Grundfos Sharing Session
Domestic System

Sharon Toh

5/11/2016

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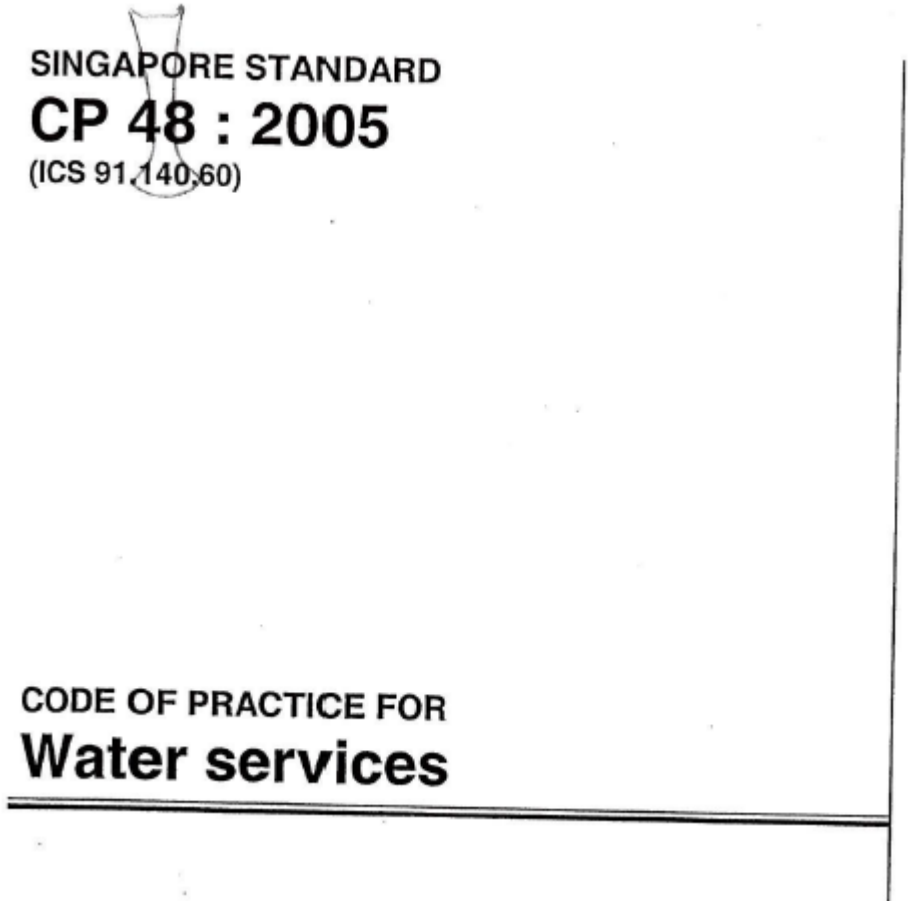
Domestic System

Code of Practices and Guide Book

- CP48 – Local Standard
- Plumbing Engineering Services Design Guide
- Australian Pipe Friction Handbook

Domestic System – CP48



SINGAPORE STANDARD

CP 48 : 2005

(ICS 91.140.60)

CODE OF PRACTICE FOR

Water services

Domestic System – CP48

Standard of materials and fittings

The casings and impellers of pumps, including all parts in contact with potable water, used in potable water service installation shall be of corrosion resistant material such as stainless steel or bronze or materials that are protected against corrosion by suitable and reliable coating.

Mode of Supply

	Height of fittings	Methods of supply
(a)	Level of highest fitting below 125 metres reduced level	Direct (see Figure 1)
(b)	Level of highest fitting above 125 metres reduced level but below 137 metres reduced level	Indirect supply through high level storage tank (see Figure 2)
(c)	Level of the highest fitting above 137 metres reduced level	Indirect supply through low level tank with pumping to high level tanks (see Figures 3 and 4)

Domestic System – CP48

Distribution in Tall Building

In tall buildings, fittings should not be subjected to pressures greater than 35 m head. This can be achieved by the provision of intermediate tanks and pumps or by use of pressure reducing valves.

Flush Valve

All flush valves must be so adjusted as to give a flush of not more than 1.5 litres, 1 litre and 0.5 litre of water per flush for large, medium and small size urinals respectively or not more than 4.5 litres of water per flush for water closets.

Domestic System – Plumbing Engineering Services Design Guide

- Loading Unit

Table 15 *Loading units*

Type of appliance	Frequency of use		
	Low	Med	High
Basin, 15mm sep. taps	1	2	4
Basin, 2 × 8mm mix. tap	1	1	2
Sink, 15mm sep/mix tap	2	5	10
Sink, 20mm sep/mix tap	-	7	-
Bath,15mm sep/mix/tap	4	8	16
Bath, 20mm sep/mix tap	-	11	-
WC Suite, 6.litre cistern	1	2	5
Shower, 15mm head	2	3	6
Urinal, single bowl/stall	-	1	-
Bidet, 15mm mix tap	1	1	-
Hand Spray, 15mm	-	1	-
Bucket sink, 15mm taps	-	1	-
Slop Hopper, cistern only	-	3	-
Slop Hopper, cistern/taps	-	5	-
Clothes washing m/c, dom.	2	-	-
Dishwasher m/c domestic	2	-	-

Domestic System – Plumbing Engineering Services Design Guide



Flush Valve

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Domestic System – Plumbing Engineering Services Design Guide48

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All flush valves must be so adjusted as to give a flush of not more than 1.5 litres, 1 litre and 0.5 litre of water per flush for large, medium and small size urinals respectively or not more than 4.5 litres of water per flush for water closets.

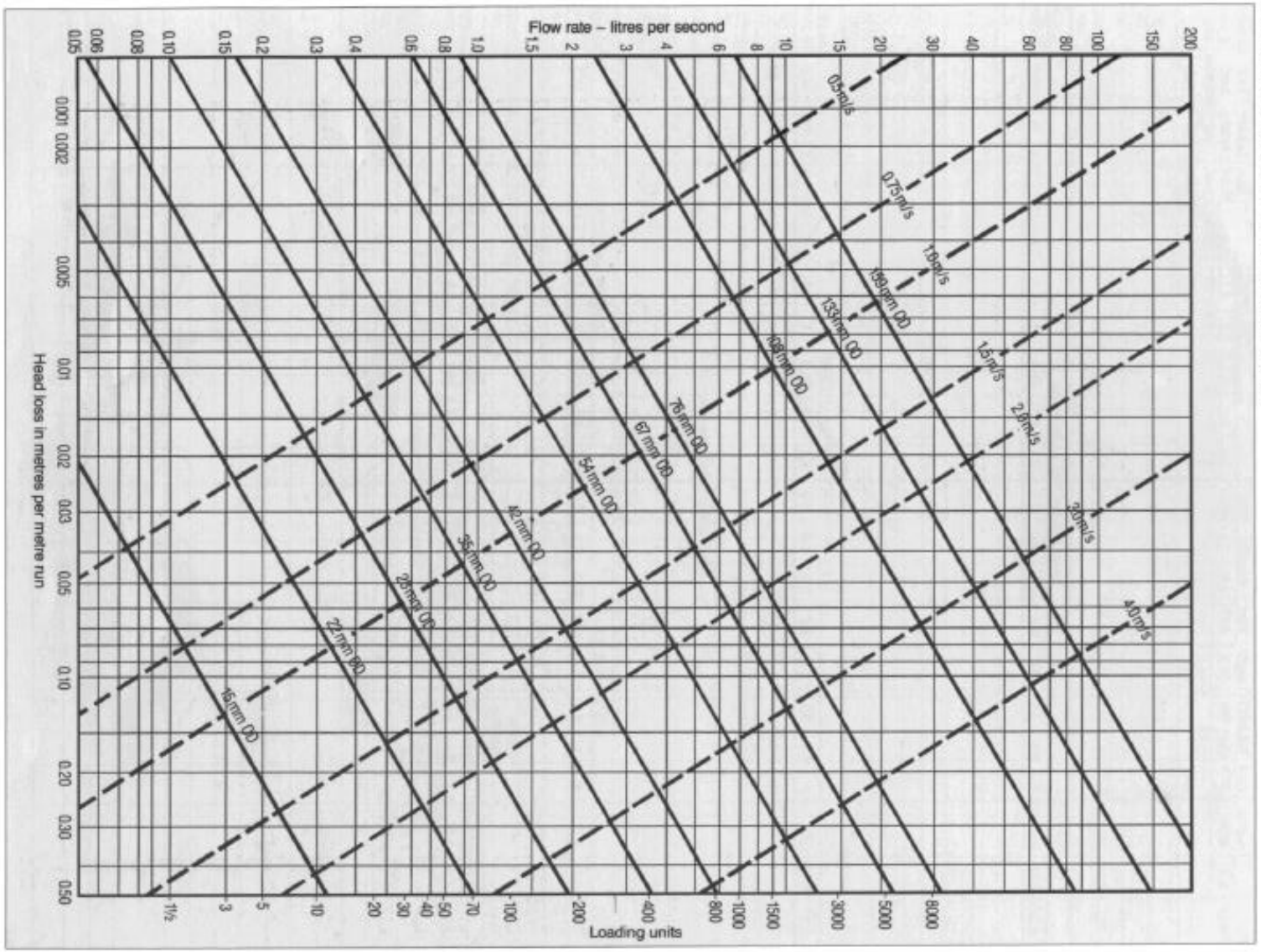
Domestic System – Plumbing Engineering Services Design Guide

