Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 79-03

Chemical Barrier Protection

VERSION 1
REVISION 4

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FOREWORD

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of WA OSH Regulations 1996 (Division 12, Construction Industry – consultation on hazards and safety management) to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

https://www.legislation.wa.gov.au/legislation/statutes.nsf/law_s4665.html

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Water Treatment Section, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

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Users should use and reference the current version of this document.

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REVISION STATUS

The revision status of this standard is shown section by section below:

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
1	1/0		All	New Standard		NH
	1/1		6, 7	1.1, 1.4	NH	DH
	1/2		6, 7	1.3.3 WC Standards updated, 1.4 Terminology updated	NH	DH
2	1/0		All	New Standard		NH
	1/1			2	NH	DH
	1/4	**03.2024**	**8**	**Minor formatting correction**	**NH**	**BM**
3	1/0		All	New Standard		NH
	1/1		9, 10	3.1, 3.2	NH	DH
	1/2		9, 10	3.1, 3.2 – new requirements added	NH	DH
	1/3	**02.2024**	**9**	**3.1 – outdoor ventilation requirements**	**NH**	**BM**
	1/4	**03.2024**	**9**	**3.1 – ventilation for humidity control**	**NH**	**BM**
4	**1/3**	**02.2024**	**11, 12**	**New section added**	**NH**	**BM**
5	1/0		All	New Standard		NH
	1/1			Appendix 1 –photos added	NH	DH
	1/2		12-16	App 1 – some photos removed and new ones added	NH	DH
6	1/0		All	New Standard		NH
	1/1			Appendix 2 – photo replaced	NH	DH
7	1/0		All	New Standard		NH
	1/1			Appendix 3 – photos added	NH	DH
8	1/1		All	New Section – Appendix 4	NH	DH

DESIGN STANDARD DS 79-03

Chemical Barrier Protection

CONTENTS

1 Introduction

1.1 Purpose

The purpose of this document is to describe methods of chemical splash risk mitigation and to provide examples of corrosive liquid chemical barrier protection that are acceptable to the Water Corporation for new assets. All Water Corporation dosing facilities that include "corrosive chemicals" are required to comply with this standard.

1.2 Background Information

This standard has been written to improve the design of chemical barrier protection installed at Water Corporation chemical facilities and complements S022 Personal Protective Equipment and Clothing.

Chemical barrier protection is a requirement of the Dangerous Goods Safety (Storage & Handling of Non-explosives) Regulations 2007 (Reg 58).

1.3 Regulations and Standards

This design standard makes reference (directly or indirectly) to the following legislation and standards:

1.3.1 Department of Mines, Industry Regulation and Safety – Dangerous Goods

Website: http://www.dmp.wa.gov.au/Dangerous-Goods/Dangerous-Goods-258.aspx

Dangerous Goods Safety Act 2004

Dangerous Goods Safety (Storage & Handing of Non-explosives) Regulations 2007

1.3.2 Worksafe Western Australia

Occupational Safety and Health Act 1984

WA Occupational Safety and Health Regulations 1996

1.3.3 Water Corporation Standards

DS 79-01 Design of Chemical Systems (Legislative Requirements and General Principles)

DS 79-02 Emergency Safety Showers and Eyewash Stations

DS 79-04 Chemical Signage, Labelling and Markers

S022 Personal Protective Equipment and Clothing

1.3.4 Australian Standards

AS/NZS 3780 The Storage and Handling of Corrosive Substances

1.4 Abbreviations and Terminology

Corrosive Chemicals	A chemical where the Safety Data Sheet (SDS) indicates it to be hazardous to people through having at least one of the following risk phases: R34 (Causes Burns), R35 (Causes Severe Burns), R36 (Irritating to the eyes), R38 (Irritating to skin) or R41 (Risk of Serious Damage to Eyes) or A chemical where the Safety Data Sheet (SDS) indicates it to be hazardous to people through having at least one of the following Health Hazard Statements: H314 (Causes Severe Skin Burns and Eye Damage), H315 (Causes Skin Irritation), H318 (causes Serious Eye Damage), H319 (causes serious Eye Irritation). NOTE: These definitions include chemicals not classified as Dangerous Goods and therefore represent a larger scope.
Dangerous Goods	Dangerous Goods are materials classified by the Australian Dangerous Goods Transport Code, on the basis of immediate physical or chemical effects. NOTE: The applicability of this design standard is for Corrosive Chemicals which may, or may not also be classified as Dangerous Goods
DMIRS	The Department of Mines, Industry Regulation and Safety (the Dangerous Goods Regulator)

2 Chemical Barrier Protection – System Risk Assessment

DS79-01, Section 4.5, requires pipework containing chemicals to be assessed for risk and then provided with appropriate risk treatment.

