

**MOKOLO AND CROCODILE  
WATER AUGMENTATION PROJECT  
PHASE 2 (MCWAP-2)**

**TENDER NO 054/2024/PMID/MCWAP2/RFB**

**PART C3.1  
SPECIFICATION**

**SECTION 32**

**PIPES AND PIPE SPECIALS**

PART C3.1

SPECIFICATION

SECTION 32

PIPES AND PIPE SPECIALS

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## **SECTION 32**

### **PIPES AND PIPE SPECIALS**

#### **32.1 SCOPE AND DEFINITION**

This Section deals with the design, manufacture, supply, installation and commissioning of all pipes and pipe specials to be installed above ground, within buildings and concrete structures (pump stations, etc.), as well as underground pipelines and within chambers.

As appropriate this Section shall apply to pipes and specials manufactured from low carbon steel plate, 3CR12 plate or stainless steel 304L or 316L and shall be read in conjunction with Section 33 – Laying and Testing Steel pipes, Section 28 – Mechanical General, Section 37 – Painting and Corrosion Protection, Section 30 – Pumps and Ancillary Equipment, Section 34 – AC Mitigation and Cathodic Protection, Section 35 – Valves and Section 41 - Control and Instrumentation - Plant and Installation.

This Section shall be interpreted as the Employer's requirements for the Contractor's design of pipe work. For all other pipe work this Section shall be interpreted as Employer's design.

##### **32.1.1 Scope**

###### **32.1.1.1 Pipe Design by the Contractor**

The Contractor shall undertake the following pipe design work:

- a) The detail design of pipe work inside pumping stations as indicated on the Drawings and according to the pipework layouts shown on the general arrangement and Drawings provided by the Employer; and
- b) The detail design of the cooling water and seal water pipe systems.

The Contractor shall submit his design calculations and Drawings (including shop drawings) to the Engineer for approval before manufacture commences. Designs shall be in accordance with AWWA M11, BS PD 5500 or BS EN 13445-3 as may be applicable.

###### **32.1.1.2 Prepare Shop Drawings, Supply and Install Pipework**

The Contractor shall also undertake the following:

- a) The production of shop drawings for fabrication of pipes, pipe ancillaries (flanges, nozzles, pipe reinforcement where appropriate, sliding and fixed pipe supports and other anchorages, etc.) and pipe specials (reducers, tees, bends, bifurcations, and the like) based upon:
  - Specified steel type, grade and minimum wall thickness;
  - In-house design and detailing of pipe ancillaries and pipe specials to an approved design code and employing specified internal and external pipes (where appropriate) pressure heads and design parameters, and providing the design calculations in support of the designs done to the Engineer for verification prior to fabrication; and
  - Approved detailed pipe work layout Drawings.

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- b) Manufacture and factory testing of pipes, pipe ancillaries and pipe specials, and delivery to Site and storage and installation on Site, including the supply of all materials and items required, including flange jointing materials where appropriate;
- c) Shop corrosion protection of specials and pipes complete with (where applicable) welded in-situ ancillaries (nozzles, sliding support reinforcement, anchorages, etc.) to lengths according to the pipework Drawings and of random lengths designed for subsequent use as field-welded closer pieces;
- d) All civil engineering work in forming and preparing box outs, chases etc., to receive the concrete imbedded parts and in establishing concrete around them or grouting-in base plates, holding down bolts and the like;
- e) Site corrosion protection of field welds;
- f) Remedial painting where necessary to remedy damage to shop painting of pipes, ancillaries and specials and to valves and appurtenant Plant supplied by others occurring after handover of such Plant by the Contractor;
- g) Site painting to specification, including site painting of valves and appurtenant Plant supplied by others;
- h) Facilitation of the Engineer's observation of the erection, installation and testing of all pipes related to hydro-mechanical Plant. The Contractor shall ensure that specialist personnel are present for the entire duration of testing;
- i) Maintenance of pipes and pipe specials during the Defects Notification Period;
- j) Preparation of an Operating & Maintenance Manual for pipes and pipe specials; and
- k) Supply of all fasteners and washers for complete installation of the entire pipe system. It should be noted that valves and flow meters are provided with fasteners in this Contract.

### 32.1.2 Definitions

Except as indicated below the definitions given in SANS 10044 and SANS 719 shall apply:

- a) **“Cut-and-shut bend”** means a bend formed by cutting out one or more V-shaped sections equally disposed about a line at right angles to the axis of the pipe, preparing the cut-out edges for welding; bending the pipe to form the bend and welding the pipe shut along the prepared edges to complete the bend.
- b) **“Exact length”** as defined in SANS 719 shall be the standard pipe length stated in Clause 32.2.8.
- c) **“Pipe”** means a straight cylinder of uniform diameter and of standard or non-standard length and having square-cut (plain or prepared) ends.
- d) **“Specials”** means any pipe other than a pipe as defined above. Included are all types of specials such as bends, tees, crosses, angle branches, reducers, tapers, couplings and flanged pipes.

### 32.1.3 Abbreviations

AIA	Approved Inspection Authority
API	American Petroleum Industry
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AWWA	American Water Works Association

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BS	:	British Standard
BS EN	:	British Standard and European Norm
BSPT	:	British Standard pipe thread
D	:	Diameter
DN	:	Nominal diameter – (ISO 6708)
ERW	:	Electrical resistance weld
FA	:	Flange adaptor
FBE	:	Flanged both ends
FOE	:	Flanged one end
FW	:	Field weld
ID	:	Inside diameter
ISO	:	International Standards Organisation
OD	:	Outside diameter
PBE	:	Plain both ends
PE	:	Plain end
PN	:	Nominal pressure (Rating) - (ISO 7268)
PQI	:	Production Quality Inspectorate
RFA	:	Restrained flange adaptor
SANS	:	South African National Standard
SAW	:	Submerged arc weld
SOC	:	Slip-on coupling
STT	:	Surface Tension Transfer welding
t	:	Wall thickness of pipes
WP (B)	:	Weld preparation (Butt)

