least 24 hours before use. The Engineer may require the Contractor to test the sand daily (or more frequently if necessary) for moisture content, impurities and grading before use.

#### TS 2.9.5.1.3 WATER:

For pipes conveying drinking water, only water intended for human consumption shall be used. For other applications, water of comparable quality, having a conductivity of less than 2 000  $\mu\text{S}/\text{cm}$  and a  $\text{KMnO}_4$  consumption of less than 10 mg/l, can be used. For the determination of these parameters the European standards shall be used when available and, if not, use relevant national standards. Water for mortar shall be clean and free from injurious amounts of dissolved mineral salts, organic matter or other substances which may impair the strength or durability of the mortar.

#### TS 2.9.5.1.4 ADMIXTURES:

An admixture is any other material apart from cement, sand and water, which is added to the cement mortar or painted onto the bare steel surface prior to cement mortar application. No admixture shall be used that has a deleterious effect on the electrochemical passivation of the steel surfaces by the cement mortar or on the potable water flowing in the pipe after the lining has been placed. In addition, no admixture shall be used that impairs the durability, fatigue strength or ability of the mortar to resist impact loadings. Prior written approval of the Engineer shall be obtained for the use of any admixture and the Contractor shall submit test data to substantiate the admixture performance.

#### TS 2.9.5.2 Sampling and testing

The testing laboratories of the SABS, CSIR, SAIW, PCI, or other laboratories subject to the prior approval in writing of the Engineer, will be accepted as approved laboratories in which tests or designs required by the specification may be carried out.

#### TS 2.9.5.3 Cement slurry

Cement slurry for use with the hand application of mortar to large areas greater than two square metres in extent or with the repair of lining defects shall consist of cement, water and admixture. A suitable admixture is a styrene-butadiene copolymer latex (SBR) manufactured for use with Ordinary Portland Cement as a bonding agent. The proportions of cement, water and admixture shall be in accordance with the manufacturer's directions.

#### TS 2.9.5.4 Cement Mortar Requirements

##### COMPOSITION:

Cement mortar for steel pipe lining shall be composed of cement, sand, water, and if required, admixture, that is well mixed and of proper consistency to obtain a dense, homogeneous coating of the required thickness that will adhere firmly to the pipe surface.

## PROPORTIONS:

The mortar mix shall be designed to produce mortar which will attain the specified compressive and flexural strengths and which will in addition have high density and impermeability. Cement mortar shall have a minimum cement to water ratio by mass of 2.8 and a minimum sand to cement ratio by mass of 1.0.

The workability of the mortar shall be the consistence measured by the dropping ball penetration test carried out in accordance with BS 4551-1:1998.

The proportions of cement, sand and water shall be based upon laboratory tests made with the cement, sand and water to be used on the work. These proportions together with the design workability shall be stated by the Tenderer in the relevant Returnable Schedule. The exact proportions of the constituents shall be determined by the characteristics of the sand used, the condition of the cleaned pipe surface, the thickness of the lining, the size of pipe and the lining equipment used.

Two mortar mixes shall be designed: one suitable for machine application and one suitable for hand application where machine application is impracticable. Guide workability levels for designing these mixes are a nine mm penetration and a six mm penetration respectively.

The Contractor shall timeously submit a report in detail of the proposed cement mortar mix designs to the Engineer for his approval before the work begins. This report, from an approved testing laboratory, shall show that the mixes comply with the specification and shall give for each design mix for at least three different water contents, one of which corresponds to the design workability level stated in the relevant Returnable Schedule, the 7-day and 28-day mortar prism compressive and flexural strengths and consistence obtained when using the materials proposed for the work.

## STRENGTH:

The mortar compressive and flexural strength shall be determined from 160 mm by 40 mm by 40 mm prisms stored, demoulded, cured and tested in accordance with ISO 679. High frequency (200 Hz) vibration shall be used to compact the mortar when moulding in order to expel all the air entrained when mixing. A minimum period of two minutes shall be used.

**Table 2.9.5.4: The minimum mortar strengths below which not more than five per cent of results may fail are:**

<b>Age of Cement Mortar</b>	<b>Compressive Strength (MPa)</b>	<b>Flexural Strength (MPa)</b>
7 day	45	5,5
28 day	60	6,5

At least six representative prisms shall be made by the Contractor for each day of machine lining application. Three of these prisms shall be tested at seven day's age and three at 28 day's age. The six prisms shall be made from one batch of mortar sampled whenever possible from the hopper of the lining machine.

## BATCHING, MIXING AND WORKABILITY

All mortar shall be batched and mixed under the supervision of a competent and experienced person. All materials shall be batched by mass and the combined error in weighing the materials shall not exceed two per cent. Equipment performance shall be checked when required by the Engineer and the Contractor shall provide the necessary apparatus for this testing.

- (a) All weighing and measuring equipment shall be checked daily, and if necessary adjusted, before cement mortar mixing commences.
- (b) The quantity of water used in each batch of mortar shall be carefully adjusted to maintain the cement to water ratio required for the approved mix.
- (c) Allowance must be made for the moisture content of the sand which shall be determined either by weighing and drying or by the speedy moisture meter. Allowance shall also be made for moisture collecting on the interior of pipe surfaces, the method of transporting the mortar from the mixer to the lining machine and the trowelling system used.
- (d) Mixing shall be continued for not less than 90 seconds after all the materials including water are in the mixer. All mortar shall be thoroughly mixed and the whole of each batch shall be uniform, free of lumps and free from segregation. The minimum time of 1½ minutes may be increased at the discretion of the Engineer.
- (e) Adequacy of mixing shall be judged visually and if in the Engineer's opinion mixing is unsatisfactory, the mixer shall be replaced by a machine which will produce acceptable mixing.
- (f) Any batch not complying with the specification shall be removed from site or disposed of as directed by the Engineer or Inspector.

The workability of the freshly mixed mortar shall be determined periodically from a sample taken immediately prior to being transported to the lining machine, or where practicable from a sample taken at the lining machine itself.

Once the optimum workability for the day's run is determined the consistence shall not vary by more than one mm DB penetration.

Freshly batched mortar shall be applied to the pipe and finished before the initial set has commenced. Under no circumstances shall the addition of extra water to the unplaced mortar in order to restore workability be allowed. Fresh mortar that has lost its workability due to the onset of initial set shall be removed from site or disposed of as directed by the Engineer or Inspector.

### TS 2.9.5.5 Application of the mortar lining

The cement mortar is applied to the inside of pipes and fittings in such a way that the lining has maximum compaction and a surface condition that aids the flow of water. Frozen material shall not be used and the mortar shall be applied at a temperature in excess of 5°C; so as to permit its correct curing.

After application, the lining shall be kept damp, and the temperature of the steel pipe shall not be allowed to fall below 5°C. To prevent the lining from drying too rapidly, the pipe ends shall be capped or as otherwise specified so that the lining is allowed to cure under moist/warm conditions in a draught-free closed

space. The curing period shall be sufficient to ensure that the pipes and fittings can be transported and stacked without the lining being damaged.

The Contractor shall cover exterior surfaces of pipe exposed to sunlight with a minimum of three layers of hessian which shall be sprinkled with water and kept damp in the daytime during the period of lining, finishing and curing so as to prevent cracking of the lining due to temperature effects.

Cement mortar linings are mainly applied in three ways:

- i. The spinning-method in which the pipe and mortar are spun at a high rotational speed after mortar distribution along the length of the pipe. Under the action of centrifugal force, the solid components of the mortar are compacted to form a smooth lining, and part of the original water content is driven out. The partly dewatered lining withstands the transportation of the tube to the curing site;
- ii. The spraying-head-method in which the mortar is thrown at the wall of the pipe or fitting, mostly through the centrifugal force exerted by a rotating spinner head. In this method the original water content of the mortar remains virtually unchanged in the process of application. Some additional smoothing of the mortar layer surface can be carried out by:
  - a. Rotation of the pipe by spinning;
  - b. Mechanical rotary trowels or drag trowel cones.
- iii. The manual-method in which the mortar is trowelled onto the steel surface by hand. This is normally done in order to repair defects in a lining and often in order to line fittings.

#### TS 2.9.5.6 Machine application of mortar lining

The lining shall be applied in one layer by use of a machine with an applicator head which will centrifugally or otherwise place mortar against the surface of the pipe without injurious rebound and with sufficient velocity or pressure to cause the mortar to be densely packed and to adhere in place. Details of the machine to be used shall be submitted in Annexure 3 of the commercial tender document. The use of compressed air in direct contact with the cement mortar will not be permitted in the process of mixing or application. The rate of travel of the machine and the rate of discharge of mortar against the wall of the pipe shall be entirely mechanically controlled so as to produce a smooth lining of uniform thickness throughout the interior of the pipeline. The lining machine shall be provided with attachments for mechanically trowelling the mortar. Both the application and trowelling of the mortar shall take place at the rear of the machine so that the freshly placed and trowelled mortar will not again be disturbed or touched until after it has set. The trowel attachment shall be such that the pressure applied to the lining will be uniform, producing a smooth surface without shoulders or undulations, and producing a lining of uniform thickness. Rand Water preferably requires that a rotary type trowel should be used for larger diameter pipes.

#### TS 2.9.5.7 Thickness and surface finish of the lining

The mean thickness of the lining shall range between 10mm and 12mm. The maximum unbiased standard deviation of thickness measurements made in accordance with the relevant section of this specification shall be less than 3.5 mm.



The lining surface finish shall be free from an excessive number of defects and when tested in accordance with clause TS 2.9.5.9 shall have a minimum pass rate of 50 per cent.

**Table 2.9.5.7: Minimum lining thickness and tolerance Preparation**

<b>Nominal Pipe Sizes (mm)</b>	<b>Thickness (mm)</b>	<b>Tolerances (mm)</b>
300-600	10	3.5
600-800	12	3.5

#### TS 2.9.5.8 Curing

Curing operations shall begin immediately following completion of machine mortar lining of a pipe or the hand mortar lining of a bend, branch, taper, or special. The lined pipe ends shall be sealed off with airtight covers and the lining shall be maintained in a surface wet condition until the lining is coated with an approved curing agent.

The air tight covers or seals shall comprise a timber, hardboard or sheet steel backing securely wired to the pipe or fitting and covered with an un-punctured sheet of plastic material secured with wire ties or polypropylene strapping.

As soon as the lining has been inspected, any defects repaired, and the lining approved a water based epoxy resin emulsion curing agent which is not harmful to human consumption (ref SANS 241) is to be applied in accordance with the manufacturer's specifications. The curing agent is to be approved by the Engineer and is sprayed or brushed onto the lining not later than two days after lining application.

The Contractor shall inspect each section that is undergoing curing twice a day to ensure it has adequate curing moisture and that all seals are in place. When necessary water shall be spray applied to maintain a surface wet lining and any seal found damaged shall be replaced.

#### TS 2.9.5.9 Inspection and testing of the lining

##### Appearance and composition of the lining

The appearance of the lining is inspected visually and shall comply with the following:

- a) Mortar lining shall be uniformly smooth and free from cavities and any visible foreign bodies, though a few isolated particles of sand protruding from the surface are acceptable;
- b) Unless otherwise specified at the time of the enquiry and/or order isolated cracks with widths smaller than 1.6mm are acceptable for drinking water application, provided that they are not deleterious to the stability of the lining;
- c) For water of an aggressive nature (e.g. waste water, saltwater), the crack width shall be limited to 0.5 mm;
- d) Should the cracks be larger, then pre-treatment with drinking water could be used until the maximum crack width has been reduced to 0.5 mm for water of an aggressive nature and 1.6 mm for drinking water. When pre-treatment with drinking water is not suitable, the cracks shall be repaired;

- e) Smoothing of defective areas of limited size is permitted. This may be carried out manually within 24 hours of application of the lining with a mortar compatible with the original mortar and if necessary containing a permitted additive;
- f) NOTE Experience shows that isolated cracks generally close up on contact of the lining with drinking water through the swelling of the mortar and/or autogenous healing. However, the self-healing capability of the cement mortar decreases when stored for long periods in moist atmospheric conditions.

The Contractor shall inspect the pipes following the application of cement mortar lining to identify defective areas in the lining, to determine the quality of the lining and to determine compliance with the specifications.

Documentation of the inspection and testing of cement mortar lining and mortar prisms shall be submitted to the Engineer regularly in terms of the quality control plan specified in the relevant section of this specification.

#### TS 2.9.5.10 Inspection of completed mortar lining

As soon as the lining has hardened to the stage that it will not be damaged by workmen, or their means of transport in the pipe, the lined surfaces shall be inspected for surface finish, thickness and other defects and the defective areas shall be marked for repair. The Contractor shall provide facilities for lighting and inspection as required by the Inspector.

In each pipe that has been lined, measurement stations will be marked out one metre away from the pipe ends and in the middle of the pipe for man-entry size pipes. The lining at each measurement station will be checked for thickness at eight points on the pipe circumference, 45 degrees apart starting at the crown of the pipe.

The lining thickness will be determined with a hand held eddy-current thickness gauge that has been calibrated against known thicknesses of mortar. The thickness gauge will also be used to locate and mark areas of lining between measurement stations that are too thin or too thick.

The lining surface finish will be measured using a 305 mm long straight edge and a 1.6 mm feeler gauge. At each measurement station the gaps between the lining and a straight edge laid parallel to the pipe axis at opposite ends of the pipe diameter, shall be checked to see if they are greater than 1.6 mm. Any one or more gaps bigger than 1.6 mm will result in a failure being recorded for that straight edge location. The ends of only one pipe diameter at each measurement station shall be checked for surface finish and this diameter shall change in a clockwise rotation of 45 degrees to the adjacent diameter at the next measurement station. The surface finish pass rate for a pipe section is the number of straight edge locations measured less the number of failures, expressed as a percentage of the measured locations.

The Contractor shall not be allowed to proceed with lining application until the Inspector has received, verified and agreed in writing the previous day's record of lining thickness, surface finish and identification of lining defects to be repaired.

#### TS 2.9.5.11 Lining defects

Defects in cement mortar lining which may include but are not limited to sand pockets or porous spots, voids, blisters, tears, gaps, excessively cracked areas, excessively debonded areas, areas of lining thinner or thicker than specified, unsatisfactory surface finish and mortar that does not meet the strength requirements specified, shall be repaired by the Contractor notwithstanding that the lined area may previously have been inspected and passed by the Inspector. This may involve the removal of large sections of lining, re-cleaning of the pipe surface and re-lining of the pipe, the costs of which shall be borne by the Contractor.

Small defective areas shall be repaired by manual removal of the defective lining and by hand application of mortar lining. In removing the defective lining, the mortar shall be cut back to a square shoulder and no chamfered joints will be permitted. Defective areas encompassing the full circumference of the pipe shall be replaced by machine application. Only small defective areas that are too thin and less than two square metres in extent may be thickened up by hand in accordance with this specification, in which case feather edge joints will be permitted.