- Loading Unit

Table 15 *Loading units*

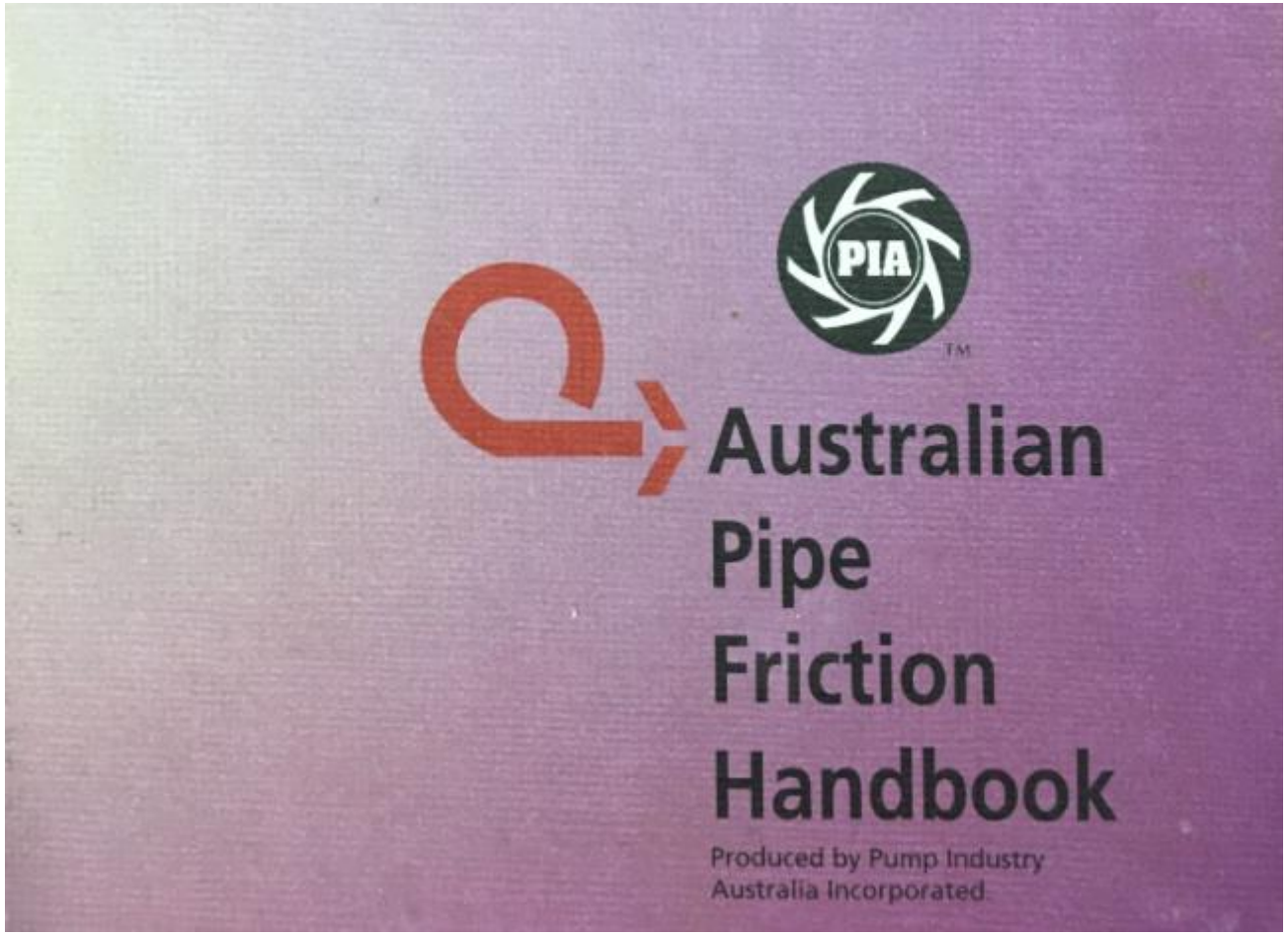
Type of appliance	Frequency of use		
	Low	Med	High
Basin, 15mm sep. taps	1	2	4
Basin, 2 × 8mm mix. tap	1	1	2
Sink, 15mm sep/mix tap	2	5	10
Sink, 20mm sep/mix tap	-	7	-
Bath,15mm sep/mix/tap	4	8	16
Bath, 20mm sep/mix tap	-	11	-
WC Suite, 6.litre cistern	1	2	5
Shower, 15mm head	2	3	6
Urinal, single bowl/stall	-	1	-
Bidet, 15mm mix tap	1	1	-
Hand Spray, 15mm	-	1	-
Bucket sink, 15mm taps	-	1	-
Slop Hopper, cistern only	-	3	-
Slop Hopper, cistern/taps	-	5	-
Clothes washing m/c, dom.	2	-	-
Dishwasher m/c domestic	2	-	-

Domestic System – Plumbing Engineering Services Design Guide



Graph 3 *Pipe sizing chart – copper and stainless steel.*

Domestic System – Australian Pipe Friction Handbook



Type of Domestic Systems

Domestic System – Type of Systems

- Transfer System

- Booster System

Domestic System – Type of Systems

- Transfer System
  - Transfer System via hardwire
  - Transfer System via pressure losses