**32.1.4 References**

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

**32.2 GENERAL REQUIREMENTS****32.2.1 Supporting Specifications**

The latest issues of the following specifications at the time of tender, and as appropriate shall be deemed to apply to the manufacture of pipes and specials using either submerged arc spiral welding or longitudinally welded "cans" rolled from low carbon or steel plate and joined by submerged arc circumferential welding to form suitable pipe lengths. The manufacture of pipe specials shall also be subject to these requirements:

SANS 62-1&62-2	Steel pipes and pipe fittings up to 150 mm nominal bore, Part 1 and Part 2
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (large bore)

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SANS 1431	Weldable structural steels
SANS 1476	Fabricated flanged steel pipework
SANS 1700	Fasteners
SANS 4633	Rubber seals – Joint rings for water supply, drainage and sewerage pipelines
SANS 15589-1	Cathodic protection of pipeline transportation systems – Part 1
BS 534 (see note 1)	Steel pipes and specials for water and sewage
BS 970 (see note 2)	Wrought steel for mechanical and allied engineering purposes
BS EN 1092	Flanges and their joints
BS 7531	Rubber bonded fibre jointing for industrial and aerospace purposes
API 5L	Line pipe
API 1104	Welding of pipelines and related facilities
AWWA M11	Steel pipe - a guide for design and installation
AWWA C208	Dimensions for fabricated steel water pipe fittings
ISO 7005	Metallic flanges
ISO 8501-1	Preparation of steel substrate before application of paints and related products
	Visual assessment of surface cleanliness – Part 1
ASME BPVC	ASME Boiler and Pressure Vessel Code Section VIII
BS PD 5500	Specification for Unfired Pressure Vessels
BS EN 13445-3	BSI British Standards Unfired Pressure Vessels
ASME B31G	Manual for Determining the Remaining Strength of Corroded Pipelines

Note 1 - Replaced by BS EN 10224 (Non-alloy steel tubes and fittings for the conveyance of aqueous liquids including water for human consumption) and BS EN 10311 (Joints for the connection of steel tubes and fittings for the conveyance of water and other aqueous liquids), but for the purpose of this Contract the previous version remains applicable.

Note 2 – BS 970 Part 1: 1991 & BS 970 Part 3: 1991 replaced by BS EN 10088-3 covering chemical composition & mechanical properties.

### 32.2.2 Welding of Specials

Welding of specials and weld inspection shall conform to the requirements of API Standard 1104 – Welding of Pipelines and Related Facilities.

All butt welds and branch fillet welds on specials shall where practical have an internal weld. The weld bead of this internal weld shall not extend above the prolongation of the original inside surface of the pipe by more than 2 mm. Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

Reducer pieces shall not have more than two longitudinal weld seams.

### 32.2.3 Qualification of Welders

All manual or semi-automatic welds and repair welds shall only be undertaken by welders qualified in terms of tests laid down in the latest issue of the API Standard 1104 – Welding of Pipelines and Related Facilities.

### **32.2.4 Non-destructive Tests and Adjudication**

Radiographic testing of welds is the preferred method of testing of welds and shall be used unless approved otherwise by the Engineer. Where welds cannot be tested using the Radiographic methods, a combination of alternative methods shall be submitted for approval.

The following standard Specifications shall apply:

Radiographic Inspection	:	API 1104
Ultrasonic Inspection	:	API 5L
Dye/Liquid Penetrating Test	:	API 1104 and SANS 1200L
Magnetic Particle Inspection	:	ASME Boiler and Pressure Vessel Code, Section V

The results of the radiographic testing shall be saved in digital format for archiving of the records.

### **32.2.5 Coatings and Linings**

Coatings and linings of pipes and specials shall be undertaken according to the requirements of Section 37 - Painting and Corrosion Protection.

The linings and coatings provided under this Contract shall be suitable for the pipelines specified in terms of this Contract and the linings and coatings shall be capable of withstanding pipe deflections as indicated in Clause 32.2.6 below.

### **32.2.6 Outside Diameters and Minimum Wall Thickness**

The design stress for pipes and pipe specials at the specified design pressures shall be as follows:

- For working pressure: 50% of the minimum yield stress of the steel;
- For surge pressure: 60% of the minimum yield stress of the steel; and
- For field test pressure: 75% of the minimum yield stress of the steel.

Unless otherwise specified in the Bill of Quantities or on the Drawings, the minimum pipe wall thickness to prevent buckling and excessive deflection of straight piping due to internal sub-atmospheric pressures and external loads shall not be less than the larger of 4 mm or the following:

- 1/150 x pipe outside diameter for buried pipes; and
- 1/130 x pipe outside diameter for exposed pipes.

Deflection (ovality) of buried pipes and specials shall not exceed:

- 2% for cement mortar lining;
- 3% for all other pipes.

Refer to Section 33 for the definition of deflection (ovality).

Pipe outside diameters and wall thicknesses shall be as shown on the Drawings. Wall thicknesses for bends exceeding 150 mm nominal bore will be as for straight pipe unless indicated differently on the Drawings or in the Bill of Quantities.

For nominal diameter pipes of 150 mm and below the provisions of SANS 62 for plain ended, heavy class pipe shall apply.



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All minimum wall thicknesses as indicated in this Specification and in the Drawings shall mean absolute minimum thickness. No negative tolerances shall be allowed on these thicknesses.

When Surface Tension Transfer (STT) welding is used for field welding on joints, the minimum pipe wall thickness should not be less than 6 mm.

### **32.2.7 Corrosion Allowance**

No corrosion allowance (sacrificial wall thickness) shall be added to the minimum pipe wall thickness required as determined by the loads imposed or functionality design.

### **32.2.8 Dimensional Requirements of Pipes**

The tolerances on all dimensions excluding pipe diameter shall be in accordance with SANS 719: 2011 Clause 5.1 inclusive of the following:

- The tolerance applicable to the outside diameters (OD) of pipe ends above 1 250 mm shall be between +2.4 mm and 1.0 mm over a length of 150 mm (Refer Table 3 of SANS 719:2011).
- The tolerance applicable for pipe outside diameters (OD) above 1 250 mm, the tolerance shall be 6 mm. (Refer Table 4 of SANS 719:2011). – Refer to note1 below.