A typical chemical dosing system consists of the following elements:

1. Chemical tank filling pipework and ancillaries

The risk with this pipework is mitigated by the fact that deliveries are an infrequent activity. The activity is subject to safe job planning that requires the delivery room and unloading area to be evacuated of personnel. Personnel associated with the delivery activity must wear maximum personal protective equipment in accordance with S022 and remain at distance from the tanker unloading panel. Water Corporation therefore does not require additional chemical barrier protection around the chemical tank filling pipework.

2. Tank outlet/pump suction pipework and ancillaries

This risk is mitigated by the fact that the pipework is only subject to tank static head. As such, the Water Corporation does not require additional barrier protection around this pipework. Note: the risk posed by this pipework to the environment is minimised by Water Corporation's design standards that require this pipework to be within a bund.

3. Pump discharge pipework and dosing panel(s)

This pipework is considered to be potentially high risk due to (typically) higher operating pressure and the number of fittings present (historically, these fittings have had comparatively high failure rates compared to piping). Examples of such fittings are elbows, tees, valves, pressure gauges, instruments, etc. Such pipework and fittings shall be barrier protected through use of enclosures that mitigate the possible failure points in the pipework system. Examples of appropriate enclosures are detailed in Section 3.

4. Transition pipework (from dosing panel to dose point)

Where this pipework leaves an enclosure and travels through a building or across a site, appropriate barrier protection shall be provided if indicated by the risk assessment. For pipework running underground, double containment may not be necessary if the ground cover is sufficient and the chemical poses minimal risk to the environment. Examples of appropriate barrier protection are detailed in Section 3.

5. Dose point pipework

The risk posed by dose point pipework or fittings shall be risk assessed and appropriate barrier protection or enclosures provided if indicated by the risk assessment. Examples of appropriate barrier protection are detailed in Section 3.

6. Other infrastructure not specified above

Any other chemical infrastructure that cannot be classified in any of the categories above shall be risk assessed by a competent person to determine the risks to environment and personnel and then identify the need for double containment, shielding or other appropriate barrier protection.

3 Chemical Barrier Protection Types

3.1 Enclosures

Enclosures shall:

- Be constructed of robust long-life components that are compatible with the chemical being contained.
- Be constructed of grey, cream or beige coloured materials in order to improve visibility within the housing and to minimise heat build-up (the latter being a particular issue for outdoor enclosures). For outdoor enclosures, baffled ventilation shall be provided to prevent excessive heat build-up – refer to section 4 for other possible heat mitigation measures.
- Be designed and constructed to resist the possible forces associated with a release (i.e. burst/spray) event and shall be completely impervious (all joints and necessary gaps sealed to prevent spray leakage).
- Be designed to safely contain and manage any chemical released in an incident. This shall take the form of a sealed base or tray that directs any leaks via pipework to the bund sump.
- To minimise humidity, include spray-proof ventilation with low level and high level vent panels to achieve cross-ventilation.
- Include spray proof ventilation and exhaust fans (with piped discharge to an outdoor location) where the chemicals contained are potentially able to generate fumes following a leak.
- Be designed to not obstruct access to Emergency Safety Showers, Eyewash Stations and egress routes.
- Be designed so that electrical cabling is not run inside the enclosure, except the short run necessary to connect to the valve or instrument. Electrical cabling shall also not be run under the enclosure.
- Not include electrical junction boxes or other termination points that require periodic maintenance access. The aim here is to minimise the amount of maintenance work that has to be undertaken with the doors of the enclosure having to be opened and to reduce the risk of any chemical spray penetrating electrical circuitry. It should be noted that some chemicals (e.g. sulfuric acid) can potentially attack electrical insulation thereby creating an electrical hazard.
- Provide sufficient access around valves, fittings and the back of pumps to allow personnel to easily operate valves or bleed points, or undo fittings and remove equipment.
- Be designed where possible so that pumps are not incorporated into the enclosure, apart from the “wet” head. This is usually achieved through the incorporation of cut-outs in the enclosure see photo below. This design feature allows some maintenance work to be undertaken on a pump without having to open enclosure doors and allows electrical connections to be outside of the enclosure. It is understood that this may not be possible for systems with large pumps.
- Be designed so that all gauges and displays intended to be read can be done so easily. This entails selection of suitable display sizes, provision of suitable lighting and appropriate positioning.

Dosing panels shall be isolated from each other (i.e. each dosing pump, or its wet end, located in a separate enclosure) to allow maintenance to occur without shutting down both duty and standby systems, unless otherwise agreed as a project specific deviation (non-critical, intermittently operated systems are a typical exception).