- Booster System

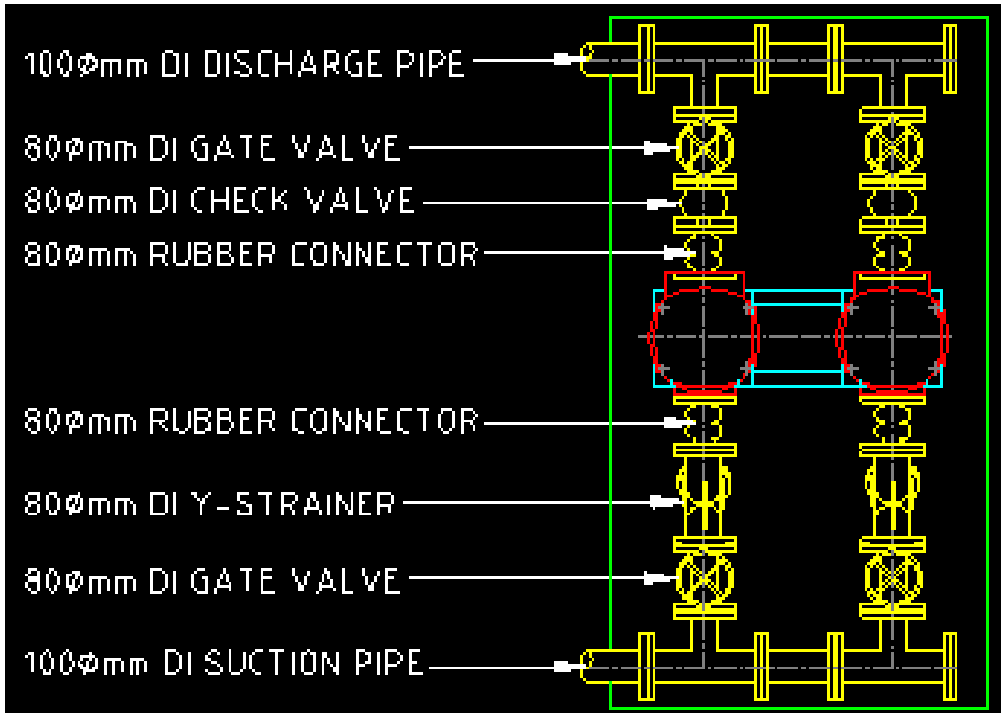
Domestic System – Type of Systems

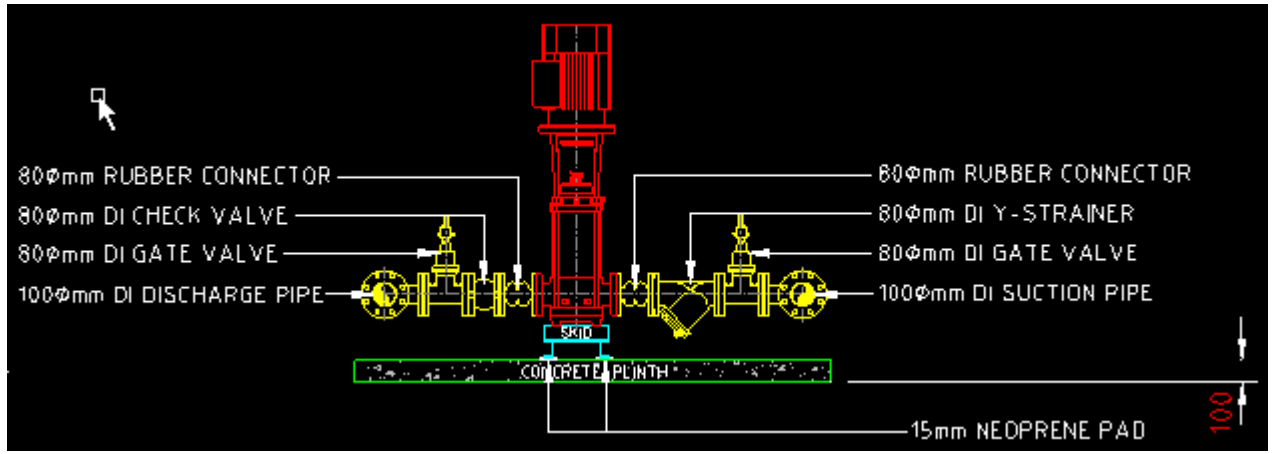
- Transfer System
  - Transfer System via hardwire
  - Transfer System via pressure losses

- Booster System
  - via pressure losses

Domestic System – Transfer System

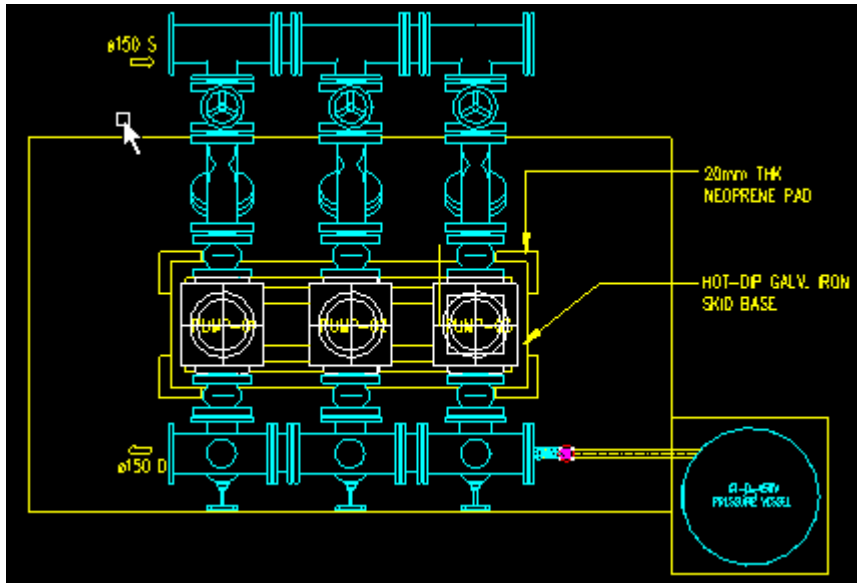
- Transfer System
  - Transfer System via hardwire

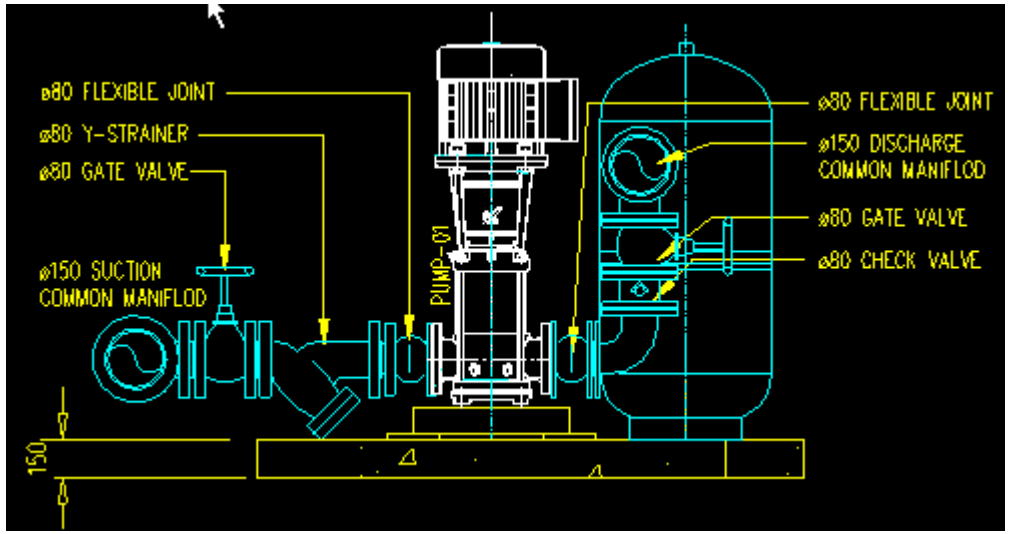




Domestic System – Transfer System

- Transfer System
  - Transfer System via pressure losses





Domestic System – Transfer System

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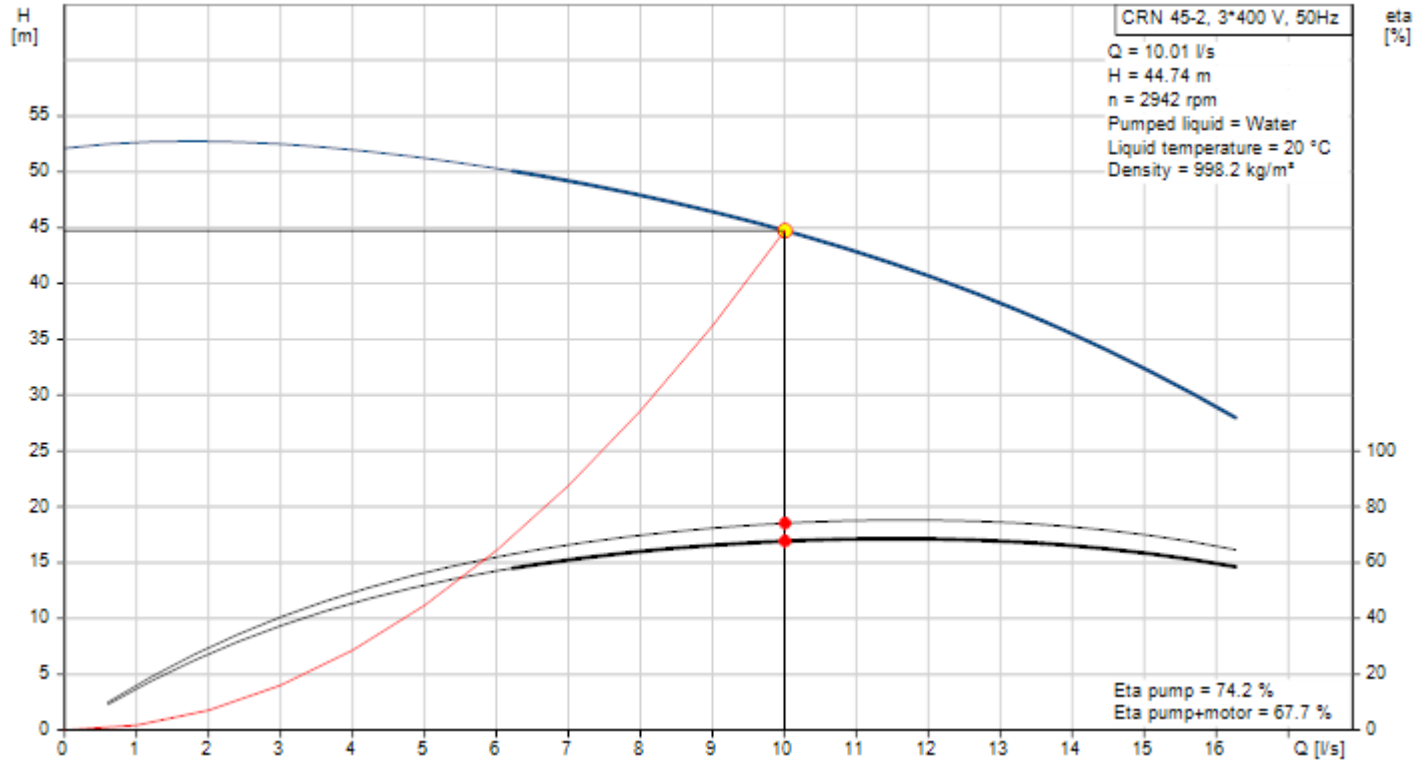