#### **Notes:**

Note 1: Where the Contractor plans cutting mitre joints the OD tolerances shall be specifically checked for compatibility when setting up these field joints. Refer to maximum offset requirements specified in Section 33 (Clause 33.6). The Contractor can instruct reduced / tighter pipe manufacturing tolerances where and when required.

Note 2: Unless otherwise specified in the Bill of Quantities or on the Drawings, all line pipes shall be of fixed standard length between 9 m and 19.5 m except where shorter lengths are specified.

Note 3: The tolerances on the squareness of the pipe ends for pipes larger than 500mm OD is described by subclause 5.1.5 b) of SANS 719:2011. The Contractor can instruct reduced / tighter pipe manufacturing tolerances where and when required to suit the planned field weld setting up requirements. The measurement method shall be subject to approval by the AIA.

For nominal diameter pipes of 150 mm and below the provisions of SANS 62 for plain ended, heavy class pipe shall apply.

### **32.2.9 Specials**

#### **32.2.9.1 General**

The Contractor shall submit his design calculations and shop drawings to the Engineer for approval before manufacture commences. Designs shall be in accordance with AWWA M11, BS PD5500 or BS EN 13445-3 as may be applicable.

Specials shall be manufactured from pipe conforming to this Specification. Where details of the specials are provided on the Drawings, the specials shall comply in all respects with the Drawings. Where constructional details are not indicated on the Drawings, the specials shall be manufactured in accordance with detailed drawings to be prepared by the Contractor and approved by the

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Engineer. The wall thickness shall be sufficient so that the water turbulence shall not cause excessive vibration or noise.

For bifurcations and branch connections the plate thickness of the barrel and branch shall be such that the maximum stress shall not be greater than that for an uncut pipe of the theoretical required minimum thickness. However, where it is more economical to provide external welded reinforcement (collar, wrapper and crotch plates, etc.) these forms of reinforcement shall be used to achieve the same results.

Lifting eyes (lugs) shall be welded to all unwieldy specials and to all specials of DN500 and larger to facilitate handling and minimize damage to the protective coating during handling.

All specials and fittings shall be manufactured exclusively at the works of an approved manufacturer. No site fabrication or repair of specials other than mitre bends of 11.25° or less will be permitted unless the Contractor's workshops, equipment, facilities, staff, quality control facilities etc. is approved by the Engineer for each specific portion of the manufacturing process and subject to the condition that it is maintained by the Contractor to the satisfaction of the Engineer. The Engineer shall retain the right to withdraw his approval at any time.

### **32.2.9.2 Bends**

Unless otherwise indicated or specified in this Section or detailed on Drawings the dimensions for bends shall be in accordance with AWWA C208. Bends shall either be smooth formed or gusseted. The maximum angle between oblique butt-ends of segments for gusseted bends including bends on sweep-T items shall not exceed 22.5° in accordance with the AWWA C208. "Cut-and-shut" bends will not be permitted. Bends shall have their "centre plane" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends during laying.

Bend radii shall be 2 times OD unless otherwise indicated on the Drawings or stated in the Bill of Quantities.

The number of segments that a gusseted bend shall comprise shall be as given below, unless otherwise indicated on the Drawings or stated in the Bill of Quantities:

- Bends 11.25° to 22.5° 3 segments
- Bends above 22.5° to 45.0° 5 segments
- Bends above 45.0° to 90.0° 7 segments

Mitres for bends (links) of 11.25° and less shall be made in the field as part of the pipe laying operation in terms of Section 33 – Laying and Testing Steel Pipes.

### **32.2.9.3 Branches and Nozzles for Bypasses, Drains, Air Valves, Pressure Gauges, etc.**

Branch connections shall have barrel and branch plate thicknesses such that the maximum stress shall not be greater than that for an uncut pipe of the theoretically required minimum thickness. However, where it is more economical to provide external reinforcement in the form of collar or wrapper or crotch plates, these forms of reinforcement shall be used to achieve the same results.

The attachment of reinforcement to pipe branches shall be by full penetration welding. Branch connections shall be as remote as possible from the seam or spiral weld on the barrel, and except where specifically indicated to the contrary on the Drawings, the positioning and extent of external reinforcement is to be determined in accordance with AWWA Manual M11.

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Branches to pipes or pipe specials shall be of minimum DN150 to allow continuity of corrosion protection within the pipe and shall be flanged and of “stub-in” type in accordance with ANSI B31.3, welded internally and externally.

Where required smaller diameter nozzles shall be provided on a blank flange on a DN 150 branch. Minimum size DN25. Such nozzles shall be threaded to BSPT and provided with appropriate reinforcement, of minimum thickness 25 mm. The Contractor shall ensure that the design will withstand the test pressure of the pipeline.

Centre lines of nozzles and branches shall be at right angles to the barrel of the pipe, unless indicated otherwise on the Drawings.

Branch connections shall be as remote as possible from the seam weld on the barrel and shall generally be placed as follows, except where specifically indicated to the contrary on the Drawings:

- a) For air valve tees the centre lines of the air valve branch and the barrel shall intersect at right angles or vertically, as shown on the Drawings, depending on the type of tee specified. The branch shall be flanged and have a nominal diameter of:
  - 700 mm for pipelines of DN700 and larger; and
  - The DN for pipelines of DN < 700 mm.
- b) For scour valve tees the branch invert shall be located on the pipe invert and point horizontally at right angles to the barrel of the pipeline. The branch flange shall be set so that the scour valve spindle points vertically upwards.