Cracks bigger than 1.6 mm shall be repaired as required by the Engineer or Inspector. This may include the brushing and wiping of cement slurry into the cracks or autogenous healing assisted by additional moist curing or a combination of both.

Defective lining removed from the pipeline, waste cement mortar from trial mixes, cleaning of pump hoses and equipment, and any other debris from the lining operations, shall be collected and temporarily deposited in a suitable heap or container and shall not litter the site. It shall be transported off site and disposed.

#### TS 2.9.5.12 Repairs

Pipes with defects as well as those which have been subjected to destructive control tests shall be repaired where instructed by the Engineer at the cost of the contractor. The repair procedure must be submitted by the Contractor to the Engineer for approval prior to commencing repairs.

#### TS 2.9.5.13 Data for coatings and linings

Full data (as per the schedules and data sheets) must be provided at tender stage for all coating and linings proposed. The data sheets / schedules must be complete in all regards, and where necessary, additional technical data shall be provided by the tenderer in support of the proposed coating or lining product.

### TS 2.9.6 Polyethylene External Coating

#### TS 2.9.6.1 General

The relevant coating systems for polyethylene are:

- a) System A1: Coating consisting of an adhesive and a polyethylene outer sheath.
- b) System A2: Coating consisting of an adhesive and a polyethylene outer sheath that has more stringent peel adhesion requirements than those for System A1.

- c) System B1: Coating consisting of a liquid or powdered epoxy primer, a polymeric adhesive and a polyethylene outer sheath
- d) System B2: Coating consisting of a powdered epoxy primer, a powdered copolymer adhesive and a powdered polyethylene outer layer.

#### TS 2.9.6.2 Surface Preparation

The external surface of the pipe shall be free from oil and grease or any other contaminants prior to the application of the coating. Moisture shall be removed by preheating the pipe before any blast cleaning and coating. The surface temperature of the pipe shall be maintained at 3°C above the dew point, but less than 150°C during any blast cleaning and inspection.

Blast cleaning shall be performed to the following requirements:

1. For Systems A1 and A2: Sa2 according to the ISO mentioned below
2. For Systems B1 and B2: Sa2½ according to the ISO mentioned below

**Table 2.9.6.2: Preparation**

ISO	8501-1	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO	8501-2	Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness -- Part 2: Preparation grades of previously coated steel substrates after localized removal of previous coatings
ISO	8501-3	Preparation grades of welds, edges and other areas with surface imperfections

The surface profile from peak to trough shall be 40 to 110 µm inclusive and be according to the raw materials manufacturer recommendations, where applicable. Residual blast products are to be removed from the pipe surface.

#### TS 2.9.6.3 Material:

Materials used shall be certified by the manufacturer to be in accordance with CSAZ245.21-02. The materials used shall be identified with the manufacturer's name, product description, batch number, location of manufacturer and date of manufacturing. Storage and handling must be in accordance to the manufacturer's recommendation.

##### TS 2.9.6.3.1 Primer

The liquid epoxy primer shall have properties as specified in Table 4 of CSAZ245.21-02 (Table 2.9.6.3.1 below).

**Table 2.9.6.3.1: Liquid Epoxy Primer Requirements**

Test	Unit	Acceptance Criteria	Test method in CSAZ245.21-02
Base resin density	g/mL	Within 0.05 of manufacturer's specified nominal	ASTM D 1475
Curing agent density	g/mL	Within 0.05 of manufacturer's specified nominal	ASTM D 1475
Base resin viscosity	mPa.s	Within 15% of manufacturer's specified nominal	ASTM D 2196
Curing agent viscosity	mPa.s	Within 15% of manufacturer's specified nominal	ASTM D 2196
Epoxy equivalent weight	WPE	Within 10% of manufacturer's specified nominal	ASTM D 1652
Total amine value	mg KOH/g	Within 15% of manufacturer's specified nominal	ASTM D 2083
Gel time (mixed components)	s	Within 20% of manufacturer's specified nominal	CSAZ245.20-02; Clause 12.2

**TS 2.9.6.3.2 Adhesive**

The properties of the adhesive shall be given as in Table 2.9.6.3.2 below.

**Table 2.9.6.3.2: Adhesive Requirements**

Test	Unit	Acceptance Criteria	Test method in CSAZ245.21-02
<b>Systems A1 and A2</b>			
Viscosity	mPa.s	Within 30% of manufacturer's specified nominal	Clause 12.1
Flow test at maximum design temperature	mm	No greater than 20% more than the manufacturer's specified nominal	Clause 12.2
Ring and ball softening point	°C	At least 20°C above maximum design temperature	ASTM E 28
Water absorption	wt%	0.1 maximum	ASTM D 570
<b>Systems B1 and B2</b>			
Flow rate	g/10 min	Within 20% of manufacturer's specified nominal	ASTM D 1238
Density	g/cm <sup>3</sup>	Within 1% of manufacturer's specified nominal	ASTM D792/1505
Vicat softening point*	°C	At least 10°C above maximum design temperature	ASTM D 1525
Brittleness temperature*	°C	-50°C or lower (System B1 for F <sub>20</sub> , system B2 for F <sub>40</sub> )	ASTM D 746
* This test required once every 12 months			

### TS 2.9.6.3.3 Polyethylene

The properties of the virgin polyethylene resin shall be given as in Table 2.9.6.3.3 below. Test plates must be prepared in accordance to ASTM D 4703 and conditioned in accordance to ASTM D 618.

**Table 2.9.6.3.3: Adhesive Requirements**

Test	Unit	Acceptance Criteria			Test Method in CSAZ245.21 -02
		Low Density (LD) Linear Low Density (LLD)	Medium Density (MD)	High Density (HD)	
Density	g/cm <sup>3</sup>	< 0.925	0.925 – 0.940	> 0.940	ASTM D792 or ASTM D 1505
Elongation at break	%	600 minimum	600 minimum	600 minimum	ASTM D 638 Type IV sample; crosshead speed 50 mm/min
Flow rate *	g/10 min	LD: 0.15 – 0.6 LLD: 0.5 – 2.0	0.1 – 1.0	0.15 – 0.80	ASTM D 1238 190°C/2. 16kg
Hardness	Shore D	45 minimum	50 minimum	60 minimum	ASTM D 2240
Heat aging **	MPa, %	At least 60% of original tensile stress at yield; minimum elongation of 150%			Clause 12.6
Tensile stress at yield	MPa	9.7 minimum	12.4 minimum	18.5 minimum	ASTM D 638 Type IV sample; crosshead speed 50 mm/min
Oxidative-induction time in oxygen at 220°C, aluminum pan, no screen	Minute	10 minimum	10 minimum	10 minimum	ASTM D 3895
Brittleness temperature **	°C	-70 or lower (for F <sub>20</sub> )	-70 or lower (for F <sub>20</sub> )	-70 or lower (for F <sub>20</sub> )	ASTM D 746
Environmental stress cracking resistance condition **	h	300 minimum (for F50) Condition "C"	300 minimum (for F50) Condition "C"	300 minimum (for F50) Condition "B"	ASTM D 1693 100% Igepal
Vicat softening point **	°C	90 minimum	110 minimum	120 minimum	ASTM D 1525
*The acceptance criteria are not applicable for System B2. The acceptance criteria for System B2 shall be within 20% of the manufacturer's specified nominal.					
**This test is required at least once every 12 months.					



#### TS 2.9.6.4 Application:

##### TS 2.9.6.4.1 Application of Primer, Adhesive and Polyethylene

The selected primer, adhesive and polyethylene shall be applied according to the manufacturer's recommendations. The minimum thickness of primer shall be 120 microns for the respective pipe outer diameter and coating systems B1 and B2. The minimum thickness of the adhesive shall be 150 microns for systems A1 and A2 for pipe outer diameters less than 275 mm and 200 microns for pipe outer diameters exceeding 275 mm. The minimum thickness of the adhesive for systems B1 and B2 shall be 100 microns for all pipe outer diameters. These requirements are as given by Table 6 in CSAZ245.21-02.

The thickness requirements of the polyethylene layer are given in Table 2.9.6.4.1 below. Application of polyethylene shall be performed immediately following the application of the adhesive.

**Table 2.9.6.4.1: Polyethylene Thickness Requirements**

Specified pipe OD, mm	Polyethylene Thickness, mm		
Systems A1 and A2			
< 75	0.55		
75 – 115	0.60		
>115 – 170	0.70		
>170 – 275	0.85		
>275	1.05		
System B1	LD or LLD	MD	HD
< 100	1.80	1.00	0.85
100 – 250	2.00	1.15	1.00
>250 – 500	2.20	1.15	1.00
>500 – 800	2.50	1.15	1.00
>800	3.00	1.15	1.00
System B2 (All pipe ODs)	0.45	0.45	0.45

The coating application shall be a continuous process in order to give an outer sheath free of pinholes, cracks and other visible defects. The polyethylene may undergo shrinkage or growth following cutback due to temperature changes (cutback length of 50mm is specified, measured from the pipe end).

##### TS 2.9.6.5 Coating Qualification Tests

The applicator shall provide the certificates of compliance, stating that the coating has been manufactured, applied, inspected and tested in accordance with the CSAZ245.21-02 standard. The coating tests results shall be included and submitted to the Engineer.

The coating qualification requirements are given in Table 2.9.6.5 below. Test rings shall be prepared in accordance to section 7.4.3 of CSAZ245.21 for the tests to be performed.

**Table 2.9.6.5: Coating Qualification Test Requirements**

Test	Acceptance Criteria	Test Method
28 d cathodic disbondment at 20°C	12 mm maximum radius	Clause 12.3 of CSAZ245.21
28 d cathodic disbondment at maximum design temperature	Purchaser's specification	Clause 12.3 of CSAZ245.21
Impact resistance	A minimum of 3.0 J/mm of actual total coating thickness	CSAZ245.20 Clause 12.12, except that for each $\mu\text{m}$ of thickness, the voltage setting for the dc holiday detector (see Clause 12.12.3.3) shall be 10V/ $\mu\text{m}$ of thickness, up to a maximum of 15000V
Flexibility	No cracking of polyethylene	CSAZ245.20, Clause 12.11; bend of 2.5°
Peel Adhesion* System A1 System A2 System B1	3.0 N minimum 19.6 N minimum 150.0 N minimum	Clause 12.4 or 12.5
28 d adhesion** System B2	Rating 1 – 3	CSAZ245.20, Clause 12.14; 28 d at 75°C
*Not suitable for system B2. **Applicable for system B2 only.		

**TS 2.9.6.6 Coating Repairs**

Coated pipe shall be repaired by patching or by stripping and re-coating in accordance with clause 8 in CSAZ245.21. All repairs shall be inspected for holidays in accordance to Clause 7.4.2 in CSAZ245.21.

**TS 2.10 EXTENT OF COATING**

The extent of the coatings shall be as indicated as per provided Rand Water Drawing. The coatings shall be cut back cleanly from the ends of the pipe. The Engineer reserves the right to modify the extent of the coating if required.

**TS 2.11 WELDING INTO DOUBLE LENGTHS**

TS 2.11.1 Where required two pipes shall be welded into a double length by setting and lining up the pipes on rollers and jointing the pipe by butt-welding. The welding shall comply with Clause TS 2.6 and the completed weld shall be tested over its full length in accordance with Clauses TS 2.6 and TS 2.7.2.

TS 2.11.2 When the jointing weld has been accepted by the Inspector the internal and external coatings shall be made good after cleaning off all slag, weld spatter and damaged coating material.

## **TS 2.12      COMPLETING COATINGS/LININGS AT DOUBLE LENGTH JOINT**

### **TS 2.12.1      Bitumen coating:**

After welding and the necessary examination have been carried out, the surface of the pipe to be made good shall be wire brushed, using mechanically operated tools, to remove loose rust and slag from the weld. The surface shall then be treated with an approved compatible primer and when this has dried successive layers of hot bitumen shall be ironed into place until a finished average thickness of 5 mm has been attained on the external surfaces. Each layer of bitumen applied to the external surface shall be reinforced with a Type I glass fibre mat. All air bubbles shall be excluded.

### **TS 2.12.2      Epoxy lining:**

Following the completion of welding the weld area shall be prepared in accordance with TS 2.9.4.2 and the surface of the previously coated area shall be cleaned and abraded and specially prepared over coating material applied in accordance with the coating manufacturer's specification.

### **TS 2.12.3      Cement Mortar:**

Following the completion of welding the weld area shall be prepared in accordance with TS 2.9.3.7 and the surface of the previously coated area shall be cleaned and abraded and specially prepared over coating material applied in accordance with the coating manufacturer's specification.

### **TS 2.12.4      Polyurethane:**

Following the completion of welding the weld area shall be prepared in accordance with TS 2.9.3.7 and the surface of the previously coated area shall be cleaned and abraded and specially prepared over coating material applied in accordance with the coating manufacturer's specification.

## **TS 2.13      EXAMINATION OF COMPLETED COATINGS AND LININGS**

**TS 2.13.1**      After the application of the either the bitumen or polyurethane coating and epoxy lining each pipe shall be examined by the Contractor in the presence of the Engineer's Representative both visually and by means of a thickness meter and a Holiday detector of the correct type and rating for the particular coating system. Insufficient coating thickness and holidays revealed shall be marked with chalk and repaired to the satisfaction of the Engineer. The Tenderer shall state in Returnable Schedule what equipment will be available to carry out the relevant testing.

**TS 2.13.2**      Visual and manual inspection: All coated pipe shall be visually inspected. The coating shall be generally smooth and free of sharp protrusions. A minor amount of sags, dimpling, scuffing, and curtaining that does not exceed 10 per cent of the surface shall not be considered cause for rejection. The coating shall have no blisters, cracks, bubbles, de-lamination, or any other visible defects.

There shall be no wet or sticky areas in the coating. All defects shall be identified and repaired.

## **TS 2.14 LIME WASHING**

All bitumen coated pipes shall be lime washed externally before dispatch. Lime washing shall be durable and withstand the effects of weather for a minimum period of two months after application such that the sunlight reflecting property of the lime coating is not reduced. The materials used in lime washing and the method of application are to be approved in advance by the Engineer.

## **TS 2.15 PIPE RECORD**

The Contractor responsible for the manufacture of the pipes shall maintain a record, in a convenient form, showing the pipe serial and delivery number, pipe length, delivery date, delivery chainage, the steel cast number for the plate used in each pipe section, the date of fabrication and hydrostatic testing together with the actual test pressure and details of defects and subsequent repairs. Each record shall be signed by the Engineer's Representative and be available for reference by the Engineer's Representative during all working hours and shall be kept for at least 24 months after the completion of all the pipes manufactured under the contract.