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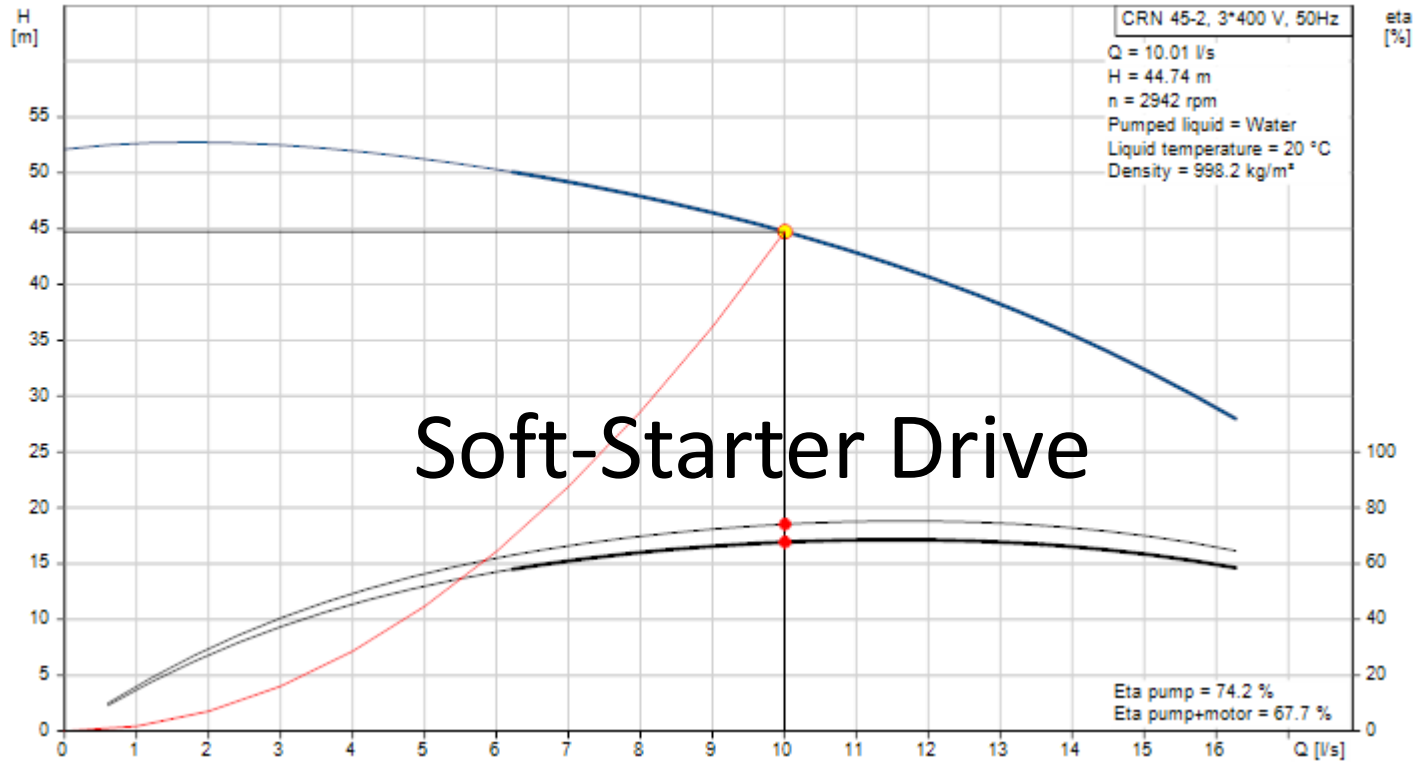

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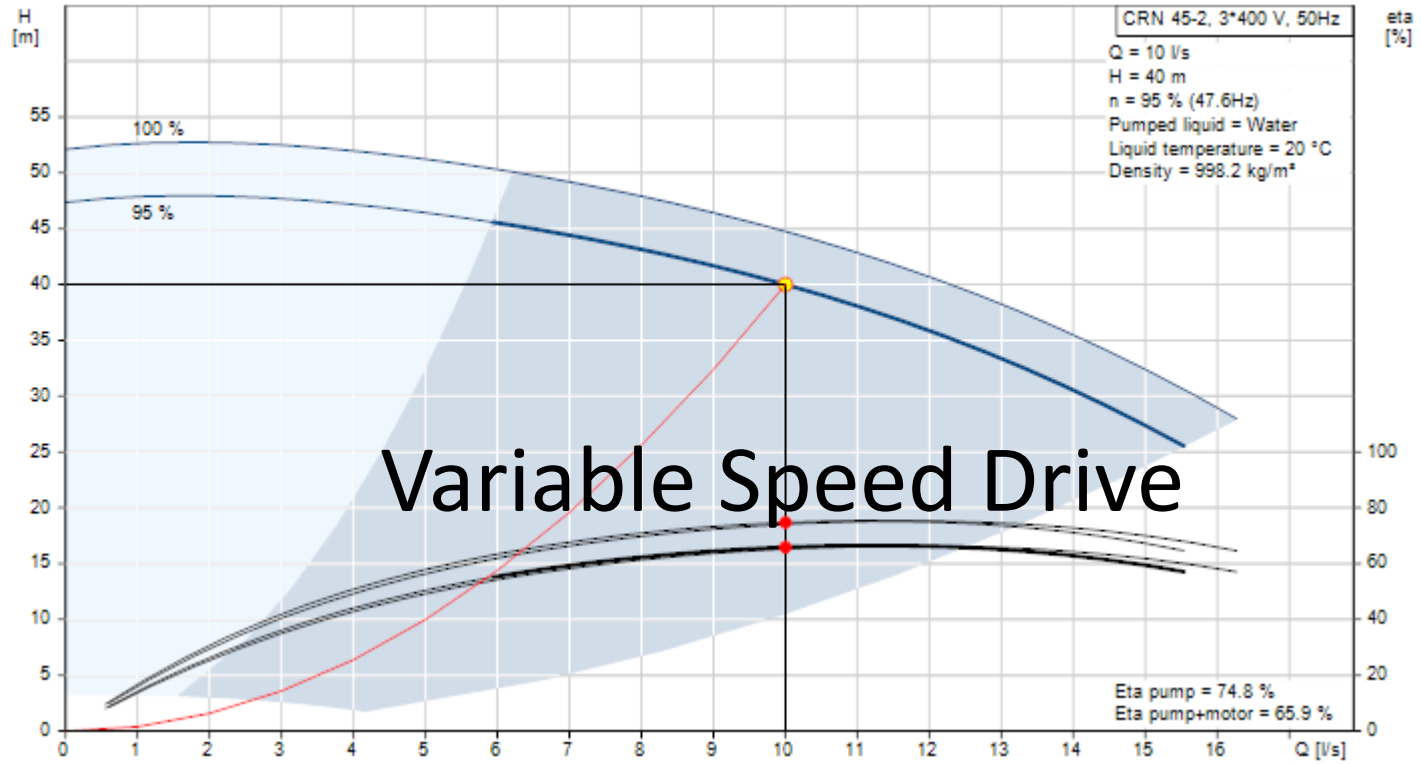
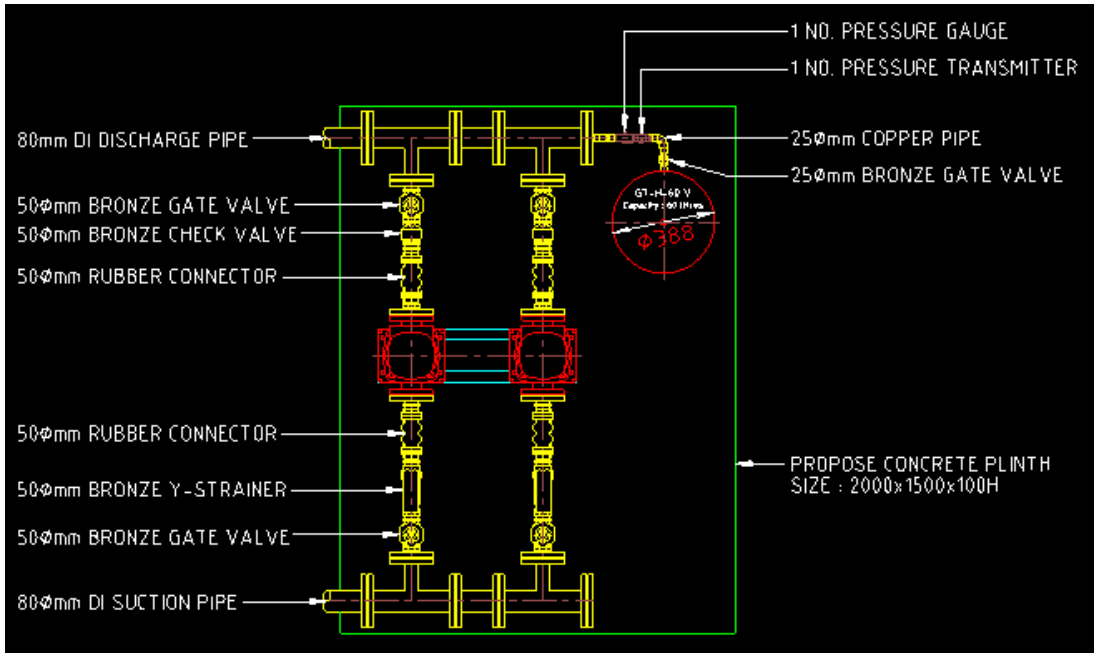
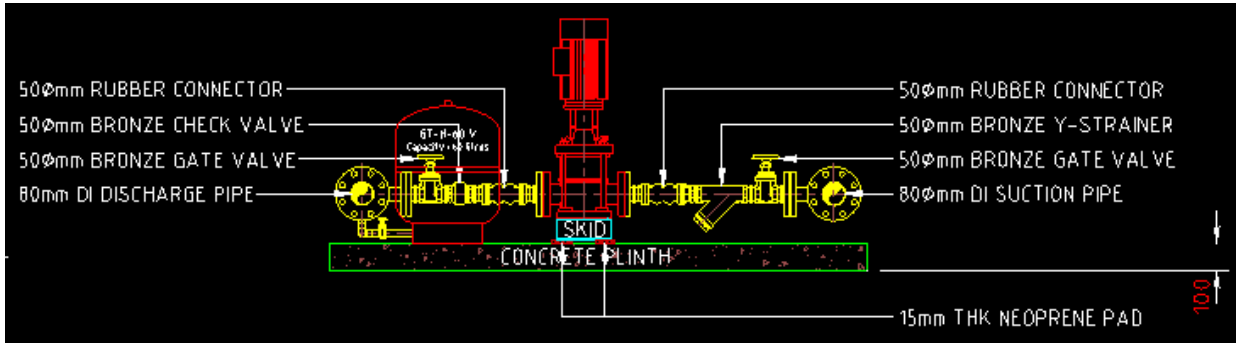