#### **32.2.9.4 Reducer Pieces**

The tapered portion of a reducer shall be at least four times the length of the tapering difference in diameter unless otherwise approved by the Engineer. Tapered sections shall also have a maximum angle of divergence of:

- 7° for concentric reducers
- 14° for eccentric reducers

Tapers shall be concentric unless otherwise indicated on the Drawings. The impact of the use of eccentric reducers upstream of the final selected pumping systems shall be verified during the detail design stage. The design of the reducers shall comply with the requirements of AWWA M11 and AWWA C208.

#### **32.2.10 Flanges and Gaskets**

Refer to Section 28 - Mechanical General in this regard.

#### **32.2.11 Pipeline Access**

Access points to pipelines shall be provided at all air valve and scour valve installations. The access opening shall be 700 mm diameter and have flanged covers to facilitate easy removal and re-installation.

Unless the pipe line is designed for pigging, access shall be provided every 600 m.

### **32.2.12 Flexible Couplings and Flange Adaptors**

The type of coupling and flange adaptor shall be subject to the Engineer's approval and Straub, Arpol or similar clamp on couplings are not acceptable.

Flexible couplings shall have a centre register, except where specified to the contrary in the Bill of Quantities or on the Drawings or approved by the Engineer. All couplings and flange adaptors shall permit a repeated movement to cater for thermal expansion and contraction of the pipes, removal of specials and valves and shall further allow for the angular deflections, all in accordance with the supplier's specification for each specific size.

During installation, all tolerances relating to permitted gaps, misalignment, angular deflection, differences in pipe OD, axial movement, lateral displacement, etc., shall be complied with.

The inner clamping rings of "Viking-Johnson" or "Klamflex" type couplings shall be machined grade. 300WA steel or similar approved. Where these type couplings or flange adaptors are being used, the end section of the pipe shall have a grade 300WA or similar approved steel collar, the length of which shall be appropriate to the specific coupling / flange adaptor. All weldments on the outer surface of the collar shall be ground smooth.

### **32.2.13 Pipe Ends for Pipes and Specials Joined by Means of Flexible Couplings**

The ends of plain ended specials to be jointed by means of flexible couplings shall be fitted with grade 300WA or similar approved steel spigots ("collar") machined to the OD specified and allowance made for the application of the specified protective coating. The length of the "collar" shall be equal to the specific coupling / flange adaptor.

The ends of pipes where machined spigots are omitted, with the approval of the Engineer, shall be round to within the tolerances specified in Clause 15 of BS 534 and the relevant clauses of API 5L and suitable for use with slip-on, or other special couplings. (See also Clause 32.3.4.1 and the relevant drawings).

### **32.2.14 Provision of Thermit Welding Pads**

Where pipes and specials are to be jointed by means of flexible couplings and will be subjected to cathodic protection, the manufacturer shall weld steel plates not less than 50 x 75 x 10 mm thick 250 mm from each end of all pipes during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for thermit welding pad bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

### **32.2.15 Insulating Flanges**

Refer to Section 28 - Mechanical General and Section 34 AC Mitigation and Cathodic Protection in this regard.

### **32.2.16 Steel Pipe Stiffeners**

#### **32.2.16.1 Stiffener Manufacture and Fixing**

Stiffeners are not required for this project. When required the detail will be specified under this clause.

#### **32.2.16.2 Quality Control**

##### **(a) Welding Requirements**

Welding on steel stiffeners shall conform to the general welding specification for pipelines as specified in this Section with the following additional requirements:

- Uniformity of appearance: All welds shall be substantially uniform in appearance and shall show full fusion and penetration throughout their lengths.
- Weld bead tolerances: The outer weld bead shall not exceed a height of 3 mm. The inner weld bead shall not project more than 2 mm and all excess weld metal shall be removed by grinding to the satisfaction of the Engineer.
- Freedom from defects: The weld, heat affected zone and surrounding parent metal shall be free from cracks and other defects described in API Specification 5L.

##### **(b) Inspection and Quality Control Requirements**

Liquid Penetrant Testing in accordance with Clause 32.10.5 shall be done on completed welds between stiffener ring halves. The full length of completed welds for the circumferential fillet welded seam made to join stiffeners to pipe shells shall be inspected in accordance with Clause 32.10.5 by Liquid Penetrant testing.

Ultrasonic inspection shall be carried out on the full length (100 per cent) of every circumferential fillet welded seam made to join stiffeners to pipe shells.

### **32.3 MANUFACTURE AND WORKMANSHIP**

#### **32.3.1 General**

Pipes and specials shall be manufactured in accordance with the specifications referred to in Clause 32.2.1 and the general requirements stated in Clause 32.2 above.

#### **32.3.2 Seams**

Longitudinal seams, spiral seams and shop girth seams shall all be butt welded.

#### **32.3.3 Rounding of Pipe and Sizing of Ends**

If it is necessary to reshape pipes after they have been welded, reshaping shall be performed by re-rolling or by pressure. Reshaping of pipes by dropping or hammering will not be permitted. Sizing

of pipe ends to achieve specified end tolerances will be permitted. This may include expanding pipe ends either mechanically or hydraulically by a maximum of 1.5% of its original diameter.

### **32.3.4 Preparation of Pipe and Special Ends**

#### **32.3.4.1 Mechanical Couplings**

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm measured perpendicularly from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm or 3 X OD whichever is the lesser (See Clause 32.2.13 and Clause 32.2.14).

#### **32.3.4.2 Fillet Welds**

Ends for use with fillet welded sleeve joints shall be prepared as specified in Clause 32.3.4.1.

#### **32.3.4.3 Butt Welds**

Pipes and specials which require joints to be butt welded on site shall be supplied with ends bevelled ("WP (B)"). Square cut ends will require approval.

For pipes and specials to be jointed by butt welding, the internal weld bead shall be ground flush with the internal surface of the pipe or special for a length of 200 mm from the ends to be jointed.

#### **32.3.4.4 Weld Beads**

The internal weld bead resulting from fusion welding and the height of the upset metal and flash on the inner surface resulting from electric resistance welding shall not exceed 2.0 mm. No undercut shall be permissible.

Unless it is stated elsewhere in the Specification or on the Drawings that pipes or specials are to be jointed by butt-welding, the external weld reinforcement or upset metal and flash shall be ground flush with the body for a length of 200 mm back from the ends.

