



Engineering

Technical Standard

TS 0464 - PVC Waterstop

Version: 2.0

Date: 06 May 2020

Status: Issued

Document ID: SAWS-ENG-0464

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Significant/Major Changes Incorporated in This Edition

The following represent key areas of change in this revised standard:

1. Section 2.2 - Waterstop shapes
2. Section 2.3 - Material Requirements
3. Section 2.4 - Approved Materials
4. Section 3 - Design Criteria
5. Appendix A Schedules of Hold Points, Witness Points and Identified Records
6. Appendix B Approved Products
7. Appendix C Example Inspection and Test Plans
8. Renamed TS 0464 (Formerly known as TS 2)




Document Controls

Revision History

Revision	Date	Author	Comments
1.0	10/01/07		First Issue as TS 2
2.0	06/05/20	Ramon Salazar R	Major revision

Template: Technical Standard Version 6.00, 10/05/2016

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1 Introduction

This Technical Standard (TS) details the type, jointing, installation and location requirements of PVC Waterstop for use in the construction of water and wastewater water retaining structures.

1.1 Purpose

The purpose of this standard is to detail minimum requirements to ensure that assets covered by the scope of this standard are constructed and maintained to consistent standards and attain the required asset life.

1.2 Glossary

The following glossary items are used in this document:

Term	Description
PVC	Poly vinyl Chloride
SA Water	South Australian Water Corporation
TG	SA Water Technical Guideline
TS	SA Water Technical Standard

1.3 References

1.3.1 Precedence of standards

When developing design and specification the Contractor shall, unless noted otherwise, observe the hierarchy of standards should any discrepancy exists among the referred standards and references, as follows:

- Contract
- SA Water Technical Standards and Procedures (this document)
- Technical Specification (if available)
- Tender and Tender Addenda
- Australian Standards and Other Standards
- Codes and Regulations

1.3.2 Australian and International

The following table identifies Australian and International standards and other similar documents referenced in this document:

Number	Title
AS/NZS 4020	Testing of Products for Use in Contact with Drinking Water
ASTM D412-98	Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
BS 2571	Specification for general-purpose flexible PVC compounds for moulding and extrusion.
BS 2782:620	Methods of testing plastics - Density
BS 2782:365B	Methods of testing plastics - Shore A hardness
BS 2782:320A	Methods of testing plastics - Tensile strength
BS 2782:320A	Methods of testing plastics - Elongation at break
BS 2782:130A	Methods of testing plastics - Thermal stability
BS EN ISO 62	Plastics. Determination of water absorption
ISO 868	Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)

1.3.3 SA Water Documents

The following table identifies the SA Water standards and other similar documents referenced in this document:

Number	Title
TS 0101	Safety in Design Technical Standard
TS 0100	Requirements for Technical Drawings
TS 0710	Concrete

1.4 Definitions

The following definitions are applicable to this document:

Term	Description
SA Water's Representative	The SA Water representative with delegated authority under a Contract or engagement, including (as applicable): <ul style="list-style-type: none"> • Superintendent's Representative (e.g. AS 4300 & AS 2124 etc.) • SA Water Project Manager • SA Water nominated contact person
Responsible Discipline Lead	The engineering discipline expert responsible for TS 0464 defined on page 3 (via SA Water's Representative)

2 PVC Waterstops

2.1 General

A waterstop is an element used in a concrete structure to prevent the passage of water, when embedded in and running continuously, through concrete joints.

Waterstops may be either metallic or non-metallic. Metallic waterstops are rigid; made from steel, copper, bronze, or lead. Metallic waterstops may be used in large dams and heavy construction projects where strength rather than flexibility is needed. Metallic waterstops are outside the scope of this standard.

Non-metallic waterstops are usually composed of natural rubber; synthetic rubbers such as butyl rubber, neoprene, styrene butadiene rubber, and nitrile butadiene rubber; and polyvinyl chloride (PVC). This standard only covers PVC waterstops.

Waterstops are grouped in two distinct categories:

- Movement/expansion joints
- Construction joints and connection joints.

Typical Applications for PVC Waterstops Include:

- Water and wastewater treatment facilities
- Dams, lock, canals, water reservoirs and aqueducts
- Tunnels and culverts
- Foundations
- Primary and secondary containment structure

2.2 Waterstop Shapes

Non-metallic waterstops are manufactured in a wide variety of shapes as illustrated in Figure 1 below.