## **TS 2.16 MARKING**

TS 2.16.1 The Contractor shall ascertain the category of steel plate from which the pipe is fabricated from the internal stamped identifying marks. The following information, the lettering and figures of which shall not be less than 100 mm high, shall be stencilled in black paint on the outside of all pipes and on the inside of the with solvent free paint approved for potable water at each alternating half circumference point on both ends of the pipe:

RAND WATER  
CONTRACT NUMBER  
PIPE NUMBER  
Grade of steel plate  
OD in mm  
Wall thickness in mm  
Length of pipe in m  
Mass of pipe in kg  
Delivery schedule reference number

Pipe diameter and wall thickness shall be marked as shown on provided Rand Water Drawings. Use the 300 WA colour coding for S355JR

## **TS 2.17 DELIVERY OF COMPLETED PIPES**

TS 2.17.1 The pipes shall be delivered to the destinations described in Project Specification. The Contractor shall make all arrangements for transporting the pipes to the site. The prices for pipes and specials shall include for the transport from the place of manufacture to the site.

TS 2.17.2 The Contractor will be required to deliver pipes and specials as and when directed by the Engineer.

TS 2.17.3 Unloading of the pipes will be arranged by the Contractor.

## **TS 2.18      STORAGE OF PIPE AT PLACE OF MANUFACTURE OR CONTRACTORS SITE**

- TS 2.18.1      All pipes that have been coated shall be stored at the place of coating until they can be accepted at the pipeline laydown area. The pipe shall be placed on approved supports in a demarcated area, which has been cleared of all vegetation and treated with an effective weed killer. The support shall be arranged so that the bearing area is adequate to prevent damage to the external coating.
- TS 2.18.2      Each bitumen-coated (if applicable) pipe shall be coated with lime wash to reduce the effect of solar heat on the coatings for the duration of the storage period. Each pipe end shall be enclosed with a white polyethylene sheet cover secured to the pipe by a metal strap. The cover shall be perforated to allow the flow of a small quantity of air through the pipe.
- TS 2.18.3      During inclement weather or for any other reason that may prevent acceptance of pipe deliveries at the site the Engineer may instruct that pipes be stored at the place of coating. Should it become necessary to store more than 1000 m of pipe the additional stored length will be paid for at the rate inserted by the Tenderer in the Price Schedule. Payment in terms of this clause will only be made for pipe that is ready for delivery and is accepted as such by Rand Water. Payment will not be made for pipe manufactured in advance of the agreed programme of work.
- TS 2.18.4      The pipes will be inspected prior to despatch and any defects arising from storage shall be made good before delivery is made.

## **TS 2.19      PROTECTION OF PIPES DURING TRANSPORTING**

- TS 2.19.1      The coated and lined pipes at all stages during transport to the site of delivery shall be protected against damage. The pipe shall be lifted by means of broad band slings and the use of chains, wire ropes, etc. will not be permitted. Chock blocks, at least 150 mm wide, suitably padded for the pipes to rest on, shall be provided on each transport vehicle.
- The Tenderer shall consider that the ends of the pipe require special protection both internally and externally (i.e. red oxide, weldable primer); their proposals of chosen alternative in this connection shall be stated at the time of tendering and specified in relevant returnable schedule. The cost of such protection shall be included in the tendered rates and this shall also be included in the Quality Control Plan for approval.
- TS 2.19.2      End covers are to be fastened to the pipes in such a manner as to prevent them from becoming dislodged during transportation.

## **TS 2.20      REPAIR OF DAMAGED PIPE SHELLS AND COATED PIPES**

The Contractor shall repair at his own cost and expense all damage to a pipe and/or its internal and external coating that may occur up to the time of delivery of the pipe to its delivery point.

## **TS 2.21      INTERNAL BRACING OF STEEL PIPES**

All pipes to be supplied with temporary internal bracing to prevent damage to the pipes during transportation and handling. Delivered pipes to maintain shape

of pipe ends to be within American Water Works Association (AWWA) C200 requirements for field jointing.

## **TS 2.22 CUT AND TIE INTO EXISTING RAND WATER PIPELINES**

Proposed shutdown requirements for connection to existing Rand Water pipelines

The Contractor shall ensure that all relevant work, as agreed with the Engineer, have been completed and signed off, before the existing pipelines are to be shut down and drained for tie in procedures.

Once the pipeline has been drained, the Contractor will be allowed to commence with the tie-in procedure which should be completed within period of eight (8) hours. Work included within shut-down period includes (but not limited to) cutting into existing pipeline and making good, welding of wide collar plate and closing of the new gate valve.

## **TS 2.23 JACKED PIPES AND CULVERTS**

Where the pipeline crosses roads in a jacked concrete sleeve pipe or an existing culvert under the road the Contractor shall install the pipes in the concrete sleeve pipe or culvert and make closures to connect into the pipes laid on either side.

Where the pipeline crosses the roads listed in the Scope of Work by means of jacked concrete pipes, the Contractor shall lay the steel pipes through the concrete pipes. The Contractor shall then brick up the ends upon completion of pipe laying and inject grout into the annulus between the steel pipe and the interior wall of the concrete pipe.

## **TS 2.24 CHANGE OF DIRECTION OF PIPELINE**

TS 2.24.1 Every pipeline change of direction shall be made by segmental cut or pipe bends as per Drawing No. RA 26732. The Contractor will be required to fabricate the change of direction of the pipe for bends 0° - 15° on site. Change of direction 15° – 90° will be manufactured off-site. The Contractor will be required to source collect and take delivery of the bends, inspect and check them and install them according to the drawings.

TS 2.24.2 Bends of 0° - 15° bends, shall be made by cutting and welding the pipe while bends of 15° – 90° shall be fabricated off-site and delivered to site.

TS 2.24.3 In every case, fabrication, testing and coating shall be carried out in accordance with TS 2.7 and TS 2.9 of the Specification and the standard of acceptance and procedure for repair shall be those stated therein.

TS 2.24.4 Items have been included in the Price Schedules for providing and installing bends. The price for a 0° - 15° bend shall include for all cutting, preparing the cut ends and welding. Where a 0° - 15° bend occurs at a joint between pipes, the cost of jointing shall be taken to be included in the item covering the bend. The price for a 15° – 90° bend shall allow for the pipe being supplied by Rand Water. For bends from 15° – 90° the Contractor shall supply and deliver the pre-manufactured bends and install them into the pipeline as shown on the drawing. Separate items have been included in the Price Schedule for making good the coatings at sets and at all segmental cuts on bends.



## **TS 2.25      SUPPLY OF VALVES**

- TS 2.25.1      All the valves required for the pipeline shall be supplied by the Contractor. The Contractor shall supply, load and transport them to the pipeline and install them in accordance with the Drawings.
- TS 2.25.2      Refer to Rand Water Valve Specifications.
- TS 2.25.3      All valves to be supplied complete with bolts, nuts and washers needed to install them in the pipeline. Rubber insertion or other gaskets approved by the Engineer shall be supplied by the Contractor.
- TS 2.25.4      No loose flanges will be supplied with the air valves since each of these items will be installed on flanges of the branches provided under TS 2.7.
- TS 2.25.5      25mm diameter plug cocks shall be supplied by the Contractor for installation by the Contractor on the pressure test points upstream and downstream of the mainline isolating valves and downstream of isolating valves on air valves from the pipeline.
- TS 2.25.6      Each 100-150mm diameter air valve will be supplied bolted to an isolating valve.
- TS 2.25.7      The Contractor shall be liable for any damage caused to the valves or plug cocks while he is loading, transporting or installing these valves or plug cocks.

## **TS 2.26      INSTALLATION OF VALVES**

Each valve shall be installed in the pipeline in accordance with applicable project drawings

### **TS 2.26.1      Isolating Valve**

One welding flange shall be welded to the downstream taper piece, which shall be laid at the chainage at which the valve is to be installed. The valve shall then be installed in its correct position on timber packing pieces on the reinforced concrete floor slab and bolted to the taper flange, using a 3mm thick rubber insertion gasket between the flanges.

The second welding flange, upstream taper-piece and the next pipe shall then be welded and laid in its correct line and level, and after fitting a 3mm thick rubber insertion or other gasket approved by the Engineer, the whole assembly shall be bolted to the upstream flange of the isolating valve.

### **TS 2.26.2      Scour Valve and By-pass Valve**

Each valve shall be installed on its flanged branch with the bolts after fitting a 3mm thick rubber insertion or other approved gasket between the flanges.

### **TS 2.26.3      Air Valve 100-200m Diameter**

A 3mm thick rubber insertion or other approved gasket shall be fitted between the flanges of the valve and its isolating sluice valve and the unit installed on its flanged branch with the bolts after fitting a second 3 mm thick rubber insertion gasket between the flanges.

### **TS 2.26.4      Plug Cock 25mm Diameter**

A plug cock shall be screwed to the boss welded to the pipeline upstream and downstream of each isolating sluice valve.

**TS 2.26.5 General**

**TS 2.26.5.1** Flanges shall be set up and installed in the pipeline with the meeting faces plumb or level according to their position in the pipeline and with the bolt holes off centre.

**TS 2.26.5.2** A 3mm rubber insertion gasket or asbestos free Clinkerrite gasket shall be supplied and fitted by the Contractor between each pair of joint flanges.

**TS 2.26.5.3** Flange bolts shall be taken up evenly all round in sequence and then shall be set using spanner approved by the Engineer. After 24 hours, the bolts shall be reset to assure that they are tight.

**TS 2.27 CLEANING OF THE PIPELINE**

The interior of the pipes shall be swept clean at the start of each working shift and more frequently if required by the Engineer. Particular care is to be taken to prevent the tramping in of sand grains. No equipment other than pipe jacks, welding conductors, cutting torches and equipment for making good internal joints shall be taken inside the pipe without the Engineer's permission.

After working hours, access into the pipeline shall be prevented by the fitting of approved end plates.

**TS 2.27.1 Disinfection of Potable Water Pipelines**

The disinfection of the entire pipeline will be monitored by Rand Water personnel. The disinfection criteria are stringent and the Contractor shall keep the pipeline clean throughout the Contract.

Once a successful hydraulic test of the entire pipeline has been achieved and the connections have been completed, the pipeline shall be drained. The pipeline shall then be re-charged in accordance with TS 2.28. Whilst being charged, a sodium hypochlorite solution shall be dosed at a temporary connection(s) made at an air valve(s), which will be confirmed by the Engineer in order to achieve a theoretical total chlorine concentration of 25ppm.

Once the entire pipeline has been filled in this manner, it shall be left for a 24-hour period. Thereafter, total chlorine concentrations shall be measured at each scour point. A concentration of 20ppm total chlorine will be considered acceptable. Should this concentration not be achieved at all scours, the Contractor shall take all steps considered necessary by the Engineer to achieve satisfactory disinfection, at his/her own cost.

Once satisfactory disinfection has been achieved, the pipeline shall be drained via the scour valves (or by other means approved by the Engineer) and sufficient sodium thiosulphate (typically 1 part of total chlorine) shall be dosed into the scour-wet wells to fully neutralise the chlorine before discharging to watercourse.

The pipeline shall then be re-charged in accordance with the stated procedure and after 24 hours, samples will be taken by Rand Water for analysis (at no cost to the Contractor). Should the following limits not be achieved, the Contractor

shall carry out at his/her own cost, all steps deemed necessary by the Engineer to achieve satisfactory disinfection.

TS 2.27.2 Water Quality Limits

• PARAMETER	COUNT
<i>e. coli</i>	0
Coliforms	0
Faecal Streptococci	0

**TS 2.28 CHARGING OF THE PIPELINE**

TS 2.28.1 On completion of the pipeline, Rand Water will arrange to fill it with water for testing in accordance with TS 2.30 with RS 1.12 as record for submission.

The entire process for filling the pipeline at any time during testing or disinfection shall be carried out under the supervision of the Engineer and will also be monitored by Rand Water personnel. Under no circumstances will the Contractor be allowed to carry out filling of the pipeline without the supervision of the Engineer, neither shall he/she permit any other persons to carry out such filling without the written permission of the Engineer.

Any damage to the pipeline caused by non-compliance with this clause shall be rectified at the Contractor's expense.

TS 2.28.2 Pipes laid under streams shall be encased in concrete. Thereafter backfilling shall be completed and the stream restored.

**TS 2.29 MAINTENANCE**

TS 2.29.1 The Contractor shall be responsible for all defects in the pipeline during the construction and maintenance periods and shall immediately make good any defects that arise.

**TS 2.30 ACCEPTANCE TEST OF COMPLETED SECTION OF PIPELINE**

TS 2.30.1 Hydrostatic Water Tightness Testing

Acceptance tests are to be carried out as detailed in Returnable Schedule RS 1.12 (Hydrostatic Test Certificate). The procedure is summarized as follows in Clause TS 2.30.

On completion of the laying of the specific sections of the pipeline and associated structures, the Contractor shall, where necessary, supply temporary pressure testing domes, install and weld the domes on the end of the pipeline, make the necessary preparations, provide the testing equipment and carry out water tightness and structural strength tests of the pipeline system. The length of each section to be individually tested will be defined by the Engineer.

After filling the section to be tested the section shall be allowed to stand for a minimum of 24 hours. The Contractor shall then place the pipeline under a test pressure corresponding to the relevant design head for that section of the pipeline determined by interpolation from the design elevations from the mean seal level as indicated on the general long section and on the hydraulic long section.

Water shall be fed into the system through a calibrated meter and the pressure in the system measured by a calibrated gauge. The Contractor shall provide the necessary pumping system, connection, meter gauges and labour. Each test shall continue for at least three days. Any decrease in pressure shall be made up every hour and the quantity of makeup water measured. The pipeline will not be considered satisfactory until the average leakage is less than 0.1 litres/mm diameter/kilometre/24 hours/30m head.

Any visible leak in the pipeline shall be made good by the Contractor. If any valve leaks it will be made tight by the supplier of the valve.

***Where the pipeline is located on dolomite, zero leakage is allowed and all leaks on pipes and valves shall be repaired to ensure zero leakage (refer to SANS 1936-3, Section 6.1.8).***

If the average leakage per 24 hours from each individually tested section of the pipeline is greater than that specified, the Contractor shall take immediate steps to reduce the leakage and shall at his own expense do any excavating necessary to locate and repair leaks or other defects which may develop under test, including removal of backfill already placed, shall make all repairs necessary to secure the necessary water tightness, shall replace such excavated materials, after which the test shall be repeated until the pipe under test is found satisfactory.

Water used for one filling of the pipeline for hydraulic testing, one filling for disinfection and one filling after draining the disinfection water will be provided by the Employer free of charge. Additional water used due to unsuccessful hydraulic tests will be charged at R5.00 per kilolitre.

Charging of the pipeline for hydraulic testing shall be carried out under the supervision of the Engineer.