#### **32.3.4.5 Spigot and Socket**

Spigot and socket ends shall be rolled or fabricated from plate, sheet or special sections to the required shape without hammering. Longitudinal or spiral welds on the inside of the socket and the outside of the spigot shall be ground to plate or sheet surface for a distance not less than the depth of insertion of the spigot into the socket.

#### **32.3.4.6 Bevelling**

All bevelling, where required, shall be delayed until after all non-destructive testing has been completed, but may be done after completion of hydrostatic testing.

#### **32.3.4.7 Flanges**

Ends to be fitted with flanges shall have the longitudinal or spiral welds ground to plate or sheet surface for a distance from the ends sufficient to accommodate the flange.

#### **32.3.4.8 Repair of Defects**

If a pipe fails to pass any of the tests specified in Clause 32.10, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the pipe to pass the test.

Repairs of welded joints will 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.

The repair procedure and performance on repairs shall be in accordance with Section 10 of API 5L. Only qualified welders shall be employed. Each repair weld shall be marked with the welder's identifying stamp. When the repair has been made, it shall be tested in accordance with Clause 32.10 and Clause 32.10.4.3(e).

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

Should a weld repair be required on a pipe subsequent to hydraulic testing the pipe shall be retested in accordance with Clause 32.10.

Dents shall, where practicable, be jacked out, provided the extent of the dent is less than what is considered allowable in terms of API 5L, Where the extent of the dent exceeds the allowable limit, a window repair will have to be done or a section of pipe replaced.

#### **32.3.4.9 Grinding Flush**

Where welds are required to be "ground flush" great care shall be taken to avoid over-grinding, thus thinning the pipe wall. Random thickness measurements at "ground flush" locations shall be made to prove that over-grinding has not occurred. In the event that material pipe wall thinning is detected the specified minimum thickness shall be restored by means approved by the Engineer.

### **32.4 CORROSION PROTECTION**

#### **32.4.1 General**

Corrosion protection of pipes and specials supplied under this Specification shall conform to Section 37 – Painting and Corrosion Protection. Colour coding shall be in accordance with Annexure 37/1 of Section 37 – Painting and Corrosion Protection.

## **32.5 MATERIALS**

### **32.5.1 Pipes and Specials**

Unless otherwise indicated on the Drawings:

- Pipes, pipe supports and specials of nominal diameter equal to or less than 150 mm shall be manufactured of steel in terms of SANS 62 (heavy class pipes up to 50 bar internal pressure) and API 5L for steel grades up to X52.
- Pipes and specials of nominal diameter larger than 150 mm shall be manufactured from steel grade A, B and C to SANS 719, steel grade 300WA or 350WA to SANS 1431 and steel grade X42, X46, X52, X56, X60 and X65 to API 5L, EN 10025-2: Steel Grade S355JR + AR, as specified.
- Pipes and specials of nominal diameter larger than 150 mm and embedded in soil shall be manufactured from a steel grade as specified (Grade 300WA steel to SANS 1431, X42 and X52 or other approved).
- Pipes and specials manufactured from stainless steel shall be grade 316L in accordance with BS 970.
- Pipes and specials manufactured from 3CR12 steel shall be in accordance with EN 10028-7.
- Seamless pipes shall comply with ASTM A106 – Schedule 40(40 bar) or 80(80 bar) as determined by the design pressure.
- Seamless specials and fittings shall comply with ANSI B16.5 & B16.9 – Schedule as determined by the design pressure.

### **32.5.2 Rubber**

Rubber for jointing rings in flexible couplings shall be manufactured from first grade natural rubber to SANS 974 Class F.

## **32.6 MARKING**

Marking shall generally be in accordance with Section 28 - Mechanical General. Additionally, all pipes and specials shall be clearly marked / stencilled alongside a longitudinal or spiral weld on both ends on the inside of the pipe with the following information:

- a) Grade and thickness of steel;
- b) Serial number of the pipe or special;
- c) Nominal diameter (mm);
- d) Factory Hydraulic Test Pressure (kPa); and
- e) Spool / Coil Number.

The applicable drilling table for each flanged pipe shall be stamped on the periphery of all flanges. Bends shall have their centre plane marked with two small punch marks close to both ends to facilitate correct positioning in laying.



## **32.7 VALVES**

Refer to Section 35 - Valves.

## **32.8 STORAGE, HANDLING AND TRANSPORT**

### **32.8.1 General**

The storage, handling and transportation of Plant shall generally conform to the requirements of Section 28 – Mechanical General.

### **32.8.2 Storage, Handling and Transport of Pipes and Specials**

Pipes and specials shall be protected against damage at all stages from manufacture to installation. Particular care shall be taken to protect the ends of all pipes and specials against denting. Repairable dents shall, where practicable, be jacked out, provided the extent of the dent is less than what is considered allowable in terms of API 5L. Where the extent of the dent exceeds the allowable limit, a window repair will have to be done or a section of pipe can be rejected and replaced.

Satisfactory temporary end covers shall be provided for the protection of flanges, prepared ends of plain-ended pipes, specials and fittings, and threads, to prevent damage to the internal lining during transportation and during handling on Site.

Pipeline materials shall be so transported, stored and handled that pipes are not overstressed at any time and specials and fittings are not damaged in any way. All coated pipes shall be handled with particular care and shall be stored on sand bags or similar supports approved by the Engineer to ensure that the pipe coating is not damaged, it is at least 150 mm above the ground level at any point and it is not subjected to concentrated pressure from stones or other objects. Pipes damaged or cracked in any way shall be removed from the Site at no cost to the Employer unless the repair of it is approved by the Engineer.

The pipes and specials shall at all times be handled with approved equipment, employing stout, wide canvas or rubber-covered slings and wide padded skids designed to prevent damage to the exterior coating.

