Polyethylene (PE) for Drinking Water Piping Systems

(To be used in conjunction with and does not replace PIPA POP018)

As a material for piping, Polyethylene (PE) has many benefits including:

- High impact strength
- Abrasion resistance
- Flexibility
- Installation ease
- Readily available fittings systems

PE pipe systems have successfully been used around the world in various industries for over 50 years. These include water, wastewater, rural and irrigation, gas, mining, industrial, electrical and communications.

The release of PE100 grades has expanded PE applications into markets which previously had been serviced by pipes of other materials, particularly metallic pipes. This has included widespread use in drinking water systems.

PE Piping Systems for Drinking Water Service Connections

Water agencies in Australia, such as the members of Water Services of Australia (WSAA), use disinfecting chemicals to remove microbial pathogens making the water suitable for drinking. Chlorine or chloramine are most commonly used with higher levels applied at the source to ensure acceptable disinfection for the full length of the pipeline.

The Australian Drinking Water Guidelines (ADWG) recommend the threshold and aesthetic drinking water limits for chlorine – ensuring the water is safe to consume and has an acceptable appearance, taste and odour.

ADWG has set the following aesthetic limits:

- Free chlorine is set at 0.6 mg/L
- Maximum chloramine level is 3 mg/L
- pH has a nominated aesthetic range from 6.5-8.5

PIPA and POP018

The Australian Plastic Industry Pipe Association (PIPA) has reviewed internationally published research to develop guidelines for polyethylene drinking water pipes in contact with chlorine-based disinfectants.

On the 29th June 2018, PIPA published an industry guideline *"POP018 - Polyethylene Drinking Water Pipes in Contact with Chlorine and Chloramine Disinfectants"* which addressed the use of PE in pipe systems using chlorine-based disinfectants.

For chlorine and chloramine disinfected systems at temperatures up to of 21°C and maintained within the aesthetic limits of the ADWG, the expected life of SDR11 PE100 and PE80 is not adversely affected.

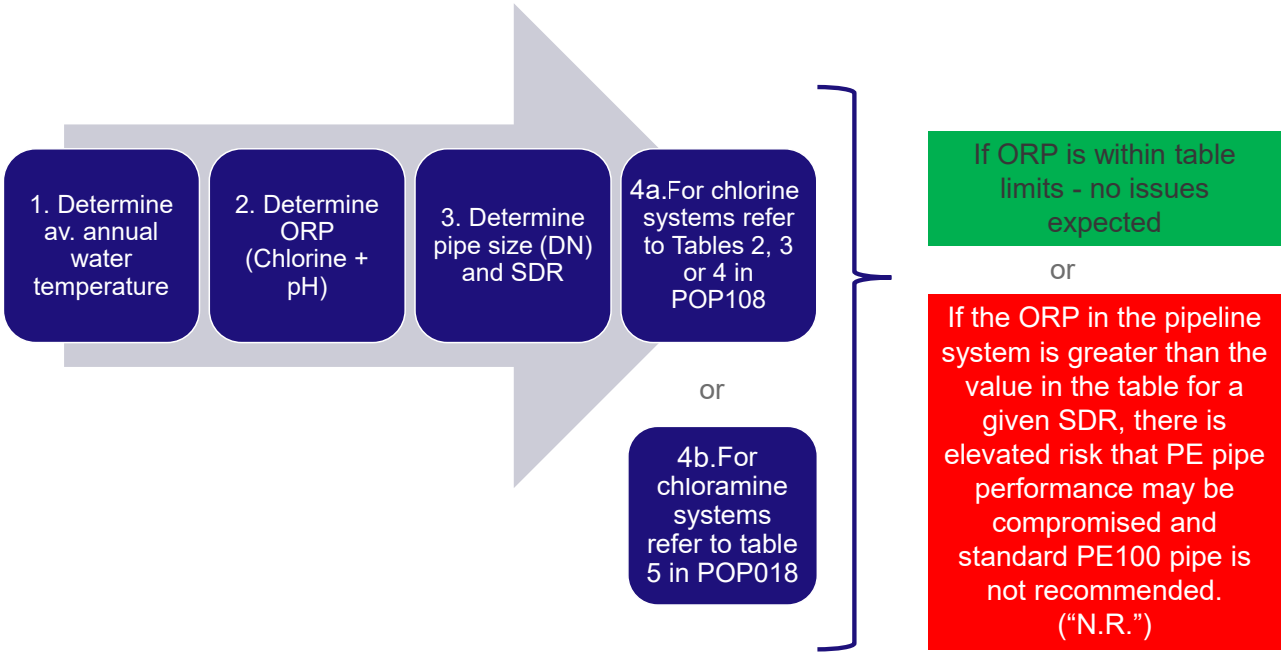
POP018 also identified that in areas ***where higher water temperatures are coupled with an aggressive oxidative environment,*** the combination of any of the following factors may compromise the PE pipe systems:

- Continuous elevated water temperatures
- High levels of disinfectant chemicals (including Chlorine & Chloramine)
- Water acidity (pH level)
- Operating pressure & velocity
- Installation conditions
- Pipe diameter and pressure rating
- Pipe material

Download PIPA POP018 here:
https://www.pipa.com.au/wp-content/uploads/2019/04/POP018.pdf

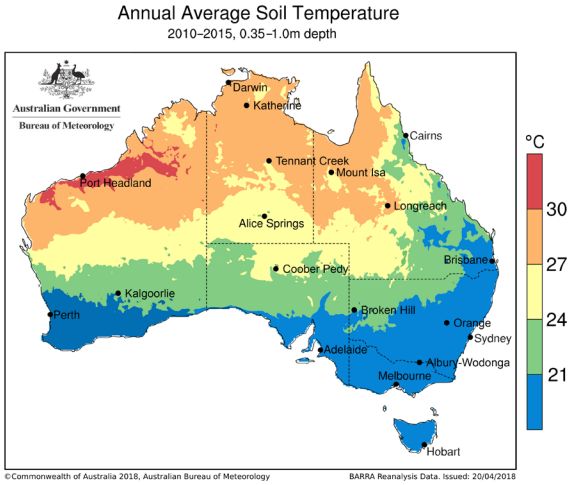
Four Steps to Determine PE Pipe's Application Suitability

Based on overseas experience and guidance, PIPA POP018 developed the following process and guidance tables to assess the suitability of PE100 pipe in a specific situation and application:



Step 1 – Average Annual Water Temperature

Average annual water temperature of the system should be determined. An estimate based on the Annual Average Soil Temperature chart at typical pipe burial depths may be used until actual service conditions are determined.

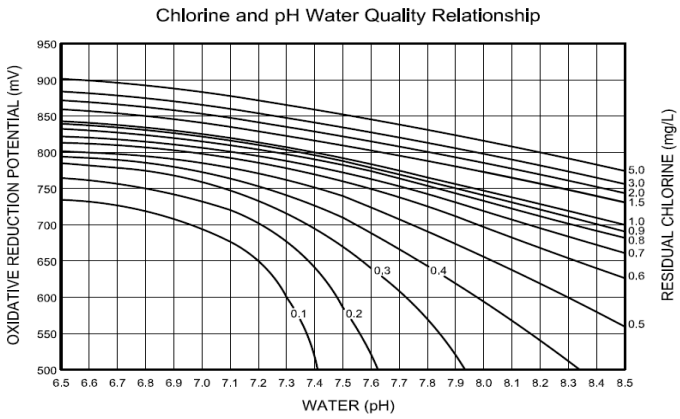


Source: PIPA POP018 Polyethylene Drinking Water Pipes in Contact with Chlorine and Chloramine Disinfectants

Step 2 – Water Quality

Water quality is defined by the Oxidative Reduction Potential (ORP) – the oxidative aggressiveness of the water (to pathogens and to pipe materials). The ORP is determined using the chart below, but has two main considerations:

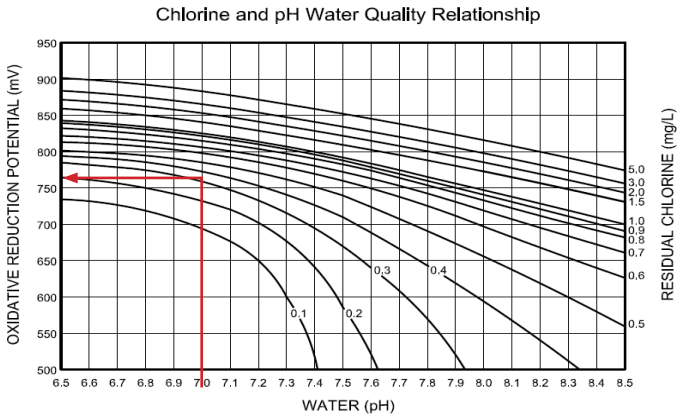
- Higher residual chlorine = higher ORP
- Lower pH (i.e. more acidic) = higher ORP



Source: ASTM Standard F2263:2014 [6]

For example, water with:

Residual chlorine = 0.5 mg/l; and
pH = 7.0
gives:
ORP = 780 mV



Source: ASTM Standard F2263:2014 [6]
(annotations added)

Step 3 Determine pipe size (DN) and SDR

Step 4a (for Chlorine disinfected systems)

Select the appropriate table based on the specific pipe size and SDR. Determine the maximum allowable ORP for the specific location and pipe size/SDR combination.