The following example enclosures represent Water Corporation best practice. Any enclosure design shall provide an equivalent or better performance (in terms of safety, access and asset life) than these examples;

1) Cabinet with doors (see Appendix 1)

This design is suitable for indoor or outdoor facilities and shall be used for chemicals that can cause severe burns to personnel on contact; e.g. Fluorosilicic Acid, Sulphuric Acid, Sodium Hydroxide (Caustic Soda).

Doors shall be made of transparent material that is resistant to the chemical to allow the condition of the interior to be viewed. Door hinges shall be robust and made of long-life materials and facilitate ready removal of the doors to allow full maintenance access to equipment in the enclosure.

This type of enclosure can be designed with security enhancements (e.g. locks, external metal grilles, etc.) where a facility is outdoors and there is a risk of intruders entering a site and attempting to operate valves etc.

2) Cabinet with curtains (see Appendix 2)

This design is suitable only for indoor facilities and only where the cabinets are below 1.5m in height (Water Corporation experience is that long curtains are prone to breaking their tracks and hangers due to their weight). This design **shall not** be used for chemicals that can cause severe burns to personnel on short contact e.g. Fluorosilicic Acid, Sulphuric Acid, Sodium Hydroxide (Caustic Soda) at commercial concentrations.

The restriction on use of curtains is due to their relatively more opaque nature even when clear (compared to perspex sheets) which may make it difficult to spot any chemical adhering to its surface, potentially allowing transfer onto PPE and then onto personnel during later PPE removal.

PVC curtains have been previously tested[1] and confirmed to resist sprays of up to 1000 kPa without buckling or allowing passage of chemical. The design shown in Appendix 2 incorporates overlap of the enclosure by the curtain to ensure that sprays cannot get past the curtain edge (top, bottom or sides).

PVC curtains shall be clear/transparent, at least 1mm thick and be held up by hangers made of a long-lasting material that is suitable for any possible chemical fumes that might be released during the life of the asset. The curtain hanger track shall likewise be made of a long-lasting material that is suitable for any possible chemical fumes that might be released during the life of the asset.

[1] A test was successfully conducted at Gwelup GWTP in May 2014 on an existing curtain at the Sodium Hypochlorite facility using an industrial water jet at 1000kPa pressure.

3) Removable cabinet/"box" that provides localised barrier protection (see Appendix 3)

This approach is intended for low complexity systems (including dose points) where there are minimal components, which therefore allows the use of a light (<15 kg weight) and easily removable (by one person) perspex box(es) to provide risk protection. Where heavier perspex boxes are employed, they shall include access points (e.g. tear drops) for valves that may need to be operated regularly.

Larger and/or heavier barrier protection boxes shall be designed to be easily removable and replaceable by two persons (e.g. to allow maintenance activities). This might include, for example, the inclusion of suitable carry handles etc. on the box.

Fixing of boxes to walls or other structures shall utilise fasteners that are simple and quick to remove and refit and ideally tool-less (e.g. wing nuts). The number of fasteners per box shall be minimised as far as is practical (without compromising integrity) to minimise the time required for removal and replacement of boxes during maintenance.

3.2 Pipe Barrier Protection

Section 2 outlines the situation where pipe barrier protection is necessary. Pipe barrier protection can take the form of spray protection systems (which don't contain the resultant leak) or double containment systems that prevent any escape of chemical to the environment.

Spray protection systems may include the simple running of a pipe within another pipe, flexible hose or duct, etc. Spray connection boxes etc. shall:

1) Not rest on pipework and instead be supported by brackets attached to walls, floors or other weight-supporting points.
2) Be designed to allow removal of segments of ducting or boxes no longer than 1.5m in length. Hence, for long runs of pipework, it may be necessary to overlap segments of ducting or boxes to achieve effective spray/splash protection and removability. An alternative would be to use ducts with removable lids – refer Appendix 4.

Double containment systems may include proprietary pipe-in-pipe systems (including those that can take pump pressure) and other fully sealed encapsulation methods (including sealed ducts that redirect leaks to bunds).

Whichever system is chosen the barrier protection shall possess the following attributes:

1) It prevents personnel from being sprayed in the event of a pipe or fitting failure (this doesn't mean that the containment system needs to be rated for the process pressure, just that it, and its fittings/connections, can withstand a burst of the dosing pipe within it),
2) It incorporates a visible means of identifying that a leak has occurred. This may simply consist of low point(s) that have a section of transparent pipe or drainage to an alarmed bund or tank. Low points shall be able to be drained using manual valving that can be used to direct collected chemical to a suitable waste collection tank.
3) Where tubing is double-contained, the design shall incorporate an easy means of replacing the tubing once it has reached the end of its service life – this can be as short as 12 months for some tubing material-chemical combinations.

