

 <b>RAND WATER</b>		<b>STRATEGIC ASSET MANAGEMENT STEEL PIPELINE DESIGN GUIDELINE</b>	
<b>TITLE: STEEL PIPELINE DESIGN GUIDELINE</b>		<b>DOC. NO: SAM DOP 00001 Ge</b>	
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## **1. PURPOSE**

The purpose of this document is to provide the guideline for all the design of steel pipelines for Rand Water.

## **2. SCOPE**

This guideline applies for all buried steel pipelines and to all fittings, miters, bends, surge tanks/vessels, tees, domed ends, coating and linings and appurtenant assets. Also as part of design the following has to be designed for or checked:

- Hydraulic: e.g. flow, friction, pressure and transient pressures,
- Structural: e.g. Internal pressures, external pressures and combinations of both, transient pressures, deflection caused soil and / or traffic loads, buckling, buoyancy, Minimum and maximum cover, vacuum conditions
- Scours and isolating valves
- Air entrapment
- Joints
- Crossing of services, wetlands and rivers
- Coating and lining
- Corrosion protection
- Field validation of Planning Brief requirements
- Cathodic Protection to be designed as per CP Design guideline
- Long section drawings to be done in accordance with Survey Draughting Procedure Manual (Quality Manual).

## **3. APPLICABILITY**

These design guidelines cover the minimum pipeline design requirements when undertaking the design of pipelines within the Rand Water network.

## **4. REFERENCES**

**Table 1 – Use Latest Version**

Document Title	Document No.	Location
<b>Design Codes</b>		
Welding of Pipelines and Related Facilities	API 1104	Library
Specification for Line Pipes transportation systems (Welding of pipelines)	API 5L	Library
Structural design of Buried Pipelines under various conditions of loading - Buckling and Deflection	BS EN 1295	Library
Unified Pressure Vessels	BS EN 13445-3	Library
Steel tubes and fitting for onshore and off shore pipelines – Bituminous hot applied materials for external coating	EN 10300	Hard copy in office
Specification for Unified Fusion Welded Pressure Vessels (Only for checking)	PD 5500	Library
The production of coated steel pipes using fibre reinforced bituminous material	SANS 1178	Electronic Library
Internal and External Organic Coating Protection for Buried Steel Pipes.	SANS 1217	Electronic Library
Welded, brazed and soldered joints - Symbolic representation on drawings	SANS 2553	Electronic Library
<b>Rand Water Reference</b>		
Architectural Design Procedure	DOAD 00001 Pr	Design Office SHEQ file
Automation Design Procedure	DOA 00001 Pr	Design Office SHEQ file
Cathodic Protection Design Guideline	SAM DOP 00002 Ge	Design Office SHEQ file
Civil Design Procedure DOC 00001 Pr Design Office	DOC 00001 Pr	Design Office SHEQ file
Electrical Design Procedure	DOE 00001 Pr	Design Office SHEQ file
Mechanical Design Procedure	DOM 00001 Pr	Design Office SHEQ file
Survey Draughting Quality Manual	DOC NO 00001 PM	Pipeline e-file
Technical Specification for pipeline excavation, backfilling and pipe trenches and pipe laying, special and testing and investigations and returnable schedules (TS)	SAM DOP 00001 TS	Design Office SHEQ file
Interface / Integration form for pipelines designs	SAM DO QA 00025 F	Design Office SHEQ file
Requirements and standard conditions for crossing of Rand Water services	SAM PP 00006 F	Design Office SHEQ file