Domestic System – Booster System

- Booster System





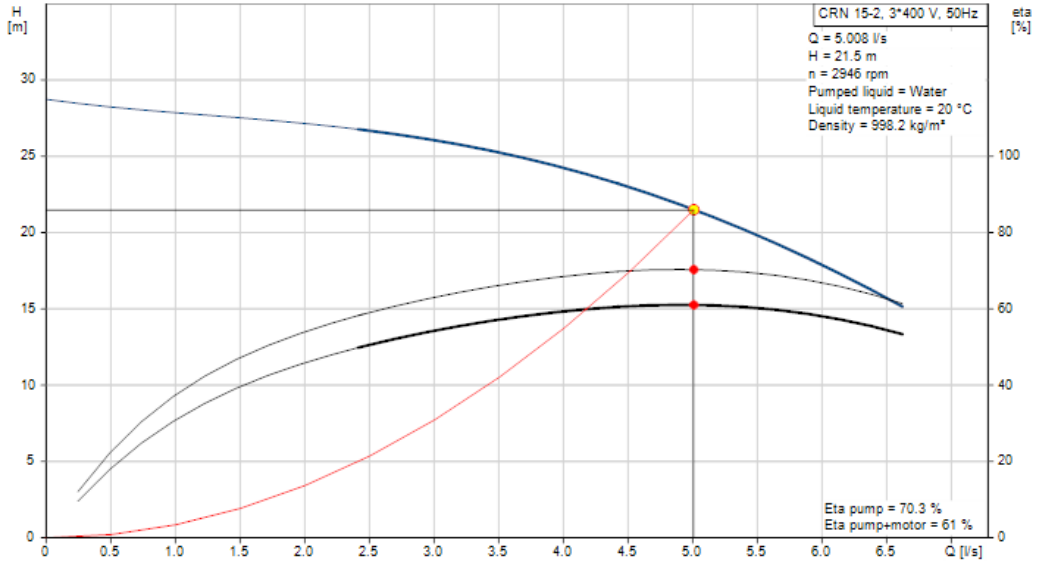
Domestic System – Booster System

- Booster System
  - Conventional System
    - DOL (≤ 2.2kW)
    - Star Delta (≥ 3.0kW to 11kW)
    - Soft Starter (≥ 15kW)

Domestic System – Booster System

- Booster System
  - Conventional System
    - maintain 1bar (min 0.7bar)

      cut-in/cut-out differentiate
    - Required bigger pressure vessel
    - Higher power consumption, lower energy saving
    - Fixed speed = fixed flowrate and pump head



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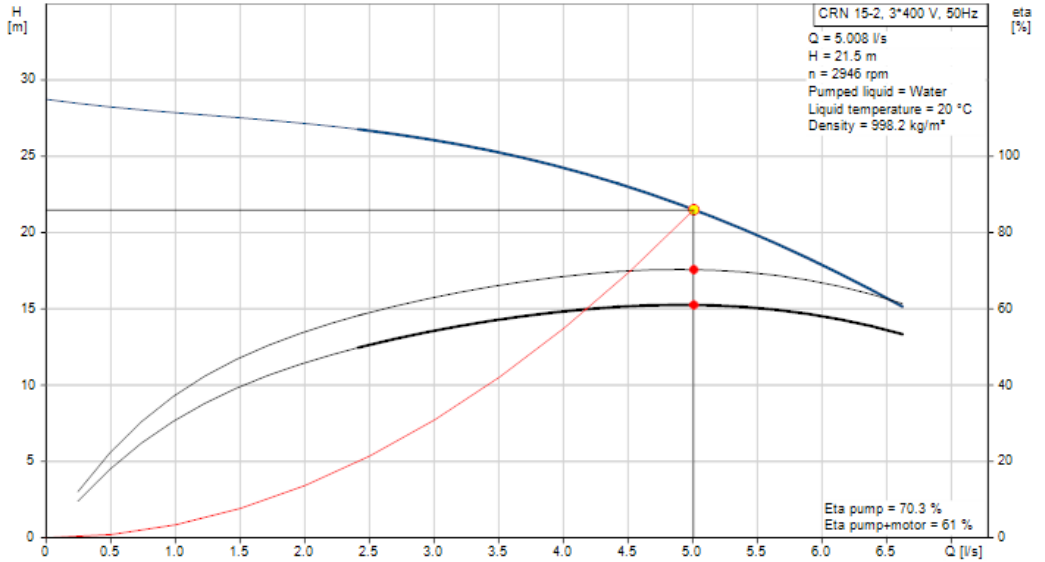

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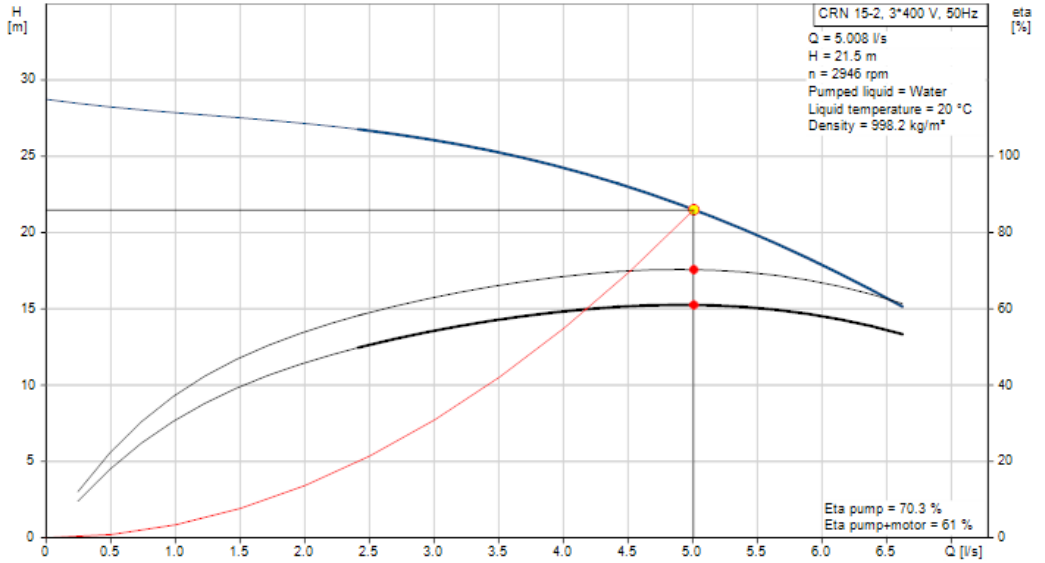