4 Heat Considerations

Consideration shall be given to the thermal impact of sun exposure on chemical barrier protection. High angle sunlight may cause temperatures within the enclosed space to significantly exceed ambient temperature (e.g. greenhouse effect) and lead to pipe fittings or seals undergoing temperature de-rating or deformation that could lead to leaks and/or pressure sustaining valve failure. Heat accumulation occurs due to both the applied energy (from incident solar insolation) and entrapment (due to poor ventilation).

Heat mitigation might be accomplished by a combination of measures such as:

- provision of shading;
- alternative barrier protection materials such as light-colour painted metals (if corrosive fumes are not normally expected) instead of PVC or polycarbonate; and
- enhanced ventilation of the enclosed space.

Shade roofs similar to those used for outdoor analyser cabinets should also be incorporated where appropriate, but consideration shall be given to operations and maintenance access requirements.

Ventilation is potentially in conflict with the objective of barrier protection, and therefore careful consideration shall be given to:

- Consider whether base of the enclosure panels can be slightly above ground level without compromising chemical spray containment, which will allow some movement of air and avoid completely sealing the enclosure.
- Vents shall be louvred (e.g. proprietary plastic louvre vent panel) to interrupt potential chemical spray.
- Provide a low level vent (inlet) and a high level vent (outlet) to ventilate the majority of the enclosed space and take advantage of thermal gradient to move the air.
- Position vents on opposite sides of the enclosure to maximise cross-ventilation to ventilate most of the enclosed space and take advantage of any outside wind pressure.

5 Appendix 1: Enclosures with Doors or Removable Panels – Examples

Figure 5-1: Medium Enclosure with cutout for pump and electrical connections

Figure 5-2: Medium Enclosure – doesn't include pump and electrical cutouts but cable duct is provided and electrical connections are mounted high (low corrosivity chemical application)

Figure 5-3: Large Enclosure – doesn't include pump and electrical cutouts but does illustrate space provision for maintenance activities

Figure 5-4: Side mounted enclosure vent, angled to prevent direct spray of chemical out

Figure 5-5: Enclosure retrofit – enclosure will prevent spray from impacting personnel (acid will spread across concrete flooring, but, this presents a lower hazard level)