The pipeline will have to be drained before the disinfection process begins and may need to be drained to carry out remedial measures. The pipeline shall be drained from scour valves in a manner that does not cause erosion of the streambeds or negatively impact on the environment in any way. Any such drainage of the pipeline shall be carried out under the supervision of the Engineer.

The pipeline will be considered commissioned and practically complete once all associated structures have been sufficiently completed to carry out their structural or hydraulic function and the hydraulic test and disinfection of the entire pipeline have been successfully completed.

## **TS 2.31 NON-DESTRUCTIVE DCVG SURVEY**

If required, a further non-destructive DCVG (Direct Current Voltage Gradient) survey will be carried out by a specialist (nominated by the Engineer) on the pipeline within 3 to 6 months after the end of the pipeline construction, within the Defects Liability Period.

All coating defects identified from the DCVG survey with a value greater than 3% IR, will need to be exposed and repaired by the Contractor at the Contractor's own cost.

Depending on the extent of the defects identified, the Engineer may call for a further DCVG survey after the initial defects have been repaired by the Contractor, the cost of which shall be borne by the Contractor.

## **TS 2.32 RAND WATER DATA PACK GUIDELINES**

The pipe manufacturer shall submit to the Engineer the steel maker's certificates covering all steel used. These certificates shall indicate the coil and heat number, the process of manufacture clearly indicating that the steel is manufactured as per API 5L standard and the mechanical properties of the steel, the chemical analysis which includes the manufacturer's product specification ranges for the selected grade.

The pipe manufacturer shall submit the mechanical properties/tests determined from specimens taken from finished pipe welds, chemical analysis from independent laboratories from the finished pipe welds, batch numbers from supplier of coating and lining used, dry film thickness, visual inspections and measurements, non-destructive testing reports, hydrostatic test reports, dust and debris reports, dew point and steel substrate temperature before coating and lining as well as salt tests.

All these requirements shall be specified and compiled into a data-pack for each pipe. Each pipe data-pack shall be bound or stapled together and all data-packs filed for submission to Rand Water at the end of the project. Checking and signing of the data-packs by the Engineer's representative shall be an on-going process during pipe manufacturing as it affects payments for finished pipes. Soft copies of the data-packs shall be made available to Rand Water periodically during manufacturing, on request.

<b>Data Pack Checklist and Reports</b>	
1.	Cover Page: Project Name, Pipe Number, Dimensions (OD x thickness), Inspector
2.	Coil Certificate
3.	Dimensional measurements & Visual Report
4.	Hydrostatic Test & X-ray/UT Reports
5.	Blast Profile Report (microns)
6.	Surface Temperature & Dew Point Temperature Report
7.	Salt Test Report
8.	Dust and Debris Report
9.	Dry Film Thickness Reports (Coating and Lining)
10.	Batch Numbers and Mixing Ratio (Base and Activator) - Coating and Lining
11.	Mechanical Test Reports (Tensile and Bend Tests) – Independent Laboratory
12.	Chemical Composition Report – Independent Laboratory
13.	Dates and signatures to be included for all the reports in 1 to 12
14.	Release and Dispatch Dates

## **TS 2.33 FLANGED JOINTS**

All pipes that are classified as non-man entry as per latest available Construction Regulation (Occupational Health and Safety Act, 1993) shall be flanged.

- TS 2.33.1 Flanges shall be truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to water tightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and at opposite ends tightened equally first.
- TS 2.33.2 The Contractor shall ensure that the correct jointing materials, i.e. gaskets, bolts and nuts are available when required. Only correct diameter and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts. The length of bolts and studs shall be such that at least two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite/grease compound immediately prior to assembly.
- TS 2.33.3 Flanged fittings shall be so installed that there are no stresses induced into the pipework, specials or fittings by forcing ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.
- TS 2.33.4 Flanges will only be wrapped as per TS 2.33.5 once hydrostatic pressure test has been performed and accepted.
- TS 2.33.5 All buried flange must be wrapped with mastic that is self-supporting, non-cracking and impervious to moisture. It must be resistant to mineral acid, alkalis and salts. A tape wrap consisting of non-woven synthetic fabric fully impregnated and coated with a flexible, high melting point bitumen compound will be used as an outer wrap over the mastic tape, applied with 55% overlap.
- TS 2.33.6 Coordinates of all buried flanges with will be recorded and submitted as part of AS-Built data as per TS 2.34.

## **TS 2.34 AS-BUILTS**

### **REQUIREMENTS**

- TS 2.34.1 A registered Surveyor to undertake the work (preferably registered with PLATO-The South African Council for Professional and Technical Surveyors)
- TS 2.34.2 The survey to be in WG29 projection
- TS 2.34.3 Note: Survey controls to be supplied by Rand Water's Land and Rights Section.
- TS 2.34.4 Accuracy within 0.1 m (Y,X,Z) meters
- TS 2.34.5 Survey every 50m (Y,X,Z)
- Top of a pipe
  - Natural Ground Level (NGL)
  - All bend points of pipe and a minimum of three (3) points along the curve of pipe bend
  - Change of grade of pipe
- TS 2.34.6 Survey all existing/new and exposed services with a minimum of two (2) points
- TS 2.34.7 Survey all valve chambers:-
- Within the servitude, including exposed pipes



- Every chamber positions
- TS 2.34.8 Start and end of culvert
- TS 2.34.9 Pipe Jacking positions
- TS 2.34.10 Spreadsheet to be supplied to Rand Water's Land and Rights Section
  - All points and description in ascii format (csv, txt, lst, etc)
  - Description of valves
  - Culvert details
  - Pipe Jacking details, etc
- TS 2.34.11 CADD plan showing all surveyed information
- TS 2.34.12 Survey Working Plan
- TS 2.34.13 Any other data that is beneficial to the project

## **TS 2.35 CCTV**

Provide side-scanning, that captures detailed visual data from every square mm of pipe wall at speeds up to 21 meter per minute. This image data, called a side scan, is then presented in multiple views (side, forward, thumbnail and virtual 3D) that can be rapidly and thoroughly analysed offline by an engineer.

Minimum Requirements:

- High-resolution visual detail from every mm of pipe wall.
- Inspect at 15 meter per minute —no stopping to pan, tilt or zoom.
- Faster review and annotation than with video.
- Links to GIS data.
- Automatic identification of cross connection, air valves, scours and joints.
- Thumbnail, side, forward and 3D navigation.
- Compact data for easy storage/transfer
- Ovality measurement.
- Pipe profiling

Contractor is to provide full ownership of the physical and intellectual property of the CCTV survey records to the Rand Water.

Begin each survey from a zero datum point defined as the centre of the manhole or pipe node. Complete survey along the entire asset length(s) from one manhole or access point setup wherever possible. If after reasonable effort the camera cannot proceed, complete the survey by starting a second survey from the manhole or access points at the other end of the asset length.

Cross-reference distances, survey directions and start and finish manhole or access points Complete as many asset length surveys as possible from the one manhole or access points. Note: distance counter must be zeroed at the start of each asset length.

All CCTV reports in colour, video footage and photos of each survey are to be supplied to Rand Water together on the same DVD. The format of this DVD must be compatible for viewing on a standard computer. Each DVD is to be

sequentially numbered with a distinct identification number e.g. LD001, LD003 etc.

Record the following information at top left side of the video screen for each separate CCTV survey:

- CCTV Contractor's name
- Location
- Manhole or access points or node where survey started (use LCC manhole or access points equipment numbers).
- Asset equipment number of pipe.
- Direction of survey (upstream, downstream).
- Pipe diameter, material
- Type of pipeline
- Date of survey
- DVD Number

Record the camera distance in metres on the right hand side of the video screen. Record the pipe gradient as a percentage at the bottom of the screen. Record each defect without moving the camera for a minimum of 3 seconds. Record each lateral connection by looking along centreline (of the connection) without moving the camera for a minimum of 3 seconds and view from different angles to enable a full assessment of the connection.

Pan the camera as required to get a clear and complete view of the defect (displaced joint, multiple cracks, encrustations etc.)

Provide a written Condition Assessment Report with the following information:

Where applicable

- Estimate of flow depth as a percentage of total pipe diameter (any changes in depth along the survey length to be noted)..
- Depth to manhole or access points invert (use a tape measure to determine).
- All defects, cracks, holes, open joints, infiltration, exfiltration.
- All connections, noting if capped off, intruding, live, standard proprietary brand fitting or non-standard.
- Changes in pipe material or size.
- Buried or uncharted manhole or access points, inspection openings or any other structures.
- Obstacles such as roots, encrustations, debris, rubbish, gravel.
- Build-up and encrustation on pipes such as silt, fatty products, calcification.
- Pipeline conditions considered to be unsafe.
- Pipe location where it differs from the alignment shown on the plans.
- Video times and distances (in metres) at start, finish, all connections and defects.

When CCTV surveying from a manhole/access hole, list the node numbers directly upstream and downstream of the manhole/access hole location as start and finish points. Show on the report that the survey was started from a

manhole/access hole and indicate how far the manhole/access hole was from the theoretical start node (this can be noted in the comments if necessary). If the theoretical start node cannot be located, then sketch on the plan the location of the manhole/access hole relative to buildings, fences etc. Depths of the pipe invert level at the manhole/access hole to be recorded.

Zero point for all surveys must be the centre of a pipe node (usually the manhole or access points centreline, but can be a junction) and all measurements must be referenced back to this datum. The depth to the invert of the pipe being surveyed must be recorded on the condition assessment report. This applies to both start and finish manhole or access points (provided that finish manhole or access points is not buried).

All survey reports must record a complete start and finish node number (Asset ID) and equipment number for the asset length.

Provide one photograph of major defects, or when a survey is abandoned. Photographs to show as much of the pipe as possible (avoid close up of the defect), general condition shot is preferable for cracks etc.

Camera image quality of DVD must be superior to that of video tape quality. Any compression should not make the image fuzzy or pixelated when viewed at full screen size. Lighting is to be sufficient to illuminate the pipe so that features are easily recognisable, yet not create lens flare or glare on the recording.

### **TS 3. PIPE LAYING, SPECIALS AND TESTING OF HDPE PIPES**

#### **TS 3.1 GENERAL REQUIREMENTS**

The general requirements regarding pipe laying, specials and testing of steel pipes according to TS2, shall also be applicable to HDPE pipes where applicable. Under this Section of the Contract the Contractor shall:

- (i) Arrange with the pipe supplier/manufacturer access to his works for inspection either during the course of manufacturing or upon completion for the design engineer all reasonable access to conduct such inspections.
- (ii) Identify and check the conditions of the HDPE pipes delivered and stored at the laydown areas and along the pipe. Pipes that are defective are to be reported to the Engineer. Agreement is then to be reached as to how these defective pipes are to be repaired and the price of the repair, or
- (iii) Identify and check the conditions of the HDPE pipes as they are delivered to site from the manufacturers. Pipes that are defective are to be reported to the Engineer. Agreement is then to be reached as to how these defective pipes are to be repaired and the price of the repair.
- (iv) Identify, establish and prepare to the satisfaction of the Engineer, temporary lay-down areas for the pipes next to the pipeline. These laydown areas do not include the working strip next to the pipeline route.
- (v) Arrange for the supply, loading, transport and unloading of fabricated pipe bends, pipe specials, valves and applicable instrumentation from suppliers/manufacturers alongside the trench for the pipeline and temporary lay-down areas.
- (vi) Arrange for the loading, transport and unloading of the pipes from the pipe storage area or from temporary laydown areas next to the pipeline (See (iii) above) alongside the trench for the pipeline.
- (vii) Install the pipes in the trenches and perform the joint welding as specified.
- (viii) Install fabricated pipe bends to form horizontal and vertical changes in pipeline direction where shown on the drawings. The Contractor will install such pipe bends according to the drawings.
- (ix) Install special pipe sections as scheduled. This will include (not limited to):
  - Tees for air-valves;
  - Reducers for the valve chambers;
  - Tees for the cross connections;
  - Tee for a future off-take;
  - Including supply of all flanges
- (x) Allow independent testing body (to be nominated by the Engineer or Rand Water) to carry out quality control tests of pipes and weld as specified.
- (xi) Install all isolating, by-pass, scour and air valves.
- (xii) Rectify defects in the pipeline during construction and for a period of 12 months after the final date of the acceptance of the contract.

### **TS 3.2            QUALITY ASSURANCE**

It is the responsibility of the manufacturer/supplier to establish Quality Assurance by means of quality control procedures, which shall ensure that the product will meet the requirements of this specification. The manufacturer/supplier shall maintain a quality system that conforms to the requirements of the SANS 9001/ISO 9001:2000 or national equivalent. The applicable standard for manufacture of pipes shall be SANS 4427/ISO 4427.

It is the responsibility of the design Engineer to ensure that all material and manufacturing details of all pipes, fittings and structures are appropriately specified in terms of the relevant SANS (or equivalent) specifications in the tender documents and that the contractor supply and install all material to the required SANS standards on site. Tender documentation must include or refer to all relevant requirements, certification or testing that may be necessary for quality assurance of raw material supply, manufacturing standards, equipment used in manufacturing or tests to ensure standards are met. Refer to SANS 4427/ISO 4427, SANS 10268, SANS 10269, SANS 10270, SANS 1655, SANS 1671, SANS 21138, SANS 674, ISO 9969 and relevant specifications. Tender documentation must allow for relevant quality control testing either by means of an appropriate clause (stating type of test and quantity) or by inclusion (specific stipulation of test requirements) in the price of the manufactured/installed item.

### **TS 3.3            INSPECTION OF MANUFACTURING PROCESS**

The design engineer must ensure that pre-delivery tests are conducted at the manufacturer's/supplier's works.

The Contractor will arrange with the supplier access to his works for the purpose of inspecting either during the course of manufacturing or when completed and shall permit the design engineer all reasonable access to conduct such inspections.

Copies of all test schedules and manufacturer's quality control records as called for in the relevant SANS (or similar) specifications and tender specifications shall be submitted by the Contractor for examination by the design engineer.

### **TS 3.4            HDPE MANUFACTURING INSPECTIONS**

It is required that an inspection be conducted of the manufacturing facility of potential suppliers of HDPE products prior to accepting products from such suppliers. Such inspections may be an unannounced or announced evaluation of the everyday manufacturing procedure of manufacturers requesting to be accepted as approved suppliers of structured wall HDPE pipe for the use in dolomite areas.

The objective of such evaluation is to conduct a manufacturing and quality inspection against the manufacturers own in-house standards as well as acceptable good manufacturing practice and specifications, e.g. SANS standards and/or Licensor guidelines.

### **TS 3.5            GENERAL PRODUCT REQUIREMENTS**

The finished product shall be free from cracks, voids, foreign inclusions and other defects, which would impair the overall performance. It shall be smooth

walled on inside and outside and shall conform to the requirements (characteristics) outlined below.