The slings for coated pipes shall be at least 500 mm wide for pipes up to DN600, 600 mm wide for pipes of above DN600 and up to DN1200 and 800 mm wide for pipes of DN1400 and larger, or as otherwise approved by the Engineer. Cement-mortar lined steel pipes shall only be lifted by means of approved spreader beams with at least two slings.

Bare cables, chains, hooks, metal bars, or narrow skids shall not be allowed to come in contact with either the exterior coating or the interior lining of the pipes.

All pipes in excess of 12 m, but not exceeding 19.5 m in length shall be lifted by means of a spreader beam with broad band slings from two points (at about 25% of the pipe length from each end), or as otherwise approved by the Engineer.

Pipe specials requiring mechanical hoisting / lifting shall be provided with suitable lifting lugs to facilitate handling without damaging the corrosion protection. The position and size of the lifting lugs shall be indicated on the workshop drawings.

The Contractor shall be responsible for the transport of pipes and pipe specials to site, off-loading and storage on Site, all in accordance with the Specification.

### **32.8.3 Transport**

Pipes and specials shall only be transported on properly constructed or adapted vehicles containing correctly shaped and padded cradles or with strong, sawdust filled bags separating pipe and vehicle body as well as individual pipes from each other. Special care shall be taken with the transport of all coated steel pipes as damaged coatings might be subject to rejection. Pipes shall be transported and stacked in a manner such as to prevent deformation of the pipe body in excess of 2% of diameter.

Rubber belts with a minimum width of 300 mm and of adequate length shall be used to ensure that the pipes cannot come into contact with each other while being transported or handled. When making deliveries by road transportation, all chains, cables or other equipment used for fastening down the load shall be carefully padded.

Profiled cradles, at least 500 mm wide for pipes up to DN500 and 1000 mm wide for larger pipes, suitably padded for the pipes to rest on, shall be provided on each delivery vehicle. A minimum of two cradles per pipe length shall be used. The padded cradle surface shall be profiled to match the coated outside radius of the pipe and shall support the pipe over an arc length of at least 1000 mm (support angle of 60 degrees).

Suitable means of strapping the pipes onto the delivery vehicle without damaging the coating shall be provided. Where pipes are larger than DN700, the ends of each pipe shall be braced with approved interior supports or spiders only if required by the Engineer. Stiffened steel pipes shall not be braced.

### **32.8.4 Loading and Off-loading**

Pipes shall never be allowed to be dropped, to fall from trucks or be allowed to collide with each other.

Care shall be taken during off-loading to prevent damage to the corrosion protection system. The pipes shall be placed on approved supports such as sandbags in a demarcated area which area has been cleared of all vegetation and treated with an effective weed killer. Supports shall be provided at  $\frac{1}{4}$  points along the pipe length. The supports shall be wide enough and so arranged that the bearing area is adequate to prevent damage to the external coating whether due to load intensity or axial thermal expansion movement.

The Contractor will be held responsible for off-loading the pipes at the delivery site and for stacking to a height determined by the formula below with pads between individual pipes, or for stringing the pipes along the trench with pipes supported at  $\frac{1}{4}$  points by padded cradles or saw-dust filled bags to prevent contact of the pipes or specials with the ground or other hard or sharp objects.

Pipes when loaded or off-loaded, or placed in trench shall be as close as horizontal as possible while being handled.

Coated steel pipes shall always be supported on a sufficient number of approved soft bolsters to prevent damage or the permanent deformation of coatings. Coated steel pipes shall not be stacked more than two pipes high, each layer separated by bolsters.

Any material which is not delivered and off-loaded on Site in the same condition as it left the factory may be rejected by the Engineer.

Each class and diameter of pipe shall be stored separately in its own stockpile or demarcated area.

**32.8.5 Material that Deteriorate under the Action of Sunlight**

All rubber rings or other materials which will deteriorate under the action of sunlight, ozone or inclement weather, shall be stored in permanent shade in lockable weather-proof sheds. Welding and the running of welding machines and electric machinery shall not be permitted in or near places where rubber or plastic products are stored and care shall be taken at all times to prevent contamination of these products by oil or other petroleum derived products.

Pipeline coating that may be subject to deterioration due to sunlight or weather conditions, shall be adequately protected, and the duration of the exposure should be limited as much as possible.

**32.8.6 Records of Materials on Site**

The Contractor shall keep and maintain a complete and comprehensive record of each pipe, special and fitting delivered to Site. The record shall at least denote the reference number, size, pressure class, location in the pipeline, date, condition at delivery and the location of delivery and the location of storage. Copies of the record shall be submitted to the Engineer at the end of each month or whenever requested by the Engineer.

When pipes, specials and fittings are delivered without reference numbers, it shall be provided by stencilling, labelling or other methods approved by the Engineer.

**32.9 INFORMATION AND DRAWINGS TO BE SUBMITTED****32.9.1 Pipe Layout and Shop Drawings**

After receipt of the order but before issue of shop drawings for manufacture, detailed pipework layout drawings shall be provided for approval in principle by the Engineer. Such drawings shall contain general arrangements and assemblies for the pipes, pipe auxiliaries, pipe specials and valves and include materials schedules, standard parts, etc. Drawings shall provide all the information necessary to demonstrate full compliance with the Drawings and Specifications and to facilitate subsequent submission of shop drawings free of fit-up error.

Pipe layout drawings shall incorporate all relevant prime and subsidiary dimensions (primarily, but not necessarily limited to, face-to-face dimensions).

Drawings shall be prepared to acceptable industry standards and in accordance with Section 28 – Mechanical General, an example of which shall be submitted for approval by the Engineer before draughting commences. Due account is to be taken in preparing drawings of the necessity, inter alia, to facilitate straight-forward subsequent fit-up on site, without undue site trimming and site preparation for butt welding, so minimizing also the necessity for extensive site repairs to, or extensions of, internal and external corrosion protection.

Only after approval of final pipework layout Drawings by the Engineer shall shop drawings for manufacture of pipes and specials commence. For subsequent approval by the Engineer these shall be in such detail as is appropriate for manufacture.