6 Appendix 2: Enclosures with Curtains – Examples

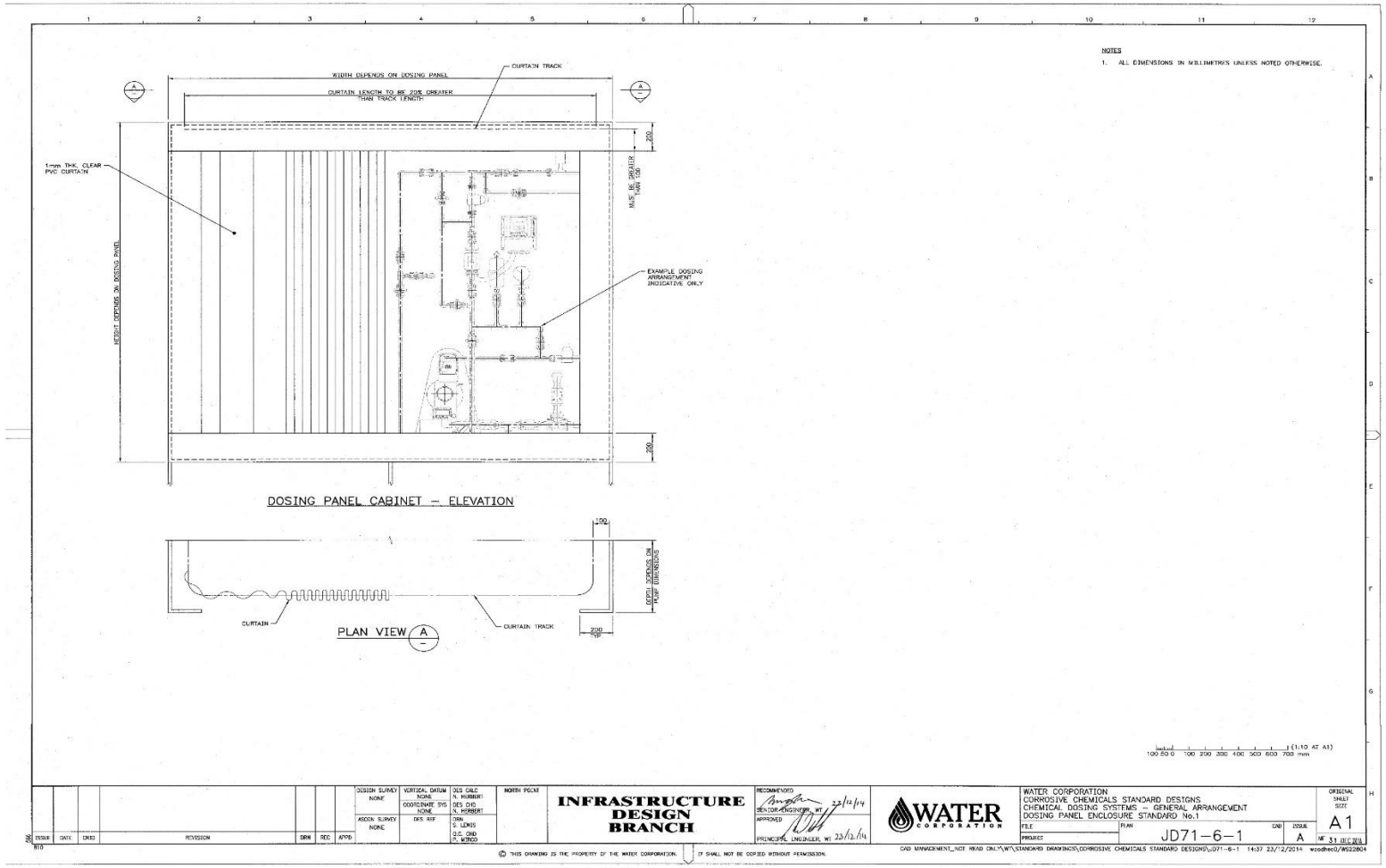

Figure 6-1: Curtain Enclosure General Arrangement Drawing

Figure 6-2: Low enclosure with PVC curtains

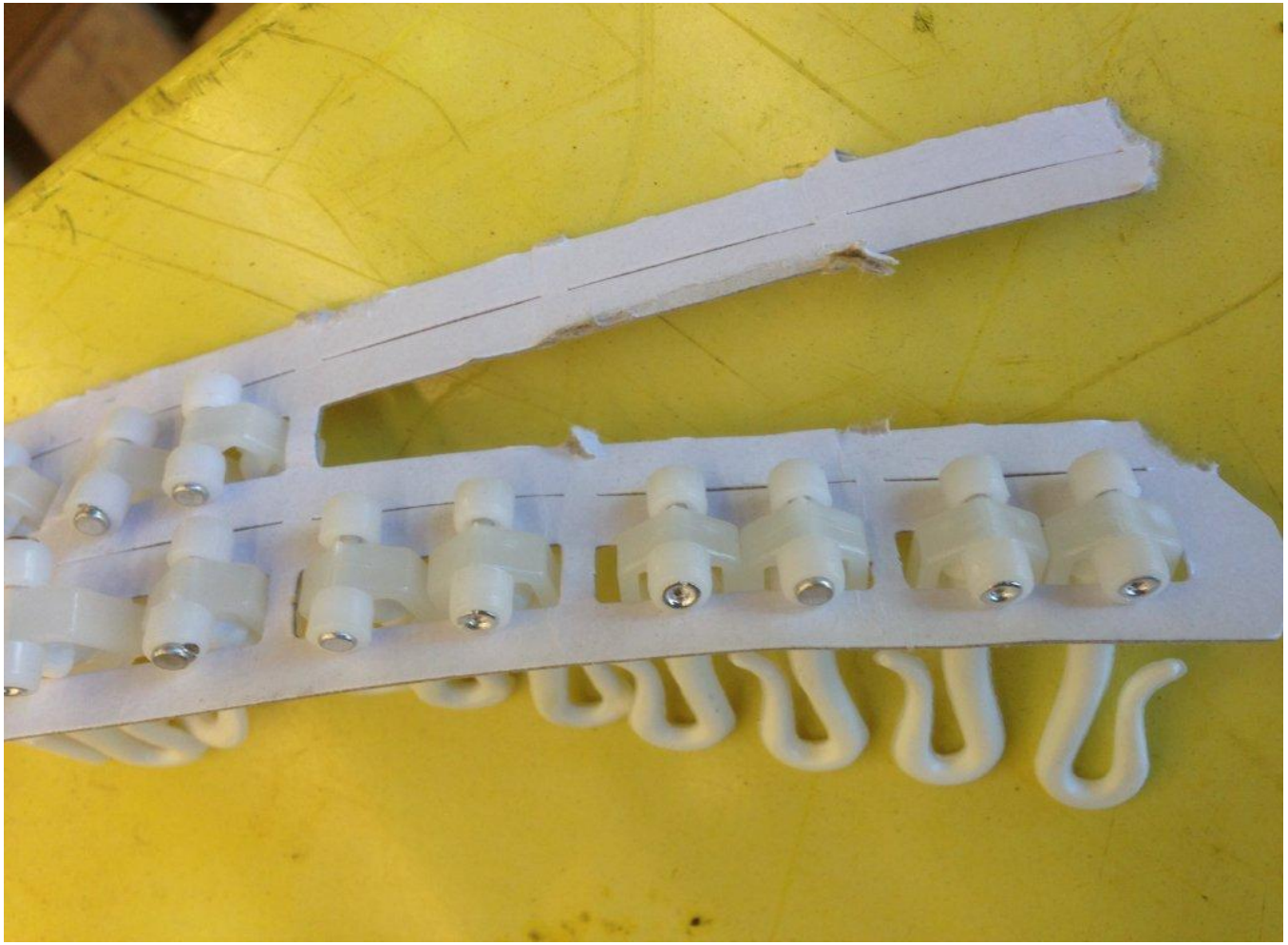

Figure 6-3: Curtain Hangers

Figure 6-4: Curtain Hanger Track