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Additional Codes and References		
Buried flexible pipelines Part 1: Structural design	AS/ NZS 2566.1	Library
Buried flexible pipelines Part 2: Installation	AS/ NZS 2566.2	Library
ASME Boiler and Pressure Vessel Code Section VIII Division 1	ASME BPVC-VIII-1	Library
ASME Boiler and Pressure Vessel Code Section VIII Division 2 Alternative Rules	ASME BPVC-VIII-2	Library
Steel Water Pipe - A Guide for Design and Installation	AWWA M11	Library
External Corrosion Control	AWWA M27	Library
Rehabilitation of Water Mains	AWWA M28	Library
Flanges and their joints – Design rules for gaskets circular flange connections Part 1: Calculation	BS EN 1591-1	Library
Flanges and their joints – Design rules for gaskets circular flange connections Part 2: Gasket Parameter	BS EN 1591-2	Library
Design and Construction of thin wall pipes	CIRIA Report 78:	Hard copy in office
Buckling of Steel Shells - European Recommendation	ECCS: 1998 4th Edition	Hard copy in office
Explanatory supplement to BS 5500 : 1988 'Specification for unfired fusion welded pressure vessels', section three 'Design' Part 2 Openings and branch connections	PD 6550 Part 2	Library

## 5. TERMS, DEFINITIONS & ABBREVIATIONS

**API** – American Petroleum Institute

**AS/NZS** – Australian / New Zealand Standards

**ASME** – The American Society of Mechanical Engineers

**AWWA** – American Water Works Association

**BS** – British Standard (BSi)

**CIRIA** – Construction Industry Research and Information Association

**Cover** – Depth from natural ground level to top of pipe

**ECCS** – European Convention for Constructional Steelwork

**EN** – European Standard

**GA** – General Arrangement

**Long Section** – A graphical plot of the position of the pipeline along its length

**O & M** – Operational and Maintenance

**PAM** – Pipeline Asset Management

**PD** – Published Document (BSi)

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**PER** – Pressure Equipment Regulation

**PPIR** – Pre Project Investigation Report

**RW** – Rand Water

**SANS** – South African National Standards

**TIC** – Technical Information Centre

**Water Hammer** - Analysis of pressure surges in piped water systems arising from say power failure, valve closure, pump trip, etc.

## **6. RESPONSIBILITY AND AUTHORITY**

Design Office Manager/Lead Pipeline Designer/relevant Engineer have the responsibility to ensure that this guideline is implemented and adhered to.

## **7. ACTION / GUIDELINE / METHOD**

### **7.1. Planning**

- 7.1.1. Receive planning briefs which indicates nominal pipe diameter, pressures, demand and also indicate if water hammer studied need to be undertaken.

### **7.2. Design Objective**

This guideline contains clauses that generally applicable to the design, manufacture and supply of steel pipes and fittings:

- 7.2.1. Provide pipeline diameter sufficient to supply demand set out in the planning brief
- 7.2.2. Provide a pipeline that meet the operational requirements
- 7.2.3. Provide sufficient operational flexibility with the existing system
- 7.2.4. Ensure the safety of the public and operating personnel and adhere to all applicable codes and standards
- 7.2.5. Provide a system design life adequate with the required lifespan of the structure or system service lifespan as stipulated by Rand Water

### **7.3. Design Requirements**

- 7.3.1. The following technical information shall be collected and considered prior and during to designing a pipeline:

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- Route of the pipeline.
- Environmental Compliance
- Wayleave conditions
- Relevant Drawings of the pipeline route, showing existing pipes and connections.
- Underground services
- Geotechnical studies done
- Operation, structural and design pressures
- Water Hammer studies if applicable
- Corrosion protection study report to assist in determining the right corrosion protection mechanism
- Consideration of internal and external stakeholders
- Optimize the system design (integrated pipe, engine room and reservoir system)

#### **7.4. Design Interface**

A pipeline design project is generally not an isolated project; it requires integration with other disciplines. Form SAM DO QA 00025 F gives the typical inputs and outputs with other disciplines as a guide for required interfacing.

#### **7.5. Detailed design**

##### **7.5.1. Determine pipe size**

Outside diameter for flanged pipes to be determine with the assistance of Rand Water's Standard Flange Dimensions, drawing number A11791, with the following guidelines:

- 600mm – 1500mm with minimum 4mm deducted from Bore of loose flange.
- 1600mm – 3500mm with minimum 6mm deducted from Bore of loose flange

##### **7.5.2. Determine thickness of the pipe based on design pressure and slenderness ratios with ranges as below:**

- $D/t \leq 120$  - Plain wall pipes
- $D/t > 120 \leq 150$  - Plain wall pipes or Stiffened pipes
- $D/t > 150$  – Stiffened pipes

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The final thickness to be determined based on loading, buckling and deflection, internal pressure and floatation prevention calculations.