Approval by the Engineer of any drawing shall not relieve the Contractor of responsibility for correct manufacture and subsequent fit-up on site.

The Engineer has the right to require manufacture to be suspended until an approved set of pipe layout and shop drawings is in his possession.

**32.10 QUALITY ASSURANCE AND FACTORY TESTING****32.10.1 General**

Tests of the Works will take place as shown in the Construction Programme.

Quality assurance and inspections shall be in accordance with Section 28 – Mechanical General.

**32.10.2 Workmanship**

Workmanship, inspections, inspection documents and repair of defects shall be in accordance with SANS 719, API 5L, Section 10 and the standards of acceptability where shown on the Drawings.

**32.10.3 Inspection and Methods of Testing**

In addition to the requirements of SANS 719 the following requirements shall apply to the testing and inspection of pipes. Specials shall be tested as indicated in the following relevant sections of this clause.

Where possible and as agreed with the Engineer, specials shall be hydraulically pressure tested in the same way as specified for pipes.

All hydraulic pressure tests on pipes and specials shall be conducted before the application of any corrosion protection.

Factory inspection, verification and witnessing of tests and inspection of test records may be carried out by the Engineer or an independent Inspectorate appointed by the Engineer or Employer.

Tests and inspections shall be carried out at the Manufacturer's works at the expense of the Contractor who shall provide all necessary testing facilities, labour, instruments, equipment and samples that might be required. The cost of these tests shall be included in the Contractor's rates. The Engineer or his representatives shall be afforded every facility during the course of manufacture and testing to enable witnessing and inspections to be carried out effectively.

The Engineer or his representatives shall have the right to select test samples and all instruments utilized for testing purposes shall be subject to the approval by the Engineer or his representatives and if in the opinion of the Engineer or his representatives any instrument requires calibration, such instruments shall be calibrated at the expense of the Contractor by such body as may be approved by the Engineer.

No mechanical re-working or straining of pipes and specials shall be allowed after testing and inspection.

**32.10.4 Non-destructive Inspection****32.10.4.1 Visual Inspection**

All finished pipes and specials shall be visually examined and shall be free of injurious defects as defined in API 5L Section 10.2.7. In addition, welds on specials shall be inspected by the application of a penetrant-dye on the inside of the welds and no trace of the dye should appear on the outside of the pipe after completion of the test.

#### **32.10.4.2 Ultrasonic Inspection**

The Engineers approval of a detailed method statement is required for the use of this test method prior to the start of production. When this method is used 100% of all longitudinal or spiral welds on straight pipes shall be checked with an approved ultrasonic method capable of continuous and uninterrupted inspection of the weld seam in accordance with API 5L, Annexure E5. The equipment shall be checked with an applicable reference standard at least twice every production shift.

#### **32.10.4.3 Radiographic Inspection**

Radiographic testing of welds are regarded as industry norm. Test records are required to be saved in digital format. It is a requirement that 100% of longitudinal, circumferential, spiral welds and scalp welds shall be subject to radiographic inspection in accordance with API 1104, Section 9.3.

##### **(a) Longitudinal Welded Pipe**

Submerged-arc fusion welded pipe, if inspected full length by ultrasonic methods, shall also be inspected by radiographic methods for a distance of 200 mm from each end of each length of pipe. Electric resistance welded pipes shall, however, only be inspected full length by ultra-sonic methods.

##### **(b) Spiral Welded Pipework**

Submerged-arc fusion welded pipe, if also inspected full length by ultrasonic methods, shall also be inspected by radiographic methods for a distance of 100 mm from each end of each length of pipe and of the complete "H" at all skelp end welds including 150 mm of the spiral welds in both directions away from the intersection points with the skelp end welds.

##### **(c) Circumferential Butt Welds**

100% of the length of all circumferential butt welds shall be examined by radiographic methods. When consistently acceptable results are obtained, the number of welds to be so tested may be reduced by the Engineer.

##### **(d) Specials**

100% of all manual or semi-automatic welds in specials (where possible) shall be examined by radiographic methods and all other welds by liquid penetrant testing.

##### **(e) Welding Repairs**

For straight piping, 100% of the total length of all repairs shall be examined by radiographic methods.

For pipe specials, 100% of all repairs shall be examined radiographically (where possible) and all other welds by liquid penetrant testing.

**(f) Welding of pipes at Rail, Road and River Crossings**

For rail, road, river and stream crossings, 100% of the total length of all welds shall be examined radiographically.

**32.10.5 Liquid Penetrant Testing**

Where requested by the Engineer or AIA, liquid penetrant testing should be done in accordance with Sub-clause 7.2.1 of SANS 1200 L, clause 9.5 API 1104, ISO 10893-4 and ASTM E165.

**32.10.6 Magnetic Particle Testing**

Where requested by the Engineer or AIA, magnetic particle testing shall be done in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 7.

**32.10.7 Destructive Testing**

The Engineer may require that any pipe be tested to destruction in accordance with SANS 719. If practicable the Engineer may require the Contractor to repair and retest such a pipe.

**32.10.8 Roundness**

Upon completion of the hydrostatic test of individual pipes, the ends of pipes and specials shall be tested by means of "Go / No-go" gauges to check whether flaring or cupping has occurred. If necessary the ends shall be expanded or ground until they comply with the Specification. (See also Clause 32.2.13).

**32.10.9 Sampling and Compliance with the Specification**

This shall be performed in accordance with Clause 6 of SANS 719.

**32.10.10 Repair of Injurious Defects**

Injurious defects found by non-destructive testing of welds, visual examination, hydrostatic testing or determined by any other means to exceed the limitations in API 5L Section 10 shall be repaired in accordance with API 5L Annexure D but subject in all respects to the requirements of this Specification Section 32.

**32.10.11 Inspectorates**

The Contractor shall appoint an Approved Inspection Authority (AIA) to carry out any independent tests and monitoring to verify compliance with the Specification. Also refer to Section 1 – General. The AIA shall have access to all testing facilities and records and shall be accorded the same consideration and facilities as the Engineer. The Engineer shall have the right to delegate some of his powers in terms of the Specifications to the AIA.