7 Appendix 3: Localised Enclosures – Examples

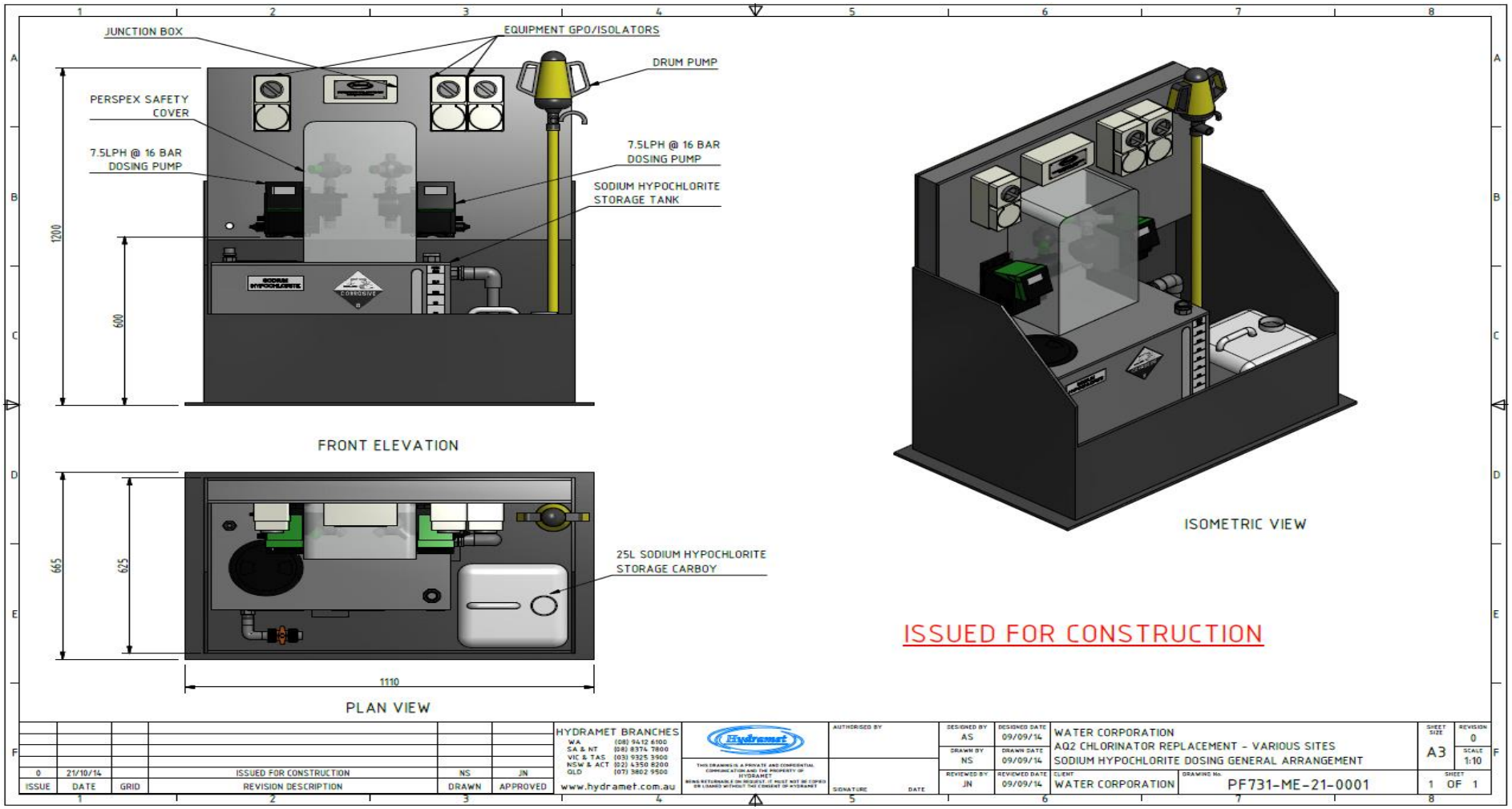

Figure 7-1: Dosing Pumps: Perspex box covers pressurised fittings on pump discharges – pipework passes through the panel itself. Pump and electrical connections not included within box