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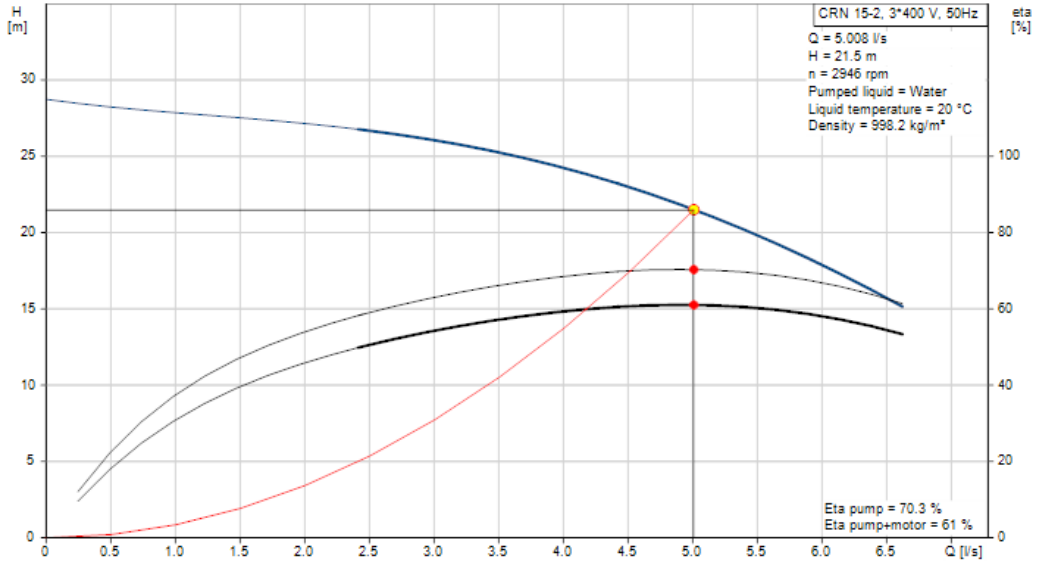
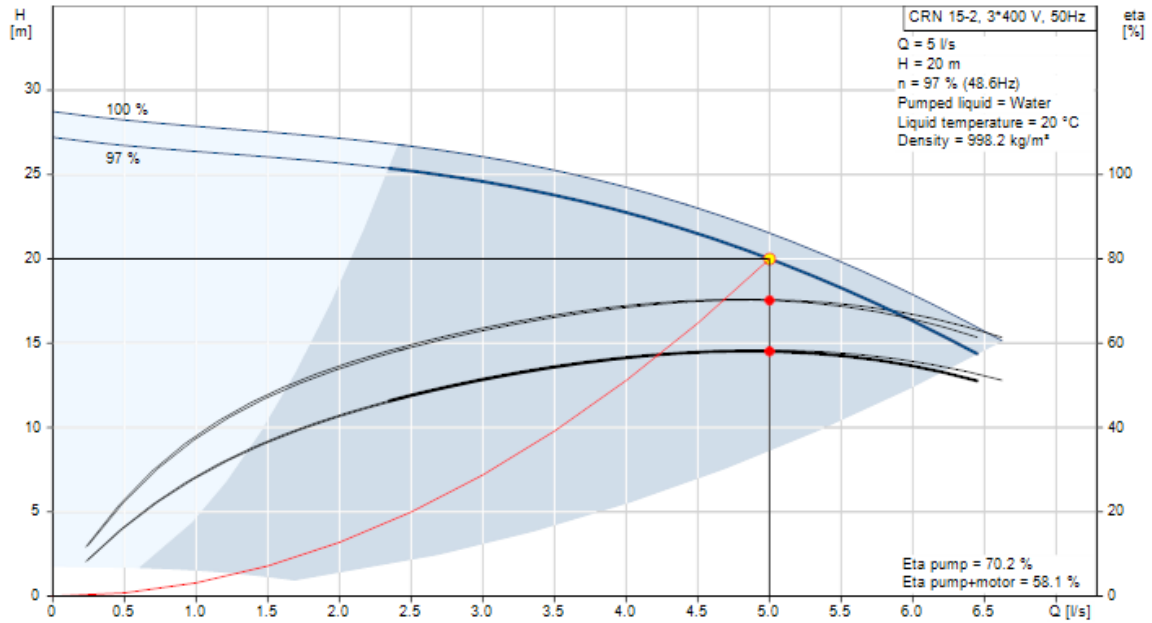


Domestic System – Booster System

- Booster System
  - Variable Speed Drive System
    - VSD (≤ 2.2kW to ≥15kW)

Domestic System – Booster System

- Booster System
  - Variable Speed Drive System
    - on/off band: 10% to 12.5% (shorter band, bigger pressure vessel)
    - Required smaller pressure vessel
    - Lower power consumption, higher energy saving
    - Variable Speed = variable flowrate and constant/variable head



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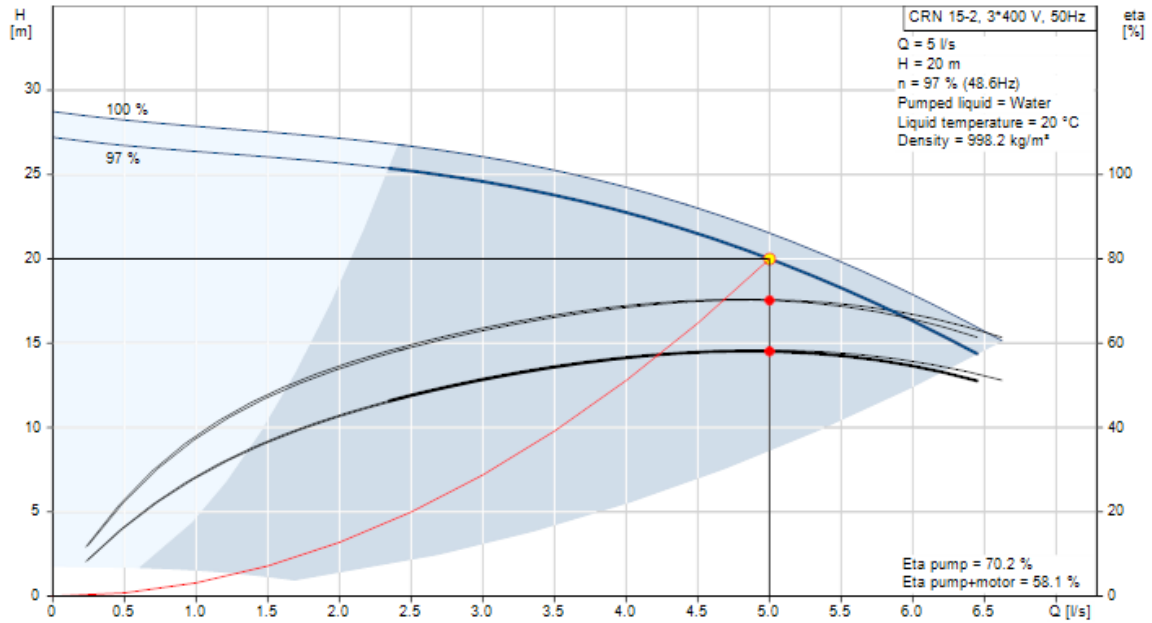

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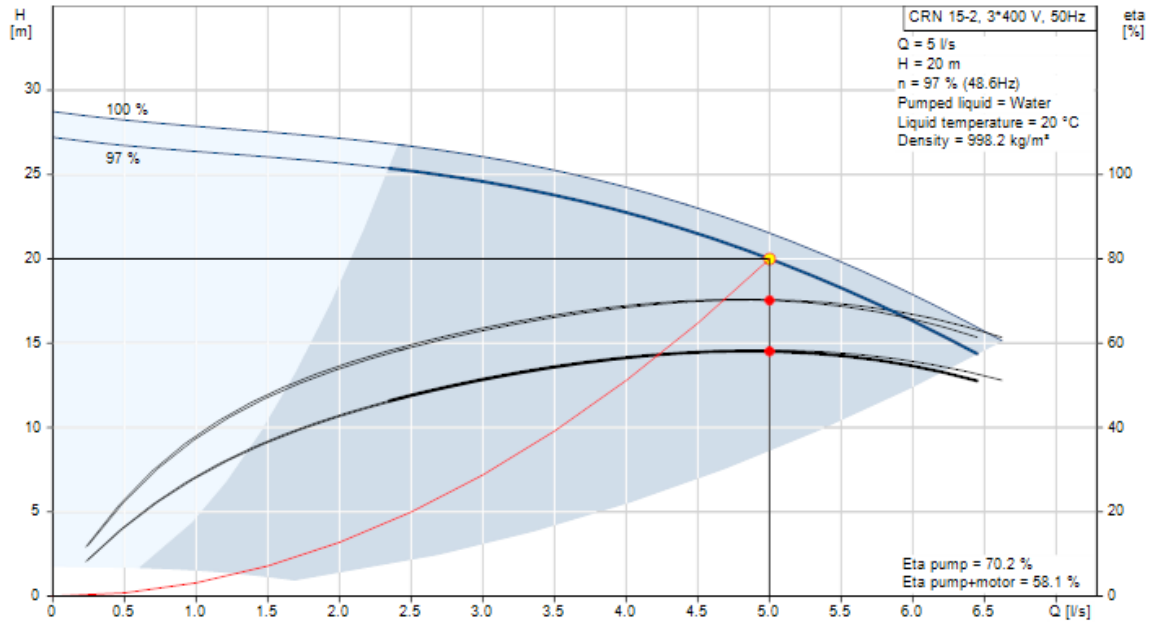