Waterstops for Movement / Expansion Joints	Ribbed waterstop with Central Bulb	
	Rear Guard waterstop with central hollow box	
Construction Joints	Flat Ribbed Waterstop	
	Rear Guard waterstop without central hollow box	

Figure 1 Various types and shapes of waterstops

Waterstops shapes varies depending on the application. They can be grouped in the following categories:

- a) Waterstops for movement/expansion joints.
 - a. One of the most used waterstop shapes is the ribbed centerbulb waterstop, which accommodates lateral, transverse and shear movement. The centerbulb is hollow, allowing for a wider range of movement in the transverse, lateral, or shear directions and provides for a greater amount of movement without excessively stretching the material. It is mainly used to seal movement/expansion joints of walls as internal waterbars.
 - b. Another type of PVC waterstop is the rear guard waterstop, used as an external joint water bar mainly for flat pavement jobs such as concrete floors. This section has a flat centre box which allows movement to be accommodated in expansion joints.
- b) Waterstops for Construction Joints
 - a. Ribbed Flat waterstops normally have several rows of ribs along the length of the flanges to provide a better mechanical bond or interlock in the concrete. This waterstop is similar to the ribbed centerbulb waterstop but without the central bulb. It is normally used to seal wall joints.
 - b. Rear guard waterstop is similar to the external movement/expansion joint rear guard waterstop but without the central hollow box. It is used mainly to seal concrete floor joints

2.3 Material General Requirements

All waterstops used for SA Water projects shall be manufactured from polyvinyl chloride (PVC) and comply with BS 2571 specification for flexible PVC compounds (Class 3, Type E3).

The basic resin shall be prime virgin polyvinyl chloride. The PVC compound shall not contain any reclaimed material or pigment.

The PVC compound physical properties shall conform to the specifications listed in the standard BS 2571.

The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to ensure that, when the material is compounded, it will meet the performance requirements given in this Specification.

The waterstop shall be produced by an extrusion process such that, as supplied for use, they will be dense, homogeneous, and free from holes and other imperfections. The cross section of the waterstops shall be uniform along its length and shall be symmetrical transversely so that the thickness at any given distance from either edge of the waterstop will be uniform.

Where used in water retaining structures, the waterstops shall be suitable for use with drinking water applications in accordance with the Australian Standard AS 4020.

As a minimum, waterstops shall comply with the following properties:

Table 1 PVC Waterstop Required Properties

Property	Standard	Criteria
Base Resin	-	Polyvinyl Chloride
Density	BS2782:620	~ 1.40 kg/l
Shore A hardness	ISO 868-2003(E) BS2782:365B	> 70 Shore A
Tensile strength	BS2782:320A ASTM D412-98	Either minimum 12 N/mm ² or ± 5%
Elongation at break	BS2782:320A ASTM D412-98	Either minimum 265% or ± 5%
Water absorption	BS EN ISO 62:1999	0.04% (at 23°C)
Thermal stability	BS2782:130A	Minimum 70 (Congo Red test at 180°C)

2.4 Approved Materials

For a Supplier to be nominated on SA Water approved suppliers list under this technical standard, the supplier of the PVC Waterstops shall provide a certificate of compliance verifying that the product complies with all the requirements of this Standard with relevant test results provided for approval.

The use of alternative waterstop types and profiles may be considered and approved by the SA Water's Principal Engineer, Materials Science.

2.4.1 Acceptance of Material

All materials shall be accepted only if the quality and requirements of this Technical Standard are met.

2.4.2 Rejection

All materials that do not comply with the requirements of this standard shall be liable to rejection by SA Water's Representative. All rejected materials shall be removed from the site.

3 Design Criteria

The choice of the profile, width and thickness of waterstops is largely governed by concrete thickness, the position of the reinforcement and the complexity of the pour.

As a guide, for wall thickness of 250mm and above a 250mm wide waterstop is suitable. For concrete less than 250mm thick, the use of a narrower waterstop approximating to the wall thickness will be appropriate.

All waterstops shall be designed and installed strictly in accordance with the Manufacturer's current Technical Data Sheet.

3.1 Locations of Waterstops

For efficient waterproofing and to minimise future maintenance, PVC waterstops shall be provided at the following joint locations of water retaining/excluding structures:

- The floor-wall junction
- All wall construction joints buried below ground surface levels.

The use of alternative waterstop types shall be approved in advance by the SA Water's Principal Engineer Materials Science.

4 Installation

4.1 General

Where PVC waterstops are required to be built into concrete, it shall be jointed continuously including bends and curves. Waterstop shall be in lengths requiring the minimum number of joints.

4.2 Jointing

4.2.1 Factory Joints

Intersections and branches shall be mitred and fused in the factory of the Manufacturer of the waterstop material, or in the factory of an approved plastics fabricator by a competent welder.