The minimum pipe wall thickness that will be allowed is 6mm.

- 7.5.3.** Decide the grade of steel with at least two alternatives
- 7.5.4.** Develop a general long pressure section drawing which shows both steel grades
- 7.5.5.** Design all openings, fittings and branches to be designed according to BS EN 13445-3 / PD 5500
- 7.5.6.** Design for relevant structural condition e.g, buckling, deflection and vacuum considering soil and traffic load based on BS EN 1295. The pipe must be designed for full vacuum and construction loading.
- 7.5.7.** Design for buoyancy when the pipe is empty, half full and fully submerged as per the water table based on the geotechnical information
- 7.5.8.** Determine the maximum and minimum cover. Absolute minimum cover is 1m.
- 7.5.9.** Determine bedding type based on the Geotechnical Investigation
- 7.5.10.** Size and position of valves location including test pressures as per the general long section. Also refer to table 2 for more details.
- 7.5.11.** Design corrosion protection taking into consideration the lining and coating and surrounding environment
- 7.5.12.** Design all other pipeline components according to the relevant discipline, i.e Chamber design (Civil, mechanical, automation, electrical, process) etc
- 7.5.13.** Jointing of pipes with flanges and continuous welding
- 7.5.14.** Include sufficient allowance for transient pressure
- 7.5.15.** Allow for different design pressures if there is interconnection with other pipes
- 7.5.16.** Compile an operation and maintenance manual
- 7.5.17.** Design of Blasting requirements
- 7.5.18.** Design for the protection of existing services
- 7.5.19.** Design for construction
- 7.5.20.** Prepare bill of quantities
- 7.5.21.** Prepare technical specifications

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#### **7.5.22. Do cost estimate**

See table below for design parameters that needs to be adhered to:

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PARAMETERS	ELEMENTS	CRITERIA
Pipe Design Flow Velocity	Gravity	2.50 m/s max
	Pumping	2.00 m/s max
Air Valve Spacing		On average 500m apart with due consideration of prevailing site conditions.
Air Valve sizing		Generic: 10% of diameter of main pipe. Adapt/ calculate to prevailing site conditions. An appropriate software and simulation for airvalve sizing to be used
Accumulator for Air Valve		Generic: RW limit the size of the accumulator to 600mm, Design of accumulator 35% of diameter of main pipe $\geq 1500\text{mm}$ and 60% of diameter of main pipe between 300 - 1500mm and 100% for main pipe smaller than 300mm. Adapt/ calculate to prevailing site conditions.
Access point		Access point to man entry pipes to be provided approximately 1 km considering site conditions
Access point relevance		Access permit required for pipe diameter as per latest Construction Regulations.
Pipe Bends	Mitre bend	$\leq 15^\circ$
	Fabricated Bend	$> 15^\circ$
	Radius	1.5D
Valve Sizing		0.7D for Gate/ Sluice valves, 1D for Butterfly valves. For cross connections use full bore
Main Isolating Valves	Max spacing	Start and end with a valve and approximately 4km apart thereafter or as per site condition and operational requirements. Use gate/ sluice valve under normal conditions and dual pressure sustaining butterfly and manual locking device with indicator. Refer to separate valve specifications (RW/0310/AS0460, RW 12/1/4-AS 0925, RW /0310/AS0465)
Sizing of bypass pipes and valves		As per latest standard drawing no. 13057. Maximum 300mm diameter. Valve to be 1D of bypass pipe. All bypass pipes to be heavy duty or as specified by Rand Water.
Scour Valve	Max	300mm $\varnothing$ , but calculate for individual pipe sections to be drained
	Emptying Time per section	Preferably 2 hours and maximum 4 hrs
Minimum Cover		Min 1.0m cover to main pipe, however checks must be performed to verify the minimum cover to include external pressure vs diameter considerations.