If the ORP in the pipeline is greater than the value in the table for a given SDR, there is elevated risk that PE pipe performance may be compromised and *standard PE100 pipe is not recommended.*

Maximum Water ORP x SDR
Pipe Sizes
DN25 to DN50
System Pressure ≤600kPa

Zone	SDR13.6	SDR11	SDR9
Blue	775mV	825mV	
Green	740mV	810mV	825mV
Yellow	720mV	785mV	825mV
Orange	700mV	755mV	825mV
Red	N.R.	720mV	785mV

* Pipe conforming with AS/NZS 4130 produced from PE100 resin listed in PIPA POP004.

Table 2 Sizes DN25 to DN50 (Chlorine disinfection)

Maximum Water ORP x SDR
Pipe Sizes
DN63 to DN90
System Pressure ≤600kPa

Zone	SDR13.6	SDR11	SDR9
Blue	800mV	825mV	
Green	780mV	825mV	
Yellow	770mV	825mV	
Orange	755mV	825mV	
Red	725mV	800mV	825mV

* Pipe conforming with AS/NZS 4130 produced from PE100 resin listed in PIPA POP004.

Table 3 Sizes DN63 to DN90 (Chlorine disinfection)

Maximum Water ORP x SDR
Pipe Sizes ≥DN110
System Pressure ≤600kPa

Zone	SDR13.6	SDR11	SDR9
Blue	825mV		
Green	825mV		
Yellow	825mV		
Orange	800mV	825mV	
Red	775mV	825mV	

* Pipe conforming with AS/NZS 4130 produced from PE100 resin listed in PIPA POP004.

Table 4 Sizes ≥DN110 (Chlorine disinfection)

Step 4b – For Chloramine disinfected systems

Chloramine Disinfected Water
Pipe Sizes DN25 to DN50
System Pressure ≤600kPa

Zone	SDR13.6	SDR11	SDR9
Blue	OK		
Green	OK		
Yellow	OK		
Orange	N.R.	OK	
Red	N.R.	OK	

* Pipe conforming with AS/NZS 4130 produced from PE100 resin listed in PIPA POP004.

Table 5 Sizes DN25 to DN50 (Chloramine disinfection)

Consult Table 5 for the SDR limitations placed on PE pipes in the size range of DN25 to DN50.

At the specified operating conditions, no additional limitations are placed on pipelines >DN50 in chloraminated drinking water.

* Installation of pipelines shall be in accordance with the relevant standards or codes (such as the WSAA National Water Code, AS/NZS 2033 [19] or AS/NZS 3500.1 [20]) and the pipes manufactured to conform with AS/NZS 4130.

Where "N.R." appears in the tables, using *existing PE material* is likely to result in reduced service life and *is not recommended.*

Measures to Improve PE Pipe Service Life

If POP018 guidance does not recommend the use of existing PE material the following measures may improve service life:

- *Adjusting water chemistry* to a more favourable ORP value
- Taking steps to *reduce the temperature of the pipe* (e.g. increased installation depth)
- *Increasing the size* (DN) of the PE pipe
- *Reducing pipe wall stress* by lowering system pressure or increasing the thickness of the pipe wall (i.e. lower SDR)
- *Selecting pipe* manufactured from PE resin with an *enhanced resistance to chlorine disinfectants*

Vinidex Chlorblue® is the preferred choice for use in applications where the water has an elevated level of chlorine and temperature.

PE with enhanced resistance to chlorine

US standards and Plastic Pipes Institute (PPI) technical notes specify PE materials and their resistance to oxidation as follows:

PE Material Class for Oxidative Resistance (Chlorine Classification)	Oxidative Resistance (ability to withstand elevated chlorine, temperature, pressue over time)
CC3	Highest
CC2	Higher
CC1	Base classification

Higher classification materials will withstand higher levels of chlorine, temperature and pressure over time.

Note: POP018 assumes existing PE100 materials align with the “base” material in the PPI technical notes.

Service Life Risk Summary

Based on the information in POP018 the table below summarises the potential risk factors for PE pipe systems used in drinking water service connections:

Factor	Reduces Risk	Increases Risk
Temperature	Lower Temperature	Higher Temperature
Water Quality	Chloramine Disinfection	Chlorine Disinfection
	High pH	Low pH
	Low ORP	High ORP
Operating Conditions	Low System Pressure	High System Pressure
Installation Conditions	Deep Installation	Shallow Installation
	No Overlying Pavement	Beneath Pavement
	Sand Pipe-Embedment	Stony Pipe-Embedment
Pipe Selection	Larger Pipe Size	Smaller Pipe Size
	Thicker Pipe Wall	Thinner Pipe Wall
	Higher Oxidative Resistance Class	Lower Oxidative Resistance Class

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