#### TS 3.5.1 HDPE Pipe Quality Control

The following must be complied with in terms of HDPE products:

1. National product specification: ISO 4427/SANS 4427;
2. Product and installation identification: In addition to the standard markings all HDPE products must carry the logo or name of the manufacturer;
3. Designation of material: all elements to be conform to specification of PE 100;
4. Nominal pressure and wall thickness of pipes: ISO 4427/SANS 4427-2, Table 2;
5. Raw Material: the HDPE manufacturing substance shall be 100% SANS ISO 4427 PE100 High Stress Crack Resistance certified virgin material (i.e. with ZERO inhouse/buy-in reworked materials or scrapings or foreign material), which material shall have been tested in accordance with the ISO13479 Notched Pipe Test by an independent 3<sup>rd</sup> party laboratory and the time to failure shall have been  $\geq 8,760$  hours;
6. Raw material declaration: the HDPE product manufacturer that the Contractor proposes to use, must declare the origin (supplier) of the raw material that will be used to manufacture the pipes for the contract;
7. Ash content: To be in accordance with SABS 533 part 1, 2 and 3 clause 6.3 maximum not to exceed 0,1%(m/m).

#### TS 3.5.2 HDPE Pipe Quality Control

Raw material composition for pipes and fittings shall be PE 100 pre-compounded black.

Table 3.5.1 Technical considerations for raw material and finished product

Physical/Chemical Property	Standard	Value	Unit
Density	ISO 1183	0,949-0,960	g/cm <sup>3</sup>
Melt Flow Index (190°C/5Kg)	ISO 1133	0,25-0,35	g/10min
Vicat Softening Point	ISO 306	64-68	°C
Crystalline Melting Range	ISO 3146-85	130-135	°C
Viscosity Number	ISO 1628-3	390	cm <sup>3</sup> /g

Mechanical Property	Standard	Value	Unit
Shore D, Hardness	ISO 868	61	-
Elastic Modulus	ISO 527	900	MPa
Tensile Yield strength	ISO 527 / ISO 6259	24	MPa
Ultimate Tensile	ISO 527 / ISO 6259	35	MPa
Ultimate Elongation	ISO 527 / ISO 6259	>600	%
Flexural Stress (3.5% Deflection)	ISO 178	19	MPa
Thermal Stability (OIT @ 210°C)	ISO 10837	>40	Minutes
Carbon Black Content	ASTM D 1603 / ISO 6964	2,25 +/- 0,25	%



Table 3.5.2 Pipe characteristics

Characteristics	Applicable Standard
Outer Diameter	ISO 11922-1 (Grade B)
Min Wall Thickness at any point	ISO 11922-1 (Grade U) – ISO 4065
Ovality	ISO 11922-1 (Grade N)

Table 3.5.3 Welding requirements

HDPE pipes and fittings welders shall be certified under the Thermoplastics Welding Institute of South Africa (TWISA)

The following standards shall apply:

SANS 10268 Part 1	Welding of thermoplastics - Welding processes - Heated tool welding
SANS 10268 Part 2	Welding of thermoplastics - Welding processes - Electro fusion welding
SANS 10268 Part 3	Welding of thermoplastics - Welding processes - Hot gas welding
SANS 10268 Part 4	Welding of thermoplastics - Welding processes - Hot-gas extrusion welding
SANS 10268 Part 10	Welding of thermoplastics - Welding processes - Weld defects
SANS 10269	Welding of thermoplastics - Testing & approval of welders
SANS 10270	Welding of thermoplastics - Approval of welding procedures and welds
SABS method 1269	Welding of thermoplastics – Test methods for welded joints
SANS 1655	Welding of thermoplastics – Welding rods, fillers and solvents
SANS 1671 Part 1	Welding of thermoplastics – Machines and equipment – Heated tool welding
SANS 1671 Part 2	Welding of thermoplastics – Machines and equipment – Electro fusion welding
SANS 1671 Part 3	Welding of thermoplastics – Machines and equipment – Hot-gas welding
SANS 1671 Part 4	Welding of thermoplastics – Machines and equipment – Hot-gas extrusion welding

WELDING OF THERMOPLASTICS STANDARDS		
SANS No	(New Numbers)	TITLE
10268-1	Processes- Pt.1:	Heated tool
10268-2	Processes- Pt.2:	Electrofusion wldg
10268-3	Processes- Pt.3:	Hot-gas welding
10268-4	Processes- Pt.4:	Hot-gas extrusion
10268-5	Processes- Pt.5:	Solvent welding
10268-6	Processes- Pt.6:	Ultrasonic welding

<b>WELDING OF THERMOPLASTICS STANDARDS</b>		
<b>SANS No</b>	<b>(New Numbers)</b>	<b>TITLE</b>
10268-7	Processes- Pt.7:	Infra-red welding
10268-8	Processes- Pt.8:	Bead & crevice free
10268-9	Processes- Pt.9:	Spin & friction wlg
10268-10	Processes- Pt.10:	Weld defects
1671-1	Machines- Pt.1:	<b>I.1.1</b> Heated tool wlding
1671-2	Machines- Pt.2:	Electrofusion wldg
1671-3	Machines- Pt.3:	Hot-gas welding
1671-4	Machines- Pt.4:	Hot-gas extrusion
1671-5	Machines- Pt.5:	Solvent welding
1671-6	Machines- Pt.6:	Ultrasonic welding
1671-7	Machines- Pt.7:	Infra-red welding
1671-8	Machines- Pt.8:	Bead & crevice free
1671-9	Machines- Pt.9:	Spin or friction
6269	-	Test methods for welded joints
1655	-	Welding rods, fillers and solvents
10269	-	Testing and approval of welders
10270	-	Approval of welding procedures

### TS 3.5.3 Raw Material Acceptance Tests

The material used for the manufacture of the pipes and fittings and ancillary elements shall be a high-density polyethylene (HDPE) PE 100. To ascertain the quality of this product the following tests shall be performed:

- a) Density;
- b) Melt Flow Index;
- c) Carbon Black Content;
- d) Thermal Stability

Only virgin materials (raw materials as received from the polymer producers, with no additives) shall be used for the manufacture of the pipes and fittings.

The pipe supplier shall accommodate regular visits by the appointed/contracted service providers/consultant representatives to their factory as and when

required to inspect/check the manufacturing process and be permitted to take samples of final products to an independent certified laboratory for acceptance tests as mentioned above.

No recycled material may be used in the manufacturing of the pipes. The supplier will be required to provide documented proof, as and when requested, that the material used conforms to the requirements of this specification.

#### TS 3.5.4 Testing of Pipes

Testing as described in ISO 4427/SANS 4427 shall apply. Independent tests shall also be conducted ad-hoc by a registered and authorised testing body as determined by Rand Water.

Documents to be submitted by the pipe manufacturer:

- a) Certificate of Registration –ISO 9001/SANS 9001 or National Equivalent;
- b) Permit Certification –ISO 4427/SANS 4427 for PE 100;
- c) Quality Control Plan (QCP) shall include Raw Material and Product Test Certificates;
- d) SANS or National Equivalent Quality Systems Audit Reports – last 2 Audits;
- e) Certificate of Conformity and Certificate of Analysis - certificate for the raw materials used for each batch. Documentation shall be kept/filed separately by the pipe manufacturer for all pipes ordered per each contract.

#### TS 3.5.5 Pipe Marking

All HDPE pipes shall be indelibly marked at 1m intervals with the following details and this marking shall always be on the top of the pipe after installation:

Table 3.5.4

Reference item	Mark printed
Trade name	Manufacturer/Supplier Name
Specification	ISO 4427/SANS 4427
Pipe OD	e.g. 400
Pipe OD tolerance	Grade B
Wall thickness	e.g. 47
Nominal pressure	e.g. PN 20
Material designation	PE 100
Batch no.	Manufacturer/Supplier Traceability
Application	WATER or any other application

#### TS 3.5.6 Material Guarantee / Product Life expectancy

The manufacturer must unconditionally guarantee all HDPE products for a period of 100 years against any form of chemical decomposition or mechanical failure as a result of normal use in a 100-year lifecycle of expected pressures.

## **TS 3.6 CONSTRUCTION AND ON SITE REQUIREMENTS**

### **TS 3.6.1 Offloading of HDPE Pipes**

The manufacturer's instructions regarding the offloading of all HDPE pipes, fittings and manufactured items must be strictly adhered to. The specification of such procedures must be in the office of the contractor at all times. The engineer must be provided with a copy of such procedures. The pipes must be offloaded by hand or mechanical crane.

During site establishment, the contractor shall clear an area specifically for the purpose of offloading HDPE products. This area must be free of rocks, boulders or any other foreign objects that may puncture, cut or scar the HDPE fittings, pipes and other manufactured items. The area must also be relatively level in one direction and the ponding of stormwater must not be permitted. The area must be kept in such condition for the duration of material being on site.

### **TS 3.6.2 Handling of HDPE Pipes on Site**

The manufacturer's specification for the handling and transporting of pipes on site must be strictly enforced. The engineer shall write a specific instruction regarding this in the absence of such a manufacturer's specification.

The site instruction must include: "Under no circumstances shall the dragging of pipes on site be allowed. Dragging of the pipe will result in cuts, scratches and puncture marks that may result in weakening of the pipe. Welded pipes shall be transported to the point of installation in accordance with the manufacturer's specification."

### **TS 3.6.3 HDPE Pipes – Visual Inspection for Defects**

The Engineer shall inspect all HDPE pipes for any visual defects such as cracks, deformation, wall thinning etc. This in no means constitute approval of the pipes. It merely serves as an additional quality control feature to ensure that pipes with obvious defects are rejected.

Pipes found to have such defects must be brought under the attention of the Contractor in writing for corrective action.

### **TS 3.6.4 Engineer's Inspection of installed Pipes**

The Engineer shall inspect all HDPE pipes and fittings prior to backfilling of trenches.

All pipes with cut, scratch, punctures marks or signs of deforming shall be rejected from a quality control perspective. In such cases the contractor must submit a certificate of approval from the pipe supplier. This document must clearly state that the supplier approves the integrity of the pipes irrespective of the noted damages.

If such an approval certificate is not supplied the engineer shall reserve the right to reject such pipes as he/she sees fit.

All welds must also be inspected for obvious visual defects.

### TS 3.6.5 Pressure Testing

Contracts shall provide for quick testing of all pipe sizes delivered to site with at least two tests per 500 m for all pipes having a diameter in excess of 200mm (OD).

### TS 3.6.6 The Pressure Testing in Laboratory

Selection of 3 samples, at random by the independent test laboratory, of pipes having a minimum length of 1m with all relevant pipe markings and free of scratches and defects. These sections shall be tested as follows:

- a) The condition of pipe or fitting in water for 12 hours at 20°C;
- b) Standard pressure test procedures according to ISO 4427/SANS 4427;
- c) Failure test: apply internal pressure at 5 bar/min until failure - PE100 pipes must reach a pressure of at least twice the minimum required strength according to ISO 4427/SANS 4427;
- d) The Engineer shall also allow for quick testing as stated above to ISO 4427/SANS 4427 as follows:

Quick tests:

- MFI: Melt Flow Index
- OIT: Oxygen Induction Time
- Screen: Polymer identification
- Pressure Test: Regression Curve
- Notch Sensitivity Test: Polymer
- Technological Bend Test: welds
- Technological Tensile Test: welds
- Demand feed stock information: certificate
- Check polymer with manufacturer

### TS 3.6.7 Hydraulic Field Testing of Water Supply Pipes

All completed pipelines shall be satisfactorily tested hydrostatically and no payment in respect of pipe laying or the supply of pipes and fittings on any section of pipeline shall be made until such tests have been completed successfully.

Hydrostatic tests shall be carried out on approved completed pipe sections with suitable length as approved by the Engineer.

The Contractor shall be responsible for arranging all aspects of hydrostatic testing and for the supply of all equipment, materials and labour required.

The test pressure for field testing shall be 1,5 times the maximum working pressure.

- Fill the pipe section with potable water and leave overnight;

- Gradually increase the pressure over a period of 3 hours to 100% of the maximum working pressure;
- Inspect the pipe for visual leaks and should leaks be observed, gradually decrease the pressure to zero and repair the leaks;
- Repeat the last two steps until no visual leaks occur;
- Then increase the pressure to 150% of the maximum working pressure and close the valve to maintain the pressure. After one hour measure the pressure. To pass the test, zero leakage (i.e. zero pressure drop) shall be recorded;
- Upon successful completion of the test, gradually decrease the pressure to zero over a period of 3 hours;
- If the test fails, find the leak(s) and repair it before repeating the test until a successful result is achieved.

The test pressure applied over any section under test, taking any differences in elevation along the pipeline into account shall be such that the pressure at any point along the section is not more than 1,5 times the maximum working pressure of the pipe.

The test procedure shall be as follows:

Water used for hydrostatic testing shall be disposed of in an approved manner without causing damage, nuisance or injury.

### **TS 3.7**

### **WELDING: SPECIAL NOTES ON HDPE WELDING WORK**

The following general site procedures need to be implemented.

For welds other than prepared butt welds, the following practical issues must be observed and implemented:

- a) The adjoining faces of pipe are scraped with a chisel to roughen up the surface and remove any oxidization of the surfaces to be welded;
- b) Angle grinders must not be used for this process, as it burns the plastic and also leaves a powder film, which is detrimental to welding;
- c) Cleaning agents (i.e. XYLENE) must be used prior to the performing of any extrusion weld, especially on all site works and repair work on dirty items;
- d) In winter conditions, preheating of the parent plastic along the prepared weld surface is sometimes necessary. This prevents heat sink (i.e. the parent plastic chills and thus removes the heat from the extruded welding filler);
- e) The welder's registration number must be imprinted on each weld prior to cooling. This number should always be on top of the pipe after installation.



## **TS 4. INVESTIGATIONS**

### **TS 4.1 GEOTECHNICAL INVESTIGATIONS**

#### **TS 4.1.1 Objectives**

The objective of the geotechnical investigation would be:

- Desk study i.e. topographical maps, aerial photographs and existing records shall be consulted to gain information on the general topography and prominent features.
- Undertake site reconnaissance to gain geotechnical information from visible features, establish the suitability of various geophysical testing methods and investigate accessibility for drilling equipment.
- Undertake geophysical investigation wherever practical which shall comprise a seismic or resistivity or gravimetric or electromagnetic evaluation of the subsurface conditions of sufficient extent and depth in order to assist in the selection of the most economic detailed investigation as well as in the siting of foundations.
- Investigation into the subsoil material condition and characteristics at the project site by sampling from trial pits and carry out field strength tests.
- Performance of field and laboratory tests to classify soil and evaluate its various characteristics to enable safe and economic design to be prepared.
- To assess subsurface soil and groundwater conditions including site topography
- To obtain information on physical properties of soil and rock.
- ***To categorise material into Material Type 1 to 3 as per Method of Prediction of Flexible Pipe Deflection M-25 Third Edition using Standard Penetration Test (SPT) for design.***
- Analysis of the results of the field tests and laboratory tests so that you could come out with the necessary information for the design of safe foundation, bedding and backfill for pipework.
- Foresee and provide measures against difficulties that may arise during construction owing to ground and other local conditions
- Advise the availability and suitability of local material for construction purposes.
- The identification and analysis of potential unfavourable soil and rock conditions of the substrata
- To understand the ease of excavation on the proposed pipeline route
- The assessment of soil corrosiveness.