4.2.2 Field Joints

The field joints shall be fused using jigs and an electric thermostatically controlled jointing tool supplied by or approved by the Manufacturer of the PVC waterstop.

4.2.3 Competency of Welder

The welding of components shall be carried out, and supervised by approved qualified and/or accredited personnel, who have successfully undertaken the following Units of Competence of the Plastics, Rubber and Cablemaking Training Package PMB appropriate to the welding processes used:

- a. PMBPROD287 — Weld plastics materials
- b. PMBPROD387 — Produce welded plastics materials
- c. PMBWELD309 — Weld plastics using extrusion techniques

"Successfully undertaken" shall mean "Statement of Attainment" for all those appropriate Units of Competence. Qualifications from Training Packages must be awarded by a registered training organisation listed by the Department of Education and Training in the "myskills" web site (www.myskills.gov.au) for the provision of training or assessment services as required.

4.2.4 Inspection and Testing

The Contractor must develop and submit an Inspection & Testing Plan (ITP) with relevant hold points (nominated in Appendix A) to SAW Representative for approval before proceeding with the work. A Inspection and test plan shall also be provided for the work. A sample ITP is presented in Appendix C to be used as a guide.

Before any field joints are made each operator shall make six test joints all of which shall meet the following test requirements:

- Butt welded joints when tested in accordance with ASTM D 412, using die "C", shall obtain:
 - a tensile strength not less than 11.5 MPa, and
 - an elongation not less than 180 percent.
- A least three of the test joints shall be branches and/or intersections.

The above testing requirements for operators may be waived if the operator can provide documented evidence of successful welding of PVC waterstop in the prior 6 months.

Straight butt welds and welds in three way and four way intersections shall be watertight. All joints shall be free from visible holes, porosity, burns or charring of the PVC and any other defect that may affect the performance of the welded joint.

4.2.5 Joint Tolerances

The maximum tolerances for field or factory joints shall be 1 mm for both longitudinal and transverse misalignment.

4.3 Installation in concrete

4.3.1 General

PVC waterstops shall be installed in the concrete in the following manner:

- The waterstop shall be carefully and accurately fixed in position with the bulkhead of the forms slotted and shaped to hold the waterstop in alignment and prevent leakage of mortar or damage to the waterstop. Provision shall also be made to hold that portion of the waterstop being built in accurately in position during placing and compaction of concrete
- After removing forms and before placing the second part of the joint concrete, waterstop shall be cleaned of mortar or other debris.
- Where required, joint filler or removable inserts for joint filler shall be placed and fixed as shown on the Project Drawings
- The second part of the joint concrete shall then be placed. Provision shall again be made to hold that portion of waterstop being built in accurately in position during placing and compaction of concrete.

4.3.2 Entrapment of Air

Care shall be taken to ensure that no air is trapped between the concrete and waterstop.

In locations where the waterstop is installed horizontally or near horizontally and the top face is not formed, the waterstops shall be bent upwards while concrete is placed in the lower part of the joint to within 10 mm of the underside of the waterstop and compacted. An excess of 1:2 cement:fine aggregate mortar shall then be placed under the turned up waterstop and the waterstop then straightened into position on a full bedding of mortar. No further concrete shall be poured on top of the waterstop until the bedding of the waterstop has been inspected and passed as satisfactory by the SA Water's Representative. Excess mortar squeezed out when straightening the waterstop shall be spread on top of the waterstop and the balance of the concrete for the joint placed and compacted.

Appendix A : Schedules of Hold Points, Witness Points and Identified Records

A1 Schedule of Hold Points and Witness Points

ITP Item *	Type	Description
1.1	Hold	Review of waterstop specification and submission to SA Water for approval
1.3	Hold	Submission of ITP, qualified joint welders and inspectors for approval (TS 0464 Clause 4.2.4)
1.4	Hold	Qualified Welders (TS 0464 Clause 4.2.3)
2.1	Hold	Qualification of welds (TS 0464 Clause 4.2.4) Tensile strength testing, not less than 11.5 MPa and an elongation not less than 180 percent. A least three of the test joints shall be branches and/or intersections
3.1	Witness	Inspect waterstop and field splices for defects and conformance
3.2	Witness	Quality assurance of welding
3.3	Witness	Inspect installation of waterstops at joints
3.4	Witness	Inspection during placement of the concrete (TS 0464, Clause 4.3.2)

*Note: Refer to Appendix C for ITP item description

A2 Schedule of Identified Records

ITP Item *	Description of Identified Record
2.1	Qualification of welds records
3.5	Inspection Records
4.1	Operation and Maintenance Manuals

*Note: Refer to Appendix C for ITP item description

Appendix B : Approved Products

The following products in Table 2 are known to comply with the requirements of this Technical Standard.