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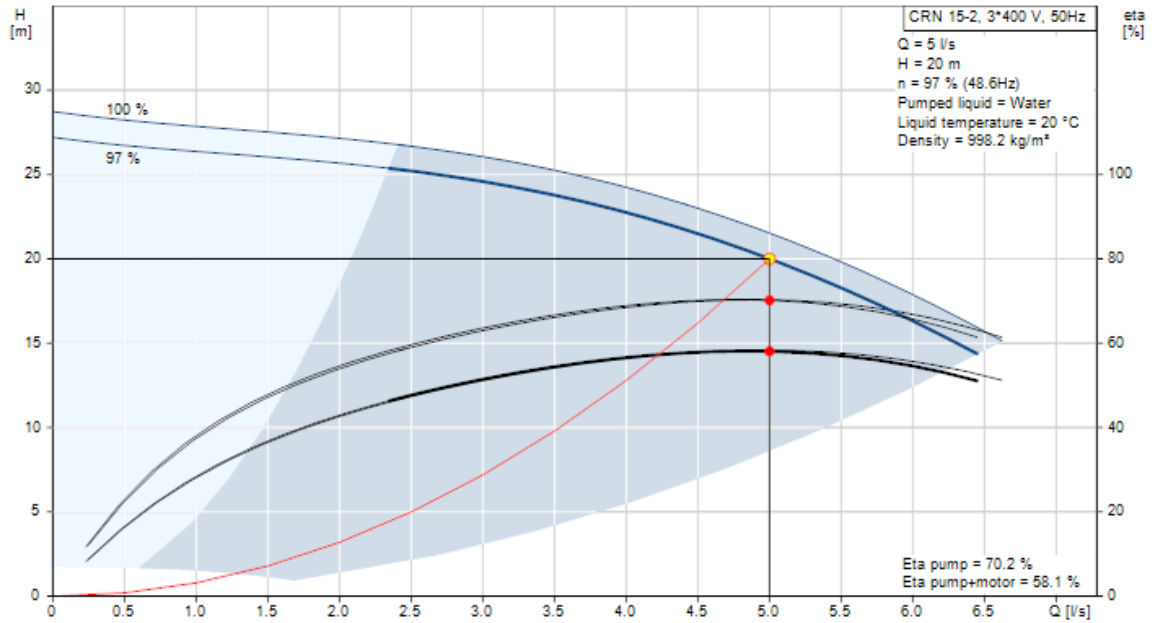


Transfer Systems Calculation

Domestic System – Transfer System Calculation

a) Based on Rooftop Tanks Size with Total Effective Capacity @ _____ 50.00 m^3

Therefore based on 4.00 hrs filling up time
Which the flowrate required from the pump is =

Eff. Cap / Fill up time
= 50.00 / 4.00
= 12.50 m^3/hr

b) Therefore total flowrate required = 3.47 L/s

- Determine the flowrate
- Filling up time: 1 – 4 hours (can be longer if multiple tanks)

Domestic System – Transfer System Calculation

- Determine the vertical static height

1) Static Lift (Vertical)

Tank level =			185.00	(Tank Level)	
Pump Room Level =			107.00	(Pump Room Level)	
Static Lift	= RL Tank Level	- RL Pump Room Level (Transfer Pump Level)		+ plinth & tank height	
	= 185.00	-	107.00	+	0.60
	= 78.60 meters				

Domestic System – Transfer System Calculation



Determine the fictional losses across pipe and fittings

2) Calculation for Pressure Head

a) Based on a flowrate of 5.00 L/s discharging from the pump.

Frictional losses

Frictional loss through pipe & fittings =		65.00	mm diameter		***(As per Inlet & Outlet)***	
Length of straight pipe =		5.00	meters		***Estimated***	
Vertical height =		0.00	meters			
i)	Gate Valve	1	x	0.45 =		0.45 m
ii)	Check Valve	1	x	3.00 =		3.00 m
iii)	Y-Strainer	0	x	24.00 =		0.00 m
iv)	Flexible Connector	1	x	0.45 =		0.45 m
v)	Elbow & Bends	1	x	4.00 =		4.00 m
vi)	Tee-joints	1	x	2.00 =		2.00 m
vii)	Motorised Valve	0	x	0.45 =		0.00 m
				Sub-Total:		9.90 m

Therefore friction losses through (14.90) meters of diameter 65.00 mm

of straight pipe is (14.90) x 0.05 m x 10%) = 0.75 meters

Velocity: 1.51 m/s

Domestic System – Transfer System Calculation

- Determine the fictional losses across pipe and fittings
- Velocity : $Q(m^3/s) / \prod r^2$

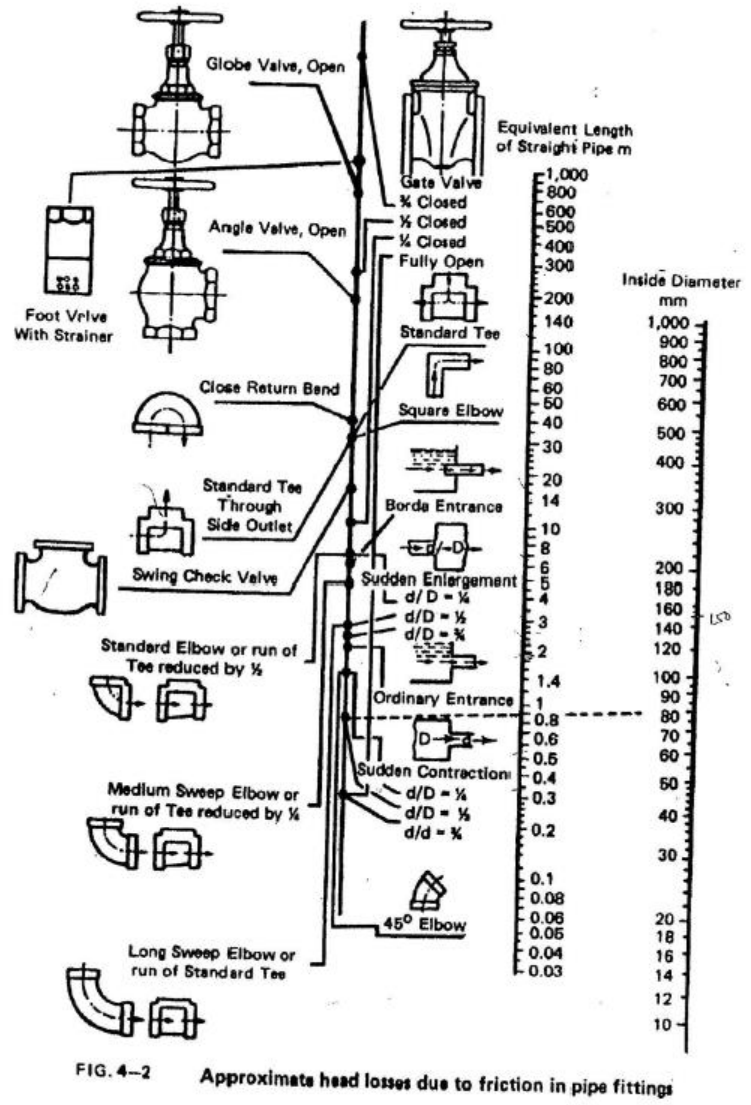
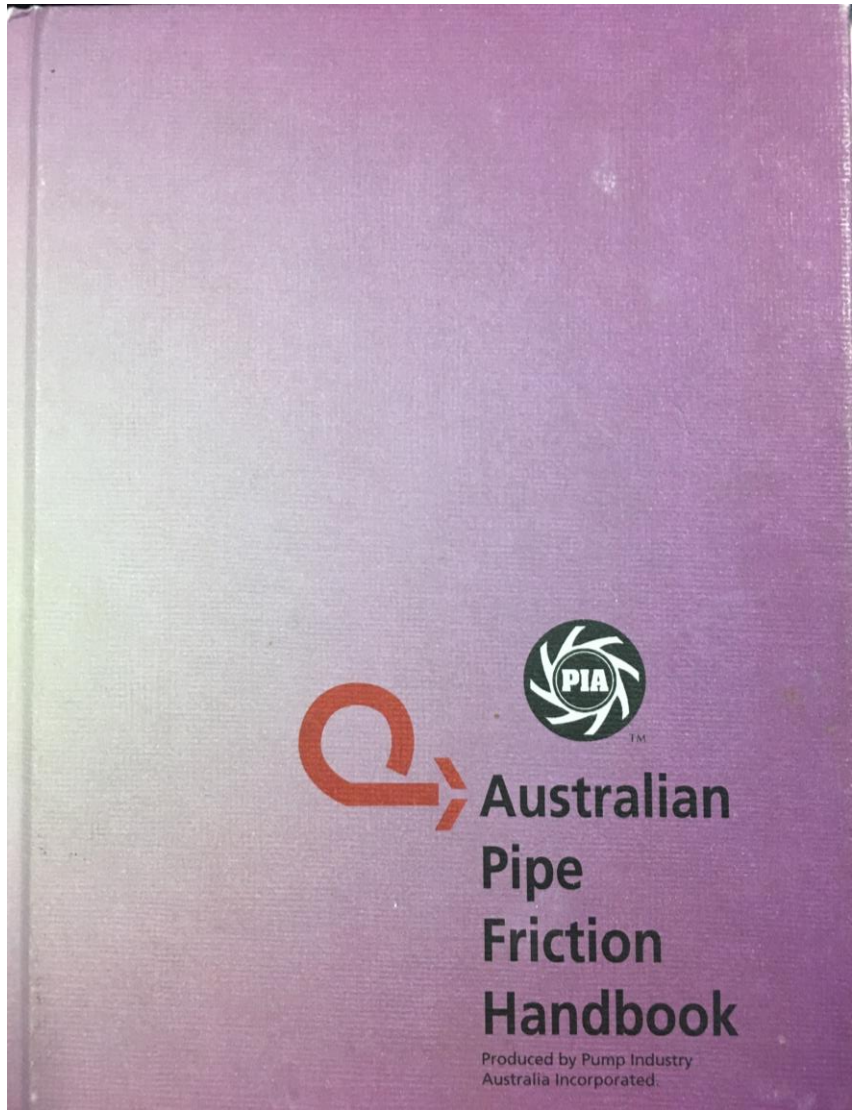