- TS 4.1.2 Scope of Work
- TS 4.1.2.1 Conduct field investigations on the pipeline route by means of exploration trial pits excavated by an excavator or TLB or ***auger drilling in order to reach the required depth.*** The depth of trial pits shall be 1m below the invert level of the pipeline and at every ***100m along the proposed pipeline. (The distance between the trial pits could increase or decrease based on the desktop study information).***
- TS 4.1.2.1 Geotechnical survey to be conducted on either side of all the pipe jacking crossings required. For all crossings please refer to the attached locality map.
- TS 4.1.2.2 Provide the detailed description and recommendation on the stratigraphy at all anticipated pipe jack crossings.
- TS 4.1.2.3** Study the usability of trench materials as ***stage 1 and stage 2 material as per Rand Water Standard Drawing No R0 27141.***
- TS 4.1.2.4 Identify the alternative potential sources of construction materials, either in areas adjacent to the pipeline or commercial sources.
- TS 4.1.2.5 Conduct soil Resistivity surveys for the entire route of the pipeline.
- TS 4.1.2.6 Provide recommendations on areas where the pipeline route pass through the soils with high collapsible grain structure, expansive and ***sinkhole*** characteristics.
- TS 4.1.2.7 Demarcate all areas of high water table and provide recommendations and procedures for dewatering.
- TS 4.1.2.8 Carry out laboratory tests on the Grading (sieve analysis and Atterberg limits), Chemical Analysis (soil and ground Water including Acid Mine Drainage (AMD)) , Moisture sensitivity analysis (Mod AASHTO), Oedometer test (stress deformation analysis ), Unified Soil Classification System (USCG) and compatibility factor tests etc.
- TS 4.1.2.9** Provide excavation and backfill quantities (soft and rock) and quantities for soiled and imported materials as per SANS 1200 DB and SANS 1200 ***LB and as per Rand Water Drawing No R0 27141.***
- TS 4.1.2.10** ***Provide soil profile of the final geotechnical long section based on final long section that will be submitted by either Rand Water (RW) or External Design Consultants in DWG format.***
- TS 4.1.2.11 Provide trench excavations and backfilling details specific for the project.
- TS 4.1.3 Conditions and Requirements
- It is the responsibility of the geotechnical consultant to apply for wayleaves for all existing underground utility services including but not limited to gas pipes, water pipes, sewerage, cables etc. from the appropriate authorities.
  - Upon completion of geotechnical investigation activities all access routes and the Work site shall be restored to their original condition including backfilling all bore holes.

- TS 4.1.4      Geo-Technical Data Report, Discussion and Recommendations
- The report on geotechnical investigations shall be compiled under the following headings and shall include, but not be limited to, the following, as relevant:
- TS 4.1.4.1    Introduction
- Terms of reference
- Description of planning stage, and the purpose for which the investigation was conducted
- TS 4.1.4.2    Description of the site
- Location of the site(s)
- Accessibility of the site(s)
- Traffic ability of the site for construction ability
- Listing of sources from which data is available or was obtained from
- Description of regional geology, vegetation, drainage and other general features of importance
- TS 4.1.4.3    Investigations carried out
- Name(s) of firm(s) responsible for the field work (consultant, contractor)
- Name(s) of person(s) responsible for the interpretation of the geophysical work and for profiling
- Dates on which the work was conducted
- Description of the types of field work undertaken and equipment used
- TS 4.1.4.4    Investigation results
- Description of the soils encountered, identifying their stability or potential problems they may present e.g. tendency to heave, collapse, settle, etc.
- Description of hard rock geology identifying the type, quality, degree of weathering, fracturing, etc
- Potential for boulders and other obstructions to deep seated foundations
- Description of the problems experienced or to be expected
- Description of ground water and expected variations
- Field and laboratory testing carried out
- Types of tests conducted on the respective materials
- Results obtained and their reliability

#### TS 4.1.4.5 Recommendations

This should be in sufficient detail including geo-technical information accumulated in the desk study, site reconnaissance, geophysical investigation, data review, field explorations, field resistivity testing, laboratory testing, etc.

The recommendations should include, but not limited to, the following:

- Existing condition
- Possible construction constraints
- Hydrological conditions
- Classes of excavation in terms of SANS 1200 DB (soft, intermediate or hard rock) and as per Table NA.8 of BS EN 1295-1
- Backfill requirements in terms of SANS 1200 and Rand Water Standard Drawing No R0 27141 included on Trench and Backfill details relevant to the project
- Trench stability
- Shrink / Swell potential/ expansive and collapsible soils/ Ground subsidence
- Earthworks and stability next to existing pipeline and other structures
- Dewatering needs
- Flooding and erosion potential
- Modulus of Soil Reaction (E values) (and other parameters) for pipe thickness design and other design requirements as per BS EN 1295-1 (Table NA.1) for every test pit
- ***Embedment material parameters E'b values to be determined in line with Method for Prediction of Flexible Pipe Deflection M-25 Third Edition.***
- ***The E'n values of the in situ trench wall material at the level of the pipe springline to be determined using SPT in line with Method for Prediction of Flexible Pipe Deflection M-25 Third Edition.***
- ***The composite modulus of soil reaction E' values to be determined in line with Method for Prediction of Flexible Pipe Deflection M-25 Third Edition.***
- Corrosive soils (conduct soil resistivity) main requirement. Soil resistivity measurements up to pin (electrode) spacing of 100 m including a report with all measured data and findings
- Trench stability with specific reference to adjacent existing services and safety
- Dump sites
- Borrow pits

- Crossings/ trench-less crossings
- Suitability of the existing roads to be used by construction vehicles.
- Mitigation alternatives to reduce potential impacts to proposed pipelines
- Backfill and bedding material analysis for every chainage on longitudinal sections drawings.
- Report to include but not limited to, a list of E' values of the in-situ material as per BS EN 1295-1 (Table NA.1), soil resistivity analysis, angle of repose etc. using appropriate tests.
- Report shall seek to address all the objectives mentioned above.
- imported or Any other information the consultant may deem applicable to the project
- State in relations to chainages material classification to whether there is rock, bedding & selected fill to be use in situ material, etc.
- Dolomitic Assessment and classification
- Soil bearing capacities including where valve chambers will be located
- Excavation quantities and spoiled or imported materials

#### TS 4.1.4.6 References

Listing of standards used for the classification of materials in respect of soil condition and rock hardness

#### TS 4.1.4.7 Annexures

- a) Locality plan to appropriate scale
- b) Results of geophysical investigations
- c) Borehole, auger hole and test pit logs
- d) Photographs of borehole cores recovered
- e) Laboratory test results including chemical analysis
- f) Trench and Backfill details relevant to the project

#### TS 4.1.5 Requirements

Consultants/Contractor shall provide one soft copy (CD) and three (3) hard copies of the original Geotechnical Engineering Report to Rand Water They will also be required to submit in dwg format a Geotechnical Long section with top strip indicating test pits and whether there is rock, bedding & selected fill to be imported or use in situ material, water table, cross sections, etc., once the final long section has been finalized by RW or by the contractor.

Submit the work program 7 days after being awarded the contract and a weekly progress report to the project manager thereafter.

Submit together with the report a spreadsheet indicating measurement of resistivity, pH, sulphates and chlorides from kilometer 0 to the last kilometer.

## **TS 4.2 GEOTECHNICAL INVESTIGATIONS ON DOLOMITE UNDERLAIN GROUND**

### **TS 4.2.1 Introduction**

Geotechnical investigations on dolomite underlain ground shall be performed according to the requirements of SANS 1936-2 (latest edition) which establishes requirements for:

- a) Feasibility-level geotechnical investigations to determine the general suitability of dolomite land for development and the installation of underground services;
- b) Design-level investigations, including footprint investigations, where necessary;
- c) The determination of the inherent hazard class of dolomite land, to be used in conjunction with SANS 1936-1 to ascertain the dolomite area designation and requirements for the development of such land;
- d) Inspection and verification during the implementation phase of a project on dolomite land.



## TS 4.2.2 Requirements

### TS 4.2.2.1 General

The general requirements for geotechnical investigations are described in SANS 1936-2 (4.1).

All percussion borehole sample logging and rotary core logging shall be undertaken in accordance with the requirements of Geotechnical Logging of Soil Profiles and Rotary Percussion Boreholes for Engineering Purposes in Southern Africa (SANS 633).

### TS 4.2.2.2 Feasibility-level Dolomite Stability Investigation

#### TS 4.2.2.2.1 General

The Competent Person (geo-professional) shall perform the feasibility level geotechnical investigation according to SANS 1936-2 (4.2.1) and formulate and document an opinion as to Inherent Hazard characterization using geophysics, the assessment of the bedrock morphology, subsurface profile from ground surface to dolomite bedrock and the geohydrological regime conditions and groundwater compartmentalization in accordance with the methodology contained in SANS 1936-2, Annexes B and C.

#### TS 4.2.2.2.2 Geophysical Survey

The geophysical survey shall include a gravity survey according to SANS 1936-2 (4.2.2). In addition, the grid spacing for gravity surveys shall in general not exceed 30m or the anticipated thickness of the overburden. Instances of outcropping and sub-outcropping dolomite might merit the undertaking of microgravity (at a spacing of 10m or less).

The location of the rotary percussion boreholes should be based on data obtained from the gravity survey, geological and geomorphological data.

A geophysical report shall be produced describing the work procedures, interpretation and conclusions of the survey.

#### TS 4.2.2.3 Borehole Drilling

Boreholes shall be drilled as specified in SANS 1936-2 (4.2.3).

Representative samples shall be retrieved for every 1m drilled and the borehole shall be logged in accordance with the requirements for Geotechnical Logging of Soil Profiles and Rotary Percussion Boreholes for engineering purposes in Southern Africa (SANS 633).

#### TS 4.2.2.4 Gathering of Geohydrological Data

The available geohydrological data shall be gathered in accordance with SANS 1936-2 (4.25).

#### TS 4.2.2.5 Report

The investigator/Competent Person (geo-professional) shall document and report all findings and opinions in a written report to the requirements of SANS 1936-2 (4.2.6) and include the following:

- a) description of the purpose of the investigation and terms of reference;
- b) description of the site, including its extent boundaries, etc.;
- c) existing information assimilated and used in the investigation;
- d) state the methodology of the investigation, including procedures and findings;
- e) dolomite stability characterisation, explain and motivate hazard characterisation in terms of ingress of water and groundwater level changes;
- f) summary of risk zoning;
- g) recommendations on water precautionary measures and special founding requirements in relation to each inherent hazard zone;
- h) outline the preliminary dolomite risk management plan requirements;
- i) identify outstanding information to be determined and confirmatory investigation to be undertaken;
- j) figures/drawings including locality plan, site layout plan, regional geology, positions of boreholes, gravity contours, dolomite stability map with inherent hazard classes and zones.

#### TS 4.2.3 Design Level Dolomite Stability Investigation

##### TS 4.2.3.1 General

Design level investigations shall conform to the requirements of SANS 1936-2 (4.3.2 and 4.3.3). The investigator/Competent Person (geo-professional) shall, during the design-level investigation confirm and refine the Inherent Hazard Zone and the associated Dolomite Area Designations, and confirm that the mandatory precautions associated with a designation have been observed.

The investigator/Competent Person (geo-professional) shall, as a minimum to comply with the above requirement interact with suitably qualified professionals and the person responsible for the development of the parcel of land or the relevant portions thereof concerning appropriate planning and design of infrastructure.

The investigator/Competent Person (geo-professional) shall develop a risk management plan strategy specific to the development in accordance with the requirements of SANS 1936 (4.3 and 4.5).

##### TS 4.2.3.2 Report

The investigator/Competent Person (geo-professional) shall prepare a design-level report generally in accordance with **TS 4.2.2.5** and also including the following:

- a) a method description of the work undertaken;
- b) a drawing indicating the location of the points profiled in the ***pipe*** trenches;

- c) records of all profiles, boreholes and tests;
- d) records of any geotechnically problematic conditions intercepted, such as paleokarst structures, sinkholes etc.;
- e) a description of any additional geotechnical investigations undertaken;
- f) a description of any precautionary or remedial measures applied to problematic conditions identified during the design-level inspections;
- g) a site/development/township layout drawing which confirms the Inherent Hazard Classes and Dolomite Area Designations of each individual stand, in accordance with the requirements of SANS 1936;
- h) an indication where the dolomite designations of stands have been changed and provide a motivation for such changes;
- i) a comprehensive list and description of any ongoing monitoring required;
- j) an indication that amended water precautionary measures shall apply.

#### TS 4.2.4 Additional Requirements for Specific Types of Development

##### TS 4.2.4.1 General

These additional requirements apply in addition to the requirements of TS 4.2.2.1, **TS 4.2.2.2** and **TS 4.2.2.3**. Also refer to the requirements of SANS 1936-2, Annex A.

Detailed footprint stability investigations form part of the design-level investigations and shall, where appropriate, be undertaken for specific structures, facilities, infrastructure or bulk services for design purposes.

##### TS 4.2.4.2 Additional Requirements for Bulk Pipelines

The requirements for bulk pipelines shall comply with the requirements of TS 4.2.2.1, **TS 4.2.2.2** and **TS 4.2.2.3** as a minimum and also with SANS 1936-2, Annex A (A.6). The investigation shall also include the following:

- a) a gravity survey over the proposed pipe alignment at 30 m grid spacing with a minimum of three lines;
- b) additional investigations for line deviations in the event that Inherent Hazard Class 6, 7 and 8 conditions (refer to SANS 1936) are encountered along the proposed alignment;
- c) investigation of potential paleosinkhole structures wherever they are exposed;
- d) where necessary, supplementary geotechnical site investigations.

##### TS 4.2.4.3 Additional Requirements for Pump Stations and Water Works

The requirements for pump stations and water works shall comply with the requirements of TS 4.2.2.1, **TS 4.2.2.2** and **TS 4.2.2.3** as a minimum and also with SANS 1936-2, Annex A (A.7). The investigation shall also include the following:

- a) additional investigations for alternative sites in the event that Inherent Hazard Class 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
- b) inspection of the open works to verify the hazard zone and to check for palaeokarst structures;
- c) investigation of potential paleosinkhole structures wherever they are exposed.