Figure 7-2: Dose Point: Hatches provided allow operator access to frequently operated valves without having to remove perspex box

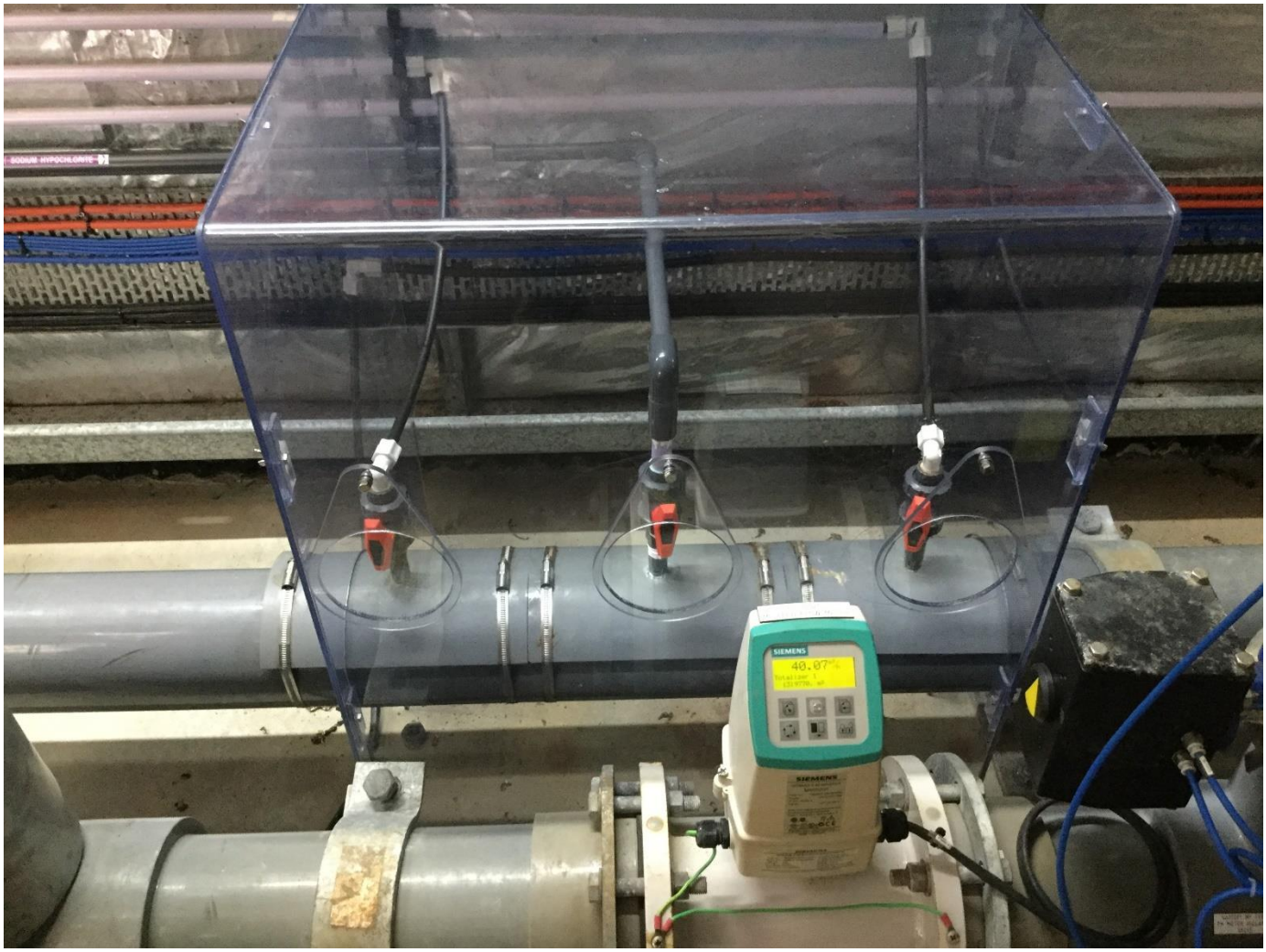

Figure 7-3: Local dose point enclosure: covers the pipework and fittings at the dose point. Tear-drops allow access for valve operation