PARAMETERS	ELEMENTS	CRITERIA
Lining	Internally	Solvent Free epoxy @ min 600 microns DFT
Coating	Externally	As per approved Rand Water coatings, see SAM DOP 00001 TS
Field joints lining and coatings		All field joint lining and coating to be compatible with the main lining and coating material.
Pipe specials include branches, y-pieces, x-pieces, scour branches	In line Branches	To be designed according to applicable designed codes. NO under pressure cuts on pipes with CML  Preferably <b>No</b> Crotch Plate
	Under pressure cuts	
Pipe ends or future connections		Domes (design as per applicable codes) /Blank flange/ Spade
Steel Properties of pipe material		As per design
Pipe Test Pressure	Factory	Hydrostatic pressure test to 85% of allowable pipe pressure on all pipes and speical before installation or as specified by the Design Engineer
	Field	Range from 1.5 x Design Pressure, should not exceed the Design Engineer's recommendation
Valve Test Pressure	Factory	Body to be tested to the specified table, and gate to be tested to half of the body pressure. Refer to drawing no. A11791
	Field	Closed valve can not exceed 50% of the rated table of the valve.
Reducer		1:7 ratio or 1:2 where space is limited
Slenderness Ratio	Plain pipes	$D/t \leq 120$
	Plain & stiffened pipes	$D/t \geq 120 \leq 150$
	Stiffened pipes	$D/t > 150$

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PARAMETERS	ELEMENTS	CRITERIA
Pipe Jacking		Sleeves to be class 100D concrete. Internal diameter of the sleeve to be minimum of 100mm larger than the OD of the steel pipe.
	Annulus	Annulus to be grouted as per specification from the Engineer.
	Cover	The minimum cover to the top of the sleeve pipe should be 1.0 OD of the sleeve pipe or as per operation or site specific requirements and or geotechnical investigations. The sleeve must allow for minimum skid size of 100mm and a maximum of 150mm
Jointing of pipes	All welded	All joints to be all welded
	Flanged	Flange to suitable table as per drawing A11791
	Dismantling	Dismantling joints to be rigid.
Above ground pipe	Support	Valve and pipe support to be designed according to the applicable codes
Suspended pipe to civil structures such as bridges		Design in accordance with specialized codes
Crossing of Rand Water's services		Refer to SAM PP 00006 F (Conditions for Pipeline Crossings)
Meter connection		To be positioned in liaison with the Planning Department and designed in liaison with the Automation Design Department. Minimum velocity through a Magflow Meter should be 2 m/s.
Chemical Dosing Points		To be designed in consultation with the Process Design Department as the pipeline lining may be affected

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## 8. DELIVERABLES

The following deliverables should be submitted

- Preliminary Design Report
- Detail Design Report with all calculations and assumptions
- Drawings
  - Drawing Register
  - Schematic Drawing show the start and end of the pipe, isolation valves and interconnection
  - Locality Map
  - Longsection showing top strip/plan, vertical and horizontal alignment, valves, geotechnical test pits, geotechnical information and cathodic protection information. A max of 2km should be plotted on A0 sheet.
  - Backfill and excavation drawing relevant to the project based on the Geotech
  - Drawing indicating all pipe specials and fittings and reference drawings
  - Typical standard drawings
  - All other drawings that are discipline specific e.g Valve Chamber, Automation etc.
- Bill of Materials and cost estimates

## 9. RECORD & DATA KEEPING

Record Document	Form/Doc Number	Location	Retention Period
Preliminary Design Report	SAM DOP 00001 R	T – Drive / Design Office	5 years
Electronic design calculations	SAM DOP 00001 T	T – Drive / Design Office	5 years
Tender Document	Work in progress	T – Drive / Design Office	5 years
Detail Design report	SAM DOP 00001 R	T – Drive / Design Office	5 years
As Built	Work in progress	T – Drive / Design Office & TIC	5 years
O & M manual	Work in progress	T – Drive / Design Office	5 years

## 10. DOCUMENT CHANGE HISTORY

The following table contains the history of this document with a description of each revision.

Date	Previous revision number	New revision number	Description of each revision
June 2016	00	01	New Document
June 2021	01	02	Document review

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