## **TS 4.3 SERVICE DETECTION**

### **TS 4.3.1 Specification**

It is required that the service provider:

- Locate and identify existing services in a non-destructive manner along and across the pipeline servitude.
- Accurately plot the service position on the pipeline layout indicating the nature, size, type, owner, depth, height, extent, protection, shape, etc of the service. No unknown service and diameters will be accepted.
- Indicate affected servitudes and source of servitude information e.g. S.G. Registration number. etc.
- Indicate position and extent of any planned future servitudes e.g. future provincial road, pipeline routes, etc.
- Indicate position, extent and type of fencing walls along or across the pipeline servitude.

The service provider's proposal must provide inter alia the following:

- Services identification and location methodology.
- Equipment to be used, accuracy and reliability to be achieved.
- Base information required from Client.
- Presentation format (report and drawings)
- Execution Programme.
- Cost proposal including necessary cost breakdown.
- Previous experience and experience and qualifications of key members.
- Health and Safety adherence

### **TS 4.3.2 Deliverables**

1. Full service detection of the required strip (to be provided by Rand Water) identifying all service crossing and running parallel to the existing Rand Water pipelines. All investigation to be done by means of non-destructive equipment and machinery.
2. Service location and detection data to be according to the following:
  - a) Surveyed locations in WG 29.

- b) Heights to be levelled to mean sea level.
  - c) No GPS heights to be accepted.
  - d) Standard survey procedures to be adopted in fixing control points (Class A accuracy) as set by PLATO. Rand Water will provide the control points where the survey should be based.
  - e) Levels to be obtained from new/ existing benchmarks to ensure required accuracy.
  - f) Level accuracy of services to within 0.1m.
  - g) List of all control points and survey report to be supplied in digital format (ascii/txt) stored on DVD Rom.
6. Digital Mapping of Services (CAD Requirements)
- a) Drawings to be in DWG format (supplied electronically). All services lines must be in 3D
  - b) All services to be labelled correctly and with legends.
  - c) All services to be on separate layers.
  - d) All service to be correctly coordinated.
  - e) All available cadastral and grid information to be added to CAD drawing.
  - f) Upstream and downstream levels must be captured for sewer and stormwater pipes (manhole and inlets levels, etc.)
7. Digital Listing of Services (Excel / Txt format)
- g) All services to be included in text/ascii format in separate files and to include X,Y,Z data with descriptions. The Z value must be the invert level for all the pipes. The list to include type, depth and the size of the services
8. No unknown services will be accepted.

## **TS 5. MEASUREMENT AND PAYMENT FOR PIPELINES**

### **TS 5.1 Supply and delivery of pipes**

The rate shall cover

TS 5.1.1 The rates tendered shall include for full compensation of all costs incurred in the manufacture, procurement, inspection, factory testing and delivery and handling into final storage on site of the specified pipes, pipe ancillaries, specials, bolts, nuts, washers and gaskets and any other work as specified.

TS 5.1.2 Examination the pipes as described in Clauses TS 2.1, **TS 2.2**, **TS 3.3** and **TS 3.4**, either at the storage area or when delivered to site, internally and externally for lining and coating defects.

..... Unit: m

### **TS 5.2 Unload pipes**

The rate shall cover the supply and operation of plant and the supply of labour to unload the pipes from the supplier's vehicles and the lay down of the pipes at the storage area, in the temporary laydown areas along the pipeline route and/or to certain positions along the route of the pipeline. The cost to supply and to form storage mounds and measures taken to protect the pipes during this procedure will be included in this item.

..... Unit: m

### **TS 5.3 Removal/installation of internal bracing**

The rate shall cover the supply and operation of plant, supply of material and cost of labour to remove the supplier's internal bracing, return the bracing to the supplier's manufacturing plant, installation of temporary bracing and the removal thereof on completion of backfilling. The cost to repair subsequent damage due to the removal and installation of the bracing will be included in this item.

..... Unit: m

### **TS 5.4 Transporting of pipes from storage area**

The rate shall cover the cost of the supply and operation of plant and cost of labour to load pipes at the storage area, transport the pipes to the excavated trench or point for installation in existing culverts or sleeves, regardless of distance and unload the pipes along the trench. The cost to supply and/or form storage mounds and measures taken to protect the pipes during this procedure will be included in this item.

..... Unit: Sum

### **TS 5.5 Install Pipes in trench**

The rate shall cover the cost of the following activities:

- i) Examine pipes prior to placing in the trench as per Clauses TS 2.5.1, **TS 3.6.3** and **TS 3.6.4**



- ii) Repair all defects as per TS 2.5.1, **TS 3.6.3** and **TS 3.6.4**
  - iii) Placing the pipe in the prepared trench including the supply and operation of plant and supply of labour to execute the work
  - iv) Cleaning of joints as per Clause TS 2.5.2 and **TS 3.7**
  - v) Vertical and horizontal lining up of the pipe including the supply and operation of plant and supply of labour to execute the work
  - vi) Supply, installation and removal of protective measures as per Clause TS 2.5.1
  - vii) Welding of the joint as per Clause TS 2.6 and **TS 3.7**
- ..... Unit: m

#### **TS 5.6 Install pipes through culverts or sleeves (Pipe Jacking)**

Rate to include for steel skid supports and props at 2,5m centres as detailed on **Drawing No. R026991/11/46**

The rate shall cover the cost of the following activities:

- (i) Examine pipes prior to placing through the culvert or sleeve as per Clause TS 2.5.1
  - (ii) Repair all defects as per TS 2.5.1
  - (iii) Prepare the pipes for installation through sleeves
  - (iv) Placing the pipe in the existing culvert or sleeve including the supply and operation of plant and supply of labour to execute the work
  - (v) Cleaning of joints as per Clause TS 2.5.2
  - (vi) Vertical and horizontal lining up of the pipe including the supply and operation of plant and supply of labour to execute the work
  - (vii) Supply, installation and removal of protective measures as per Clause TS 2.5.1
  - (viii) Internal welding of the joint as per Clause TS 2.6
- ..... Unit: m

#### **TS 5.7 External welds**

The rate shall cover the supply and operation of plant and supply of material and labour to execute the completion of external welds as per as per Clause TS 2.6

..... Unit: No

#### **TS 5.8 Complete protective coatings at joints**

The rate shall cover the supply and operation of plant and supply of material and cost of labour to execute the completion of internal lining and external coating at the welded joint as per Clause TS 2.5.4

..... Unit: No

## **TS 5.9 Steel Pipe Mitre Bends**

The rate shall cover the cost of the following activities:

- (i) Supply, deliver, line-up, cut, install, clean joints, weld (internally and externally), horizontal and vertical bends and/or mitres over 1° and up to and including 15° cut from coated and lined pipe supplied by the pipe supplier.
- (ii) Supply and operate plant and supply of material and labour to apply internal and external field joint corrosion protection to the entire bend and/or mitre as per Clause TS 2.5.4

..... Unit: No

## **TS 5.10 Fabricated Bends**

The rate shall cover the cost of the following activities:

- (i) Supply of complete bends, transport to and unload at point of installation, line-up, install, clean joints and weld, internally and externally, horizontal and vertical bends over 15° and up to and including 90°.
- (ii) Supply and operate plant and supply of material and labour to apply internal and external field joint corrosion protection to the entire bend as per Clause TS 2.5.4

..... Unit: No

## **TS 5.11 Pipe Specials**

The rate shall cover the cost of the following activities:

- (i) Supply, transport to and unload at point of installation, line-up, install, clean joints and weld, internally and externally, various pipe specials as listed in the Schedule of Quantities

..... Unit: No

- (ii) Supply and operate plant and supply of material and labour to apply internal lining and external coating to the entire pipe special as per Clause TS 2.9

The lining and coating of straight pipes shall be measured per meter length of pipe lined and coated.

The lining and coating of specials, whether lined by hand or otherwise, shall be measured per unit of complete special, except where such specials are lined and coated in a single in-situ operation by mechanical means, when the lining and coating of same shall be included in measured per linear meter of complete pipeline lined or coated, or per square meter as per Price Schedule.

Payment for factory applied linings and coatings shall be included in the payment for pipes delivered to site.

Payment for in-situ applied linings and coatings shall be for completed linings and coatings at the rates schedules.

..... Unit: m

## **TS 5.12 Valves**

The rate shall cover the cost of the following activities:

- (i) Supply, transport, unload and provide protective measures at point of installation install to manufacturer's specifications and depicted drawings all valves as listed in the schedule of quantities.
- (ii) Comply with all requirements of Clauses TS 2.25 and TS 2.26.
- (iii) Installation, fitting, tightening and setting of gasket rings, flange bolts, nuts and washers as supplied with the valve.

..... Unit: No

## **TS 5.13 Flanges**

The rate shall cover the cost of the following activities:

- (i) Supply of flanges at specials (Including gasket rings, bolts, nuts and washers).
- (ii) Installation, fitting, tightening and setting of gasket rings, flange bolts, nuts and washers

..... Unit: No

## **TS 5.14 Manufacture and installation of make-up pieces**

The rate shall cover the cost of the following activities:

- (i) Cutting of make-up pieces, regardless of length, from coated and lined pipe supplied by the pipe supplier.
- (ii) Preparation of cut backs on both ends of the make-up piece as per Clause TS 2.7
- (iii) Installation, line-up, clean joints and weld, internally and externally, make up pieces
- (iv) Supply and operate plant and supply of material and labour to apply internal lining and external coating to the make-up piece as per Clause TS 2.5.4

..... Unit: Sum

## **TS 5.15 Radiographic examination of circumferential welds**

The Provisional Sum shall cover the cost to appoint a nominated specialist to provide and operate equipment (including mark-up) to execute the radiographic examination of circumferential welds and provide the Engineer with the results and reports of the examinations, as per TS 2.7.3 and TS 2.6.3

..... Unit: Prov. Sum

Contractors mark-up on Provisional sum above ..... Unit: %

<b>TS 5.16</b>	<b>Acceptance test</b>
	The rate shall cover the cost to supply and operate all plant and machinery and the cost of labour to execute pressure tests as per the requirements of <u>TS 2.30</u> and <u>TS 3.6.7</u> for the sections and to the test pressure specified by the Engineer.
	..... Unit: Sum
<b>TS 5.17</b>	<b>Standing Time</b>
	The rate shall include for overheads, plant charges, wages and all other costs incurred when the Contractor is unable to carry out the work of the contract, for reasons beyond his control.
	..... Unit: Days
<b>TS 5.18</b>	<b>Cleaning and disinfection</b>
	The rate shall include supply and operate plant and labour to keep the entire pipeline clean and disinfection of the pipeline after pressure testing in accordance with the Project Specifications as per Clause <u>TS 2.27</u>
	..... Unit : Sum
<b>TS 5.19</b>	<b>Charging of Pipeline</b>
	The rate shall include supply and operate plant and labour to charge the pipeline for pipeline hydraulic testing and disinfection. Rand Water to supply the water as per clause <u>TS 2.30</u> .
	..... Sum
<b>TS 5.20</b>	<b>Inspection Requirements</b>
	Allow a sum for the attendance of a RW official, or any person as designated by RW, to travel to, inspect manufacturing and testing at the manufacturer's premises, to include all travel, accommodation and incidental costs
	Prov. Sum
	Contractors mark-up on Provisional sum above ..... Unit: %
<b>TS 5.21</b>	<b>Additional Non Destructive testing</b>
	Additional tests as ordered by the Engineer including for DCVG survey and other non-destructive pipe testing
	..... Prov. Sum
	Contractor's mark-up on Provisional sum above ..... Unit: %
<b>TS 5.22</b>	<b>Cut and Tie in to Existing Pipes.</b>
	The rate shall cover the cost of the following activities:

- (i) Planning of all activities required prior to shut down of existing pipes as per Clause TS 2.22
- (ii) Supply and operate plant and supply of material and labour to cut into existing pipe, cleaning of joints, internal and external welding, repair and internal and external coating to the joints as per Clause TS 2.5.4 or TS 2.9 as relevant.
- a) Description of tie in point  
..... Unit: No
- b) Etc  
..... Unit: No

#### **TS 5.23      Quality assurance of HDPE welded joints**

- a) Independent quality control testing of HDPE welded joints  
..... Unit: Prov Sum
  - b) Percentage charges and profit on (a) ..... Unit: Percentage
- The stated provisional sum shall cover the cost for the independent quality control of the welding operations, quality control systems and testing as ordered by the Engineer. The expenditure of this scheduled item is at the discretion of the Engineer and does not relieve the contractor of his obligation to do normal quality control as stipulated.

#### **TS 5.24      Special Tests Requested by the Engineer**

- a) Pipeline acceptance control and testing by an independent inspectorate  
..... Unit: Prov Sum
  - b) Percentage charges and profit on (a) ..... Unit: Percentage
- The stated provisional sum shall allow for conducting factory and on-site inspections and adjudication of test records that are relevant to the construction of the pipeline (e.g. welds and repairs, etc.) by an independent inspectorate appointed by the Engineer to act on his behalf.

#### **TS 5.25      As built**

The sum shall cover the Contractor's cost of all materials, labour and plant required to execute and complete the work activity as specified under TS 2.34 or described in the Bill of Quantities or as shown on the drawing(s), and/or, where appropriate, shall cover the cost of all requirements and obligations with respect to the work activity

..... Unit : Sum

**TS 6. RETURNABLE SCHEDULES (RS)**

**RS 1.1 DETAILS OF EQUIPMENT (INCLUDING MANUFACTURER'S DATA SHEETS & TECHNICAL PUBLICATIONS)**

**RS 1.2 MATERIALS AND METHOD OF MANUFACTURE OF STEEL SHELLS AND SPECIALS**

<b>Name of manufacturer</b>		
<b>Place of manufacturer</b>		
<b>Name of manufacture of steel strip</b>		
<b>Place of manufacture of steel strip</b>		
<b>Description of method of fabrication of pipes</b>		
<b>Description of method of welding</b>		
<b>Details of welding electrodes and fluxes:</b>		
<b>Steel</b>	<b>Electrode</b>	<b>Flux</b>
<b>Grade:</b>		
<b>Description of hydrostatic testing equipment</b>		
<b>Facilities and equipment for non-destructive testing of welds:</b>		
<b>Radiographic examination</b>		
<b>Facilities and equipment for testing to destruction of welded strips :</b>		
<b>Tensile testing</b>		
<b>Guided bend testing</b>		

**RS 1.3      DETAILS AND METHODS OF COATING AND LINING (REFER TO TECHNICAL SPECIFICATION)**

**DETAILS OF MATERIALS, EQUIPMENT AND PLANT, AND SUB-CONTRACTORS**

**RS 1.4      CEMENT MORTAR MATERIAL (see TS2.10).**

- CEMENT

Type and factory and manufacture .....