The Contractor shall set up and maintain a welding and corrosion protection quality management and supervision capacity that is aligned with the planned production rates. This Contractor's production quality inspectorate (PQI) shall be responsible for all routine and production testing and inspections and the recording of such on Site as well as in the factories.

### **32.10.12 Marking Procedure**

All weld lengths to be radiographed shall be clearly marked by the PQI inspector using his identification symbol. This symbol shall appear on the respective radiograph. The radiographed weld and symbol shall not be obliterated by finishing processes until the PQI inspector has accepted the respective weld.

### **32.10.13 Hydrostatic Testing**

When all aspects of fabrication have been completed, but before being cleaned, lined or coated all straight pipes and specials shall be subjected to an approved hydrostatic test in accordance with SANS 719, Sub-clause 7.3 to a test pressure determined by the formula:

$$P = \frac{1800 \cdot f \cdot t}{D}$$

Where P is the test pressure in kPa, D is the outside diameter of the pipe in mm, f is the guaranteed minimum yield strength in MPa for the steel plate and t is nominal wall thickness in mm. This test pressure will produce a circumferential stress in the steel of 90% of the minimum yield stress of the steel. The Contractor shall ensure that secondary stress in the pipe wall due to the test method does not cause the stress to exceed 90% of the yield strength.

The pressure shall be applied gradually by approved means and maintained without variation sufficiently long for proof and inspection. While under test pressure the pipe shall be struck smartly and repeatedly along its length with a hammer of a mass of not less than 1 kg.

Should water sweat or ooze from any part or any defects of any nature be discovered the pipe shall be emptied and the defects repaired in accordance with Clause 32.3.4.8. The pipe shall then be retested. Should a pipe, after repair, fail to pass the second hydraulic test the Engineer may order its rejection.

The fact that any pipe may have passed the hydrostatic test at the manufacturer's works shall not exempt the Contractor from his liability with regard to successful testing in terms of the Contract.

### **32.10.14 Testing of Specials**

Where hydrostatic testing of specials is not practicable, the welds shall be subjected to 100% dye / liquid penetrant tests to determine surface cracks, and/or where ordered by the Engineer, to one of the tests specified in Clause 32.10.4 to determine internal defects. Dye / liquid penetrant testing shall be done as specified in Clause 32.10.5. Notwithstanding the requirements of this clause, at least 20% of all welds on specials shall be radiographically tested.

## **32.11 MEASUREMENT AND PAYMENT**

### **32.11.1 General**

The rates tendered under this Section shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the items provided in Section 1 – General.

Separate items have been provided in the Bill of Quantities as complete systems of pipework as indicated on the Drawings or described in the Bill of Quantities.

The items provided to be priced are:

- Design of pipes and specials (where applicable) and supply of all pre-manufacture documentation for approval;
- Procurement / manufacture of pipes and specials and delivery to Contractor's site store; and
- Preparation of Operating and Maintenance Manuals and Drawings.

### **32.11.2 Installation and Testing of Pipes and Specials**

Payment will be made under Section 33 - Laying and Pressure Testing of Steel Pipes.

### **32.11.3 Hydrostatic Test**

Payment will be made under Section 33 - Laying and Pressure Testing of Steel Pipes.

### **32.11.4 Tests on Completion**

Tests on completion required on pipework are covered under Section 48 - Tests on Completion. Payment for testing of valves will be made under Section 35 – Valves and Section 33 - Laying and Pressure Testing of Steel Pipes as relevant.

### **32.11.5 Scheduled Items**

#### **32.001 Contractors Design and manufacturing documentation (Shop drawings)**

**Unit: lump sum (Sum)**

Separate items are provided in the Bill of Quantities for the design and/or detailing of the pipes and specials as indicated on the Drawings. (Change description)

The rates tendered shall include full compensation for the design and/or detailing of the complete installation including full design calculations, detail working drawings for all items, layout drawings, material schedules, programmes of work (manufacture and on-site) and any other work as specified.

Measurement and Payment for the preparation and submission of O&M Manuals shall be covered under Clause 48.11 of Section 48 – Tests on Completion and paid elsewhere.



## PART C3.1 - SPECIFICATION

**32.002 Manufacture and supply of pipes, pipe ancillaries and specials and delivery to storage on site (Excluding corrosion protection)****Unit: number (No)  
metre (m)**

Separate items are provided in the Bill of Quantities for the supply and delivery of the pipes and specials to Site.

The rates tendered shall include for full compensation of all costs incurred in the manufacture, procurement, inspection, factory testing, trial erection and dismantling, and delivery and handling to storage on site of the specified pipes, pipe ancillaries, specials, bolts, nuts, washers and gaskets and any other work as specified. Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

Payment for corrosion protection on pipes and specials shall be made under item 32.005.

Payment for the supply and fixing of pipe stiffeners shall be made under item 32.004.

**32.003 Manufacture and supply of pipes, pipe ancillaries and specials and delivery to storage on site (Including corrosion protection)****Unit: number (No)  
metre (m)**

Separate items are provided in the Bill of Quantities for the supply and delivery of the pipes and specials to Site.

The rate tendered shall include for full compensation of all costs as incurred under item 32.002 as well as for all costs to apply the specified corrosion protection system on the pipe or special.

**32.004 Manufacture, supply and fixing of pipe stiffeners****Unit: number (No)**

Separate items are provided in the Bill of Quantities for the manufacture, supply and fixing of pipe stiffeners.

The rates tendered shall include for full compensation of all costs incurred in the manufacture, procurement, inspection, testing, delivery, fixing, corrosion protection as specified, grouting and repairing of the specified pipe stiffeners. Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

**32.005 Corrosion protection****Unit: Pipe Diameter m**

Separate items are provided in the Bill of Quantities for the application of the various corrosion protection systems as specified in Section 37 - Painting and Corrosion Protection.

The rate tendered shall include for full compensation of all costs incurred in the application of the specified corrosion protection system.