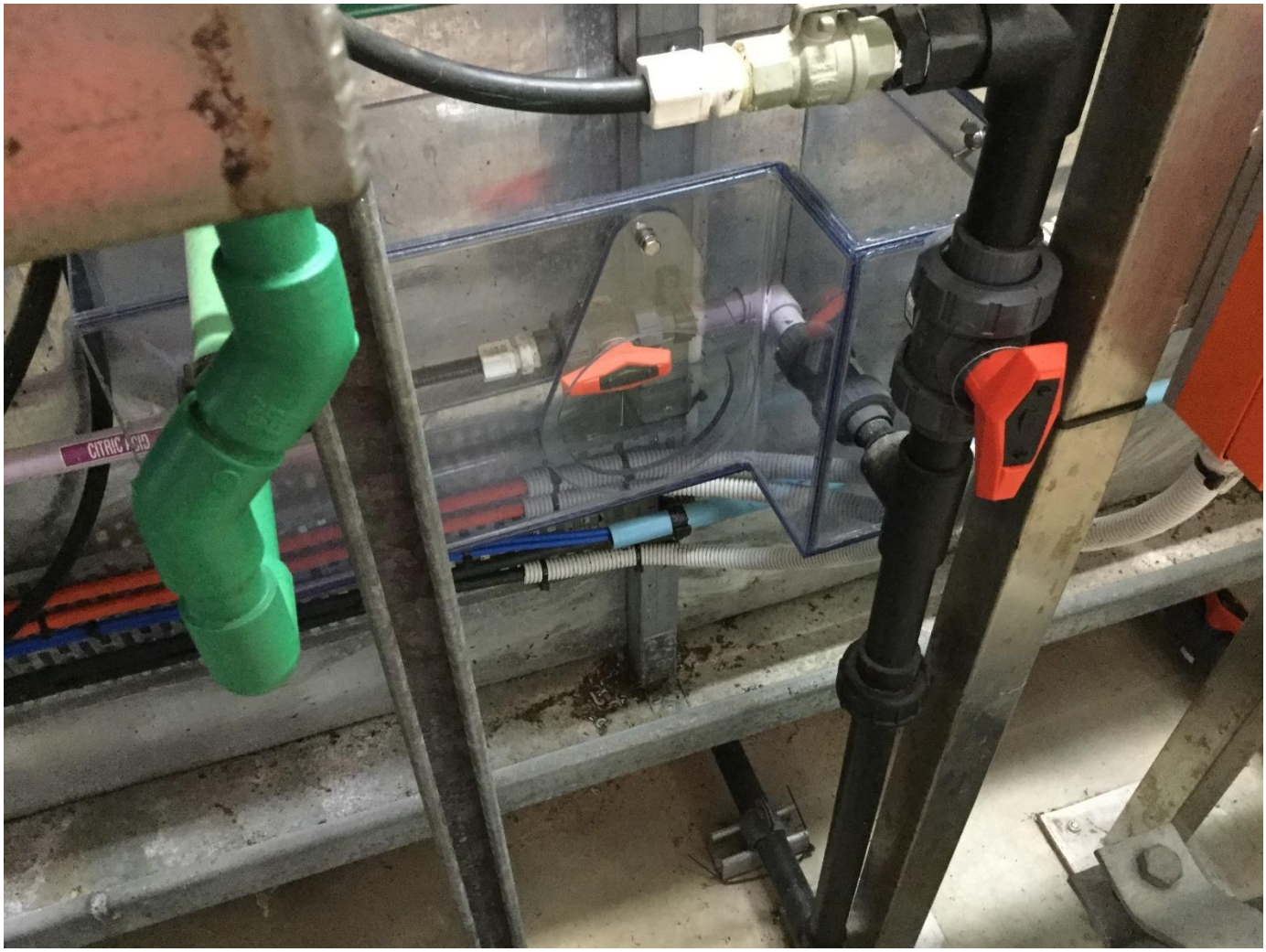

Figure 7-4: Local dose point enclosure: covers the pipework and fittings at the dose point despite a change in direction. Tear-drop allows access to main isolation valve

8 Appendix 4: Pipe Covers

Figure 8-1: Pipe cover is segmented

Dose Point: Tear drop allows operator access to isolation valve without having to remove perspex box. Valve can be accessed for maintenance by removing 4 wing nuts.