- SAND

Supplier of sand .....

Type of sand .....

Water demand at 8,5mm DB penetration for sand to cement ration by mass of one to one : ..... $\ell/m^3$

Typical grading envelope:

Sieve size (mm)	Percentage passing by mass
4,750	
2,360	
1,180	
0,600	
0,300	
0,150	
0,075	

- ADMIXTURES

Machine placed mortar : .....

Hand placed mortar: .....

Cement slurry: .....



- MORTAR MIXES (see TS2.10)

Item	Units	Type of mix	
		Machine placed	Hand placed
Water	kg/m <sup>3</sup>		
Admixture	kg/m <sup>3</sup>		
Cement	kg/m <sup>3</sup>		
Sand	kg/m <sup>3</sup>		
Air	(%)		
Design workability	Mm DB		

- CLEANING EQUIPMENT

Method of cleaning steel pipe .....

Number of machines available .....

- LINING MACHINE

Description .....

.....

Number of machines available: .....

Method of transporting mortar from mixer to lining machine

.....

Maximum mortar delivery rate (m<sup>3</sup>/hour) .....

### Limitations of lining equipment

Limiting pipe dimensions	Lining equipment capability							
	Machine 1				Machine 2			
	Traverse line and trowel	Traverse and line	Traverse only	Cannot negotiate	Traverse line and trowel	Traverse and line	Traverse only	Cannot negotiate
Maximum out of roundness of straight Pipe (mm)								
Minimum short bend radius (m)								
Maximum bend deflection angle (X°)								
Maximum single miter bend angle (X°)								

- CEMENT MORTAR MIXER

Type of machine .....

Normal batch capacity (m<sup>3</sup>) .....

Method of batching water .....

Number of machines available .....

- OTHER PLANT THAT WILL BE PLACED ON THE WORK (Contractor to specify)

Description	Number available
(i)	
(ii)	
(iii)	
(iv)	
(v)	

**RS 1.5            DETAILS OF EPOXY LINING MATERIAL (see TS2.10)**

General

Type / brand .....

Manufacturer .....

Supplier .....

Delivery period after order (in weeks).....

Conformance to TS2.10        YES / NO

If not, supply details of other specification(s) .....

.....

Technical Specification / Brochure included: YES / NO

Note : Include technical details during tender stage.

Mixing and thinning instructions included:    YES / NO

Recommended type and quantity of solvent required for thinning during application:

Type                                : .....

Quantity (ℓ per ℓ)                : .....

Pot life of mixed product (hours): .....

Mixing ratio .....

Maximum recommended dry film thickness per coat (mm):.....

Recommended time intervals between coats (hours):.....

Recommended minimum and maximum pipe surface temperature during application (°C): .....

Time for complete drying and curing on steel surface (hours) : .....

Recommended humidity during application : .....

Recommended field repair kit    : .....

Type / brand                        : .....

Manufacturer                       : .....

Supply technical details           :    YES / NO

- EPOXY MIXER / PLANT / EQUIPMENT

Type of machine .....

Normal batch capacity (m<sup>3</sup>) .....

Method of batching epoxy .....

.....

Number of machines available .....

- OTHER PLANT / EQUIPMENT THAT WILL BE PLACED ON THE WORK (CONTRACTOR TO SPECIFY):

Description	Number available
(i)	
(ii)	
(iii)	
(iv)	
(v)	

**RS 1.6                      DETAILS OF RIGID POLYURETHANE MATERIAL (see TS2.10)**

General

Type / brand .....

Manufacturer .....

Supplier .....

Delivery period after order (in weeks) .....

Conformance to TS2.10: YES / NO

If not, supply details of other specification(s) .....

.....  
Technical Specification / Brochure included: YES / NO

Note : Include technical details during tender stage.

Mixing and thinning instructions included: YES / NO

Recommended type and quantity of solvent required for thinning during application :

Type : .....

Quantity (ℓ per ℓ) : .....

Pot life of mixed product (hours) : .....

Mixing ratio : .....

Maximum recommended dry film thickness per coat (mm) : .....

Recommended time intervals between coats (hours) : .....

Recommended minimum and maximum pipe surface temperature during application (°C) : .....

Time for complete drying and curing on steel surface (hours) : .....

Recommended humidity during application : .....

Recommended field repair kit: .....

Type / brand : .....

Manufacturer : .....

Supply technical details : YES / NO

- POLYURETHANE MIXER / PLANT / EQUIPMENT

Type of machine .....

Normal batch capacity (m<sup>3</sup>) .....

Method of batching polyurethane .....

.....

Number of machines available .....

Other plant / equipment that will be placed on the work (Contractor to specify) :

Description	Number available
(i)	
(ii)	
(iii)	
(iv)	
(v)	



**RS 1.7      DETAILS OF POLYMER MODIFIED BITUMEN MATERIAL (PMB) (see TS2.10)**

General

Type / brand .....

Manufacturer .....

Supplier .....

Delivery period after order (in weeks) .....

Conformance to TS2.10 9.2: YES / NO

If not, supply details of other specification(s) .....

Technical Specification / Brochure included: YES / NO

Note : Include technical details during tender stage.

Mixing and thinning instructions included : YES / NO

Recommended type and quantity of solvent required for thinning during application :

Type : .....

Quantity : .....

Maximum recommended dry film thickness per coat (mm):.....

Recommended time intervals between coats (hours):.....

Recommended minimum and maximum pipe surface temperature during application (°C): .....

Time for complete drying and curing on steel surface (hours) : .....

Recommended humidity during application: .....

Recommended field repair kit : .....

Type / brand : .....

Manufacturer : .....

Supply technical details : YES / NO

- PMB / PLANT / EQUIPMENT

Type of machine .....

Normal batch capacity (m<sup>3</sup>) .....

Method of batching PMB .....

Number of machines available .....

- OTHER PLANT / EQUIPMENT THAT WILL BE PLACED ON THE WORK (CONTRACTOR TO SPECIFY):

Description	Number available
(i)	
(ii)	
(iii)	
(iv)	
(v)	

**RS 1.8****DETAILS AND EXPERIENCE OF SUB-CONTRACTORS**

Please provide on a separate A4 sheet the name, physical address, equipment that will be used (if different from those listed above) and list the experience (relevant projects / contracts) and references of the Sub-Contractor that will be used. The Engineer's approval will have to be obtained, should the Contractor decide to change this Sub-Contractor during the course of the Works:

**CEMENT MORTAR LINING**

- CEMENT MORTAR LINING APPLICATION

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

- CLEANING OF PIPES

Name of Sub-Contractor : .....

Physical address and telephone number: .....

.....

Equipment : .....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

- SURFACE PREPARATION FOR CEMENT MORTAR LINING

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

**RS 1.9****EPOXY LINING**

- SURFACE PREPARATION FOR EPOXY PAINTING**

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

<b>Year completed</b>	<b>Description of Works</b>	<b>Contract Value (R)</b>	<b>Name and telephone number of reference</b>

- EPOXY LINING APPLICATION**

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

- CLEANING OF PIPES

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

## RS 1.10 RIGID POLYURETHANE COATING (PU)

- Surface preparation for RIGID POLYURETHANE COATING

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

- RIGID POLYURETHANE COATING APPLICATION

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....



Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

- Cleaning of pipes

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

**RS 1.11 POLYMER MODIFIED BITUMEN COATING (PMB)**

- SURFACE PREPARATION FOR POLYMER MODIFIED BITUMEN COATING

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

- POLYMER MODIFIED BITUMEN COATING APPLICATION

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

- CLEANING OF PIPES

Name of Sub-Contractor : .....

Physical address and telephone number : .....

.....

.....

Equipment : .....

.....

.....

Experience:

Year completed	Description of Works	Contract Value (R)	Name and telephone number of reference

## RS 1.12 HYDROSTATIC TEST CERTIFICATE

CONTRACT No \_\_\_\_\_

SCHEME: .....							
PIPELINE: .....							
PIPE TEST CONTRACT		METHOD 1. Rand Water Formula		DATE		TEST SECTION: ..... BEGIN (m): ..... END (m): .....	
PIPE DIAMETER (OD) ..... (mm)  PIPE GRADE AND t (mm) .....		LENGTH OF TEST SECTION ..... (km)		TEST PRESSURE ..... (MPa)		ALLOWABLE LEAKAGE RATES 1. Rand Water – Clause TS 8 $0.1 \times \text{Diameter} \times \text{length} \times \text{Test pressure} \times 24 / 30$ (mm) (km) (MPa) (hr) (m) = ..... litre	
TEST PUMP TYPE: ..... MANUFACTURER: .....		PRESSURE GAUGE(S) TYPE: ..... DIAMETER: ..... DIVISIONS: ..... CALIBRATION: .....			MEASURING DEVICES: METER RECORDER VOLUME: ..... DIVISIONS: ..... CALIBRATION: .....		
TIME: 30 min		TIME: 60 min		TIME: 12 hours		TIME: 24 hours	
VOLUME .....	CUMULATIVE .....	VOLUME .....	CUMULATIVE .....	VOLUME .....	CUMULATIVE .....	VOLUME .....	TOTAL .....
FILLING SOURCE OF WATER SUPPLY .....					LEAKAGES		CH (m)
START DATE ..... TIME .....					.....		.....
END DATE ..... TIME .....					.....		.....
		NAME			SIGNATURE		
CONTRACTOR		.....			.....		
RESIDENT ENGINEER		.....			.....		
PIPELINE ASSETS		.....			.....		
DESIGN ENGINEER		.....			.....		
OPERATIONS		.....			.....		

**RS 1.13 Pre –Testing Checklist**

<b>Pre-Testing Checklist :</b>	<b>Yes or No</b>
• Has all the pipeline construction on test section been completed, inspected and signed off?	
• Has it been verified by QA/QC that the proper pipe material, diameters, DR's, flange ratings, fittings ratings, are in accordance with the drawings and specifications?	
• Has the last fusion joint been allowed to cool sufficiently to ambient temperature?	
• Has the pipeline been cleaned of all construction debris and foreign matter?	
• Are the facilities available for preparations for testing?	
• Have local authorities/ citizens been notified of the intent to conduct hydro-testing? • Are all foreign construction materials removed from the trench in contact with the pipe?	
• Are there any point loads on any fittings? (remove them)	
• Are the pipelines supported by backfill or otherwise restrained by sandbags to prevent lateral movement or axial contraction under test pressure?	
• Where cast concrete has been used, has the concrete cured in excess of 7-days?	
• Will the hydro-test be scheduled to occur in dry weather, so that leaks may be detected?	

(testing in wet weather or in water filled trenches is not recommended)	
• Have the proper environmental and regulatory permits been obtained for access to sufficient volumes of fill water, post-test water analysis and treatment, and proper disposal of the test water?	
• Has the pipeline elevation profile and filling procedure been analysed for the fill velocity potential against dynamic surge pressure during filling, which might over-pressure local components, especially in low elevations?	
• Has the volumetric rate of fill, fill method, and fill procedure been finalized?	
• Has the rate of initial pressurization, prior to full pressure hydro-test, been finalized?	
• Has the test plan manual been approved, circulated to all operators, and understood by all participants in pre-test safety and quality meeting? (sign-in sheet)	
• Are some bolted joints going to be left exposed for visual inspection and possible re-torquing during or after testing?	
• If desired, is compacted embedment and trench fill going to be placed so that certain specified joints, fittings, service connections, or valves are exposed, in accordance with the owner's test plan?	
• Have all high elevation points and lateral / cross connections been identified with provisions made to properly install adequately	

sized air vent valves of sufficient volume & pressure capacity	
• Has it been verified that all vent points are installed in the “open” position, for proper operation during filling?	
• Blind-flanges may be used as high-point vents when they are snugly bolted and subjected to low filling pressure, such that trapped air is pushed out past the snug gasket, until the fill-water reaches it and sprays out, thus indicating that all air is expelled, followed by the mechanic fully torqueing the flange per the approved bolting procedure with just static head against the blind.	
• Are all intermediate valves open and capable of passing or venting entrapped air? • Has all the equipment been reviewed for capacity to perform its function without fault during the test?	
• Have all gauges, dead-weight testers, data recorders, temperature recorders, water volume meters, etc, been calibrated within the last 6 months; are certificates on file? Are the gauges permanently identified with traceability to calibration records?	
• Are at least two calibrated pressure gauges or instruments placed into the test system to be used as a cross-check for gauge accuracy? Typically, one calibrated pressure gauge is placed at each end and then monitored, to assure the entire test section was pressurized. When an additional dead-weight tester is used, the pressure readings shall be recorded at a minimum of ½-hour increments. When a calibrated pressure recorder is used, it shall record continuously during the test. Any pressure gauge used shall have sufficient	

pressure range to 150% of the maximum allowable test pressure.	
• Are all temporary tools such as hoses, connection fittings, flanges, blinds, isolation valves, etc, rated higher than the maximum hydrostatic pressure?	
• Is an adequately sized and calibrated hydro-test Valve installed and checked for proper operation?	
• Are properly sized drain ports correctly installed at the lower position along the pipeline, so as to enable emptying of the pipeline as required by contract specifications?	
• Have provisions been made for treatment and disposal of the hydro-test water? Note: when draining is started, have provisions been made to open the upper air vents, to avoid a vacuum internal to the pipeline and to facilitate speed of draining?	
• Are the test heads restrained? Blind flanges are fully restrained. Mechanical ends that are not end load resistant shall be temporarily strutted or anchored to withstand the test pressure thrust without movement. Temporary supports shall not be removed until the pipeline is de-pressurized and shall have signs noting the load limits on temporary fittings and supports.	
• Does the hydrostatic pressurizing pump have its own calibrated valve? • Has the pressurizing equipment been placed in the proper position and checked for proper operation without leakage?	



<ul style="list-style-type: none"> <li>• Is the pressurization pump “right-sized”? Too small of a pump will extend the test duration, and too large of a pump may inhibit adequate control of the test pressure. SAFETY</li> </ul>	
<ul style="list-style-type: none"> <li>• Has there been a safety meeting to review the safety measures and safe practices that are being employed?</li> </ul>	
<ul style="list-style-type: none"> <li>• Will test operators be supplied radio or cell phone communications so that the test progress at remote, non line-of-sight sections can be monitored for venting, or possible leaks or other problems?</li> </ul>	
<ul style="list-style-type: none"> <li>• Has a safety perimeter or boundary been established along the pipeline, surrounded or marked by posts supporting yellow safety-tape or safety-line, to assure unnecessary personnel and equipment stay out of the area during pressurized testing?</li> <li>• Have the on-site hydro-testing personnel filed their OQ (operator qualifications)</li> </ul>	
<ul style="list-style-type: none"> <li>• Have the Hydro test Data, record types, and final Report Forms and format been prepared</li> </ul>	