Other products which can demonstrate compliance with this Technical Standard, may also be utilised subject to the requirements of Section 2.4:

Table 2 - Approved Prodcuts

Manufacturer	Product
Parchem / Fosroc	Supercast

Appendix C : Example Inspection and Test Plans

		TS 0464 - PVC Waterstop				Doc ID:				
Client: SA Water		Contract No:				Prepared By:		Date:		
Project: XXXX						Reviewed By:		Date:		
Construction Process: XXXX						Approved By:		Date:		
Specifications: TS-0464, IFC Drawings										
Structure / Component: XXXX										
Item	Inspection / Test Activity (Specification / Drawing)	Responsibility	Frequency	Inspection / Test Method	Acceptance Criteria	Record	Contractor	Subcontractor	SA Water	Sign/Date
1. Preliminaries										
1.1	Review of waterstop specification and submission to SA Water for approval	Contractor	Pre-commencement	Review	TS 0464	Contract	S		H	
1.2	Inspection of waterstops	Contractor	Pre-commencement	Review	Manufacturer's specification	Checklist		V		
1.3	Submission of ITP, qualified joint welders and inspectors for approval TS 0464 Clause 4.2.4	Subcontractor	10 days before commencement	Review	Documents submitted	Submission		S	H	
1.4	Qualified Welders (TS 0464 Clause 4.2.3)	Contractor / SAW	Pre-commencement	Review	Work crew trained by appropriate Units of Competence of the Plastics, Rubber and Cablemaking Training Package PMB	Certificates	V		H	
2. Preparation										
2.1	Qualification of welds (TS 0464 Clause 4.2.4)	Subcontractor	Six test joints	ASTM D 412, using die "C".	Tensile strength not less than 11.5 MPa and an elongation not less than 180 percent. A least three of the test joints shall be branches and/or intersections.	Test sheets	M	V	H	

3. Application										
3.1	Inspect waterstop and field splices for defects and conformance	Subcontractor	Each location before placement of concrete	Visual Inspection and record	Check for damaged or unacceptable waterstop	Checksheet	R	W	W	
3.2	Quality assurance of welding	Subcontractor	Each location before placement of concrete	Visual Inspection	Check butt-welded joints making sure they don't have defects such as: <ul style="list-style-type: none"> • Visible porosity in the weld. • Charred or burnt material. • Bubbles or inadequate bonding. • Visible signs of splice separation when cooled splice 	Checksheet	I	W	W	
3.3	Inspect installation of waterstops at joints	Subcontractor	Each location before placement of concrete	Visual Inspection	Waterstop is positioned to ensure proper distance from steel reinforcing bars to prevent rock pockets and honeycomb. Waterstop is centred on joint, with approximately one-half of waterstop width to be embedded in concrete on each side of the joint.	Checksheet	I	W	W	
3.4	Inspection during placement of the concrete (TS 0464, clause 4.3.2)	Subcontractor	Each location	Visual Inspection	Concrete has been compacted and an excess of 1:2 cement: fine aggregate mortar has been placed under the turned up waterstop (horizontal waterstops)	Checksheet	I	W	W	
3.5	Documentation	Supervisor Subcontractor / Applicator	Entire project	Verify	Supply inspection record and photos of each completed location.	MDR		S		
4. Post-Installation										
4.1	O & M Manuals	Contractor	Con Lot		Collate all documentation including as-built drawings, ITP's, ITC's and vendor information to the O & M Manuals		S		A	

Final Inspection

The signature below verifies that this ITP has been completed in accordance with the XXXX Quality Systems, Procedures and verifies compliance with Specifications.

Print Name:

Position:

Signature:

Date:

Notes:

Legend

Abbreviation	Activity	Description		
H	Hold Point	Work shall not proceed past the HP until released by the Superintendent	SAW	SA Water
W	Witness Point	An inspection which must be witnessed by the Superintendent	Sub	Subcontractor
S	Send	Send documentation for review, verification or approval	Con	Contractor
M	Monitor	Monitor activity in an ongoing basis	Sup	Supervisor
R	Review	Review of product, procedures or documentation	QC	Quality Control
T	Test Point	Product compliance test to be undertaken and recorded/reported	Insp	Inspector
I	Inspect	Inspection to be done and recorded	3rd	Third Party Inspector
A	Approve		PE	Project Engineer