FIG. 4–2 Approximate head losses due to friction in pipe fittings

Domestic System – Transfer System Calculation

- Determine the fictional losses across pipe and fittings
- Using Hazen Williams Law

$$H_L=[(3.3 \times 10^6 \times Q) / (d^{2.63} \times C)]^{1.852}$$



Domestic System – Transfer System Calculation



Determine the Total Dynamic Head (TDH)

6) Total Dynamic Discharge Head

TDH =	**Frictional loss**	**+**	**Static Hd**	**+**	**Discharge Pressure**
=	38.29	+	78.60	+	5.00
=	121.89	meters			

Booster Systems Calculation

Domestic System – Booster System Calculation

- Determine the flowrate

Location / Sty	Taps	W.C (Cistern)	WB	Sink	RF	Shower	WM	Long Bath	UR
Roof	5	5	5	5	1	5	5	2	
Total	5	5	5	5	1	5	5	2	0

1) Calculations of flowrate

a) Litres / min	Quantity		Loading Units		
i) Taps	5	x	1	=	5
ii) W.C (Cistern)	5	x	5	=	25
iii) WB	5	x	4	=	20
iv) Sink	5	x	10	=	50
v) RF	1	x	1	=	1
vi) Shower	5	x	6	=	30
vii) WM	5	x	2	=	10
viii) Long Bath	2	x	11	=	22
ix) UR	0	x	1	=	0
					163 (Loading Units)

Therefore total flowrate required, with reference to Graph 3 of Hot & Cold Water Supplies from *Plumbing Engineering Services Design Guide from Institute of Plumbing* , is 1.77 litres/sec

Domestic System – Booster System Calculation

Domestic System – Plumbing Engineering Services Design Guide

- Loading Unit

Table 15 Loading units

Type of appliance	Frequency of use		
	Low	Med	High
Basin, 15mm sep. taps	1	2	4
Basin, 2 × 8mm mix. tap	1	1	2
Sink, 15mm sep/mix tap	2	5	10
Sink, 20mm sep/mix tap	-	7	-
Bath,15mm sep/mix/tap	4	8	16
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WC Suite, 6.litre cistern	1	2	5
Shower, 15mm head	2	3	6
Urinal, single bowl/stall	-	1	-
Bidet, 15mm mix tap	1	1	-
Hand Spray, 15mm	-	1	-
Bucket sink, 15mm taps	-	1	-
Slop Hopper, cistern only	-	3	-
Slop Hopper, cistern/taps	-	5	-
Clothes washing m/c, dom.	2	-	-
Dishwasher m/c domestic	2	-	-

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Domestic System – Booster System Calculation



Determine the flowrate

2) Calculation for Pressure Head

a) Based on a flowrate of | 2.00 | L/s discharging from the pump.

Frictional losses

Frictional loss through pipe & fittings =		40.00	mm diameter			***(As per pump inlet/outlet size)***
Length of straight short pipe =		5.00	meters			***(Estimate)***
Vertical height =			meters			
i)	Gate Valve	1	x	0.27	=	0.27 m
ii)	Check Valve	1	x	1.8	=	1.8 m
iii)	Y-Strainer	0	x	14	=	0 m
iv)	Flexible Connector	1	x	0.27	=	0.27 m
v)	Elbow & Bends	2	x	2.6	=	5.2 m
vi)	Tee-joints	1	x	1.2	=	1.2 m
vii)	Motorised Valve	0	x	0.27	=	0 m
					Sub-Total =	8.74 m

Therefore friction losses through (13.74) meters of diameter 40 mm
of straight pipe is (13.74 x 0.10) x 10% = 1.44 meters,
Velocity of 1.59 m/s

Domestic System – Booster System Calculation

- Determine the fictional losses across pipe and fittings
- Velocity : $Q(m^3/s) / \prod r^2$

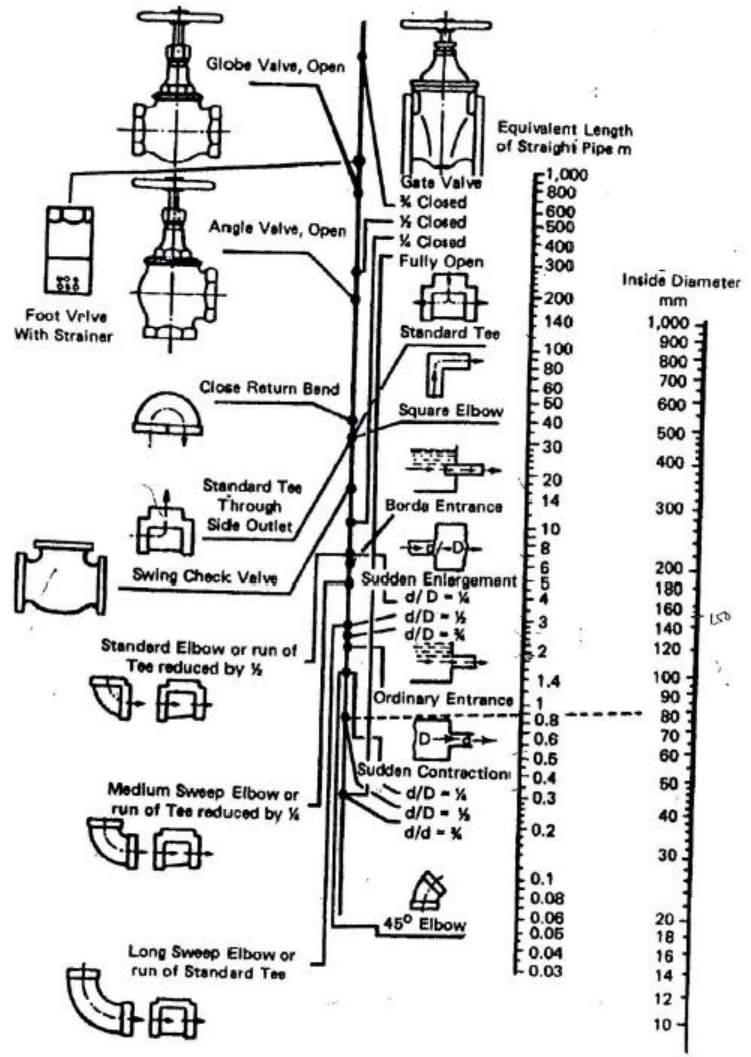

FIG. 4–2 Approximate head losses due to friction in pipe fittings

Domestic System – Booster System Calculation

- Determine the fictional losses across pipe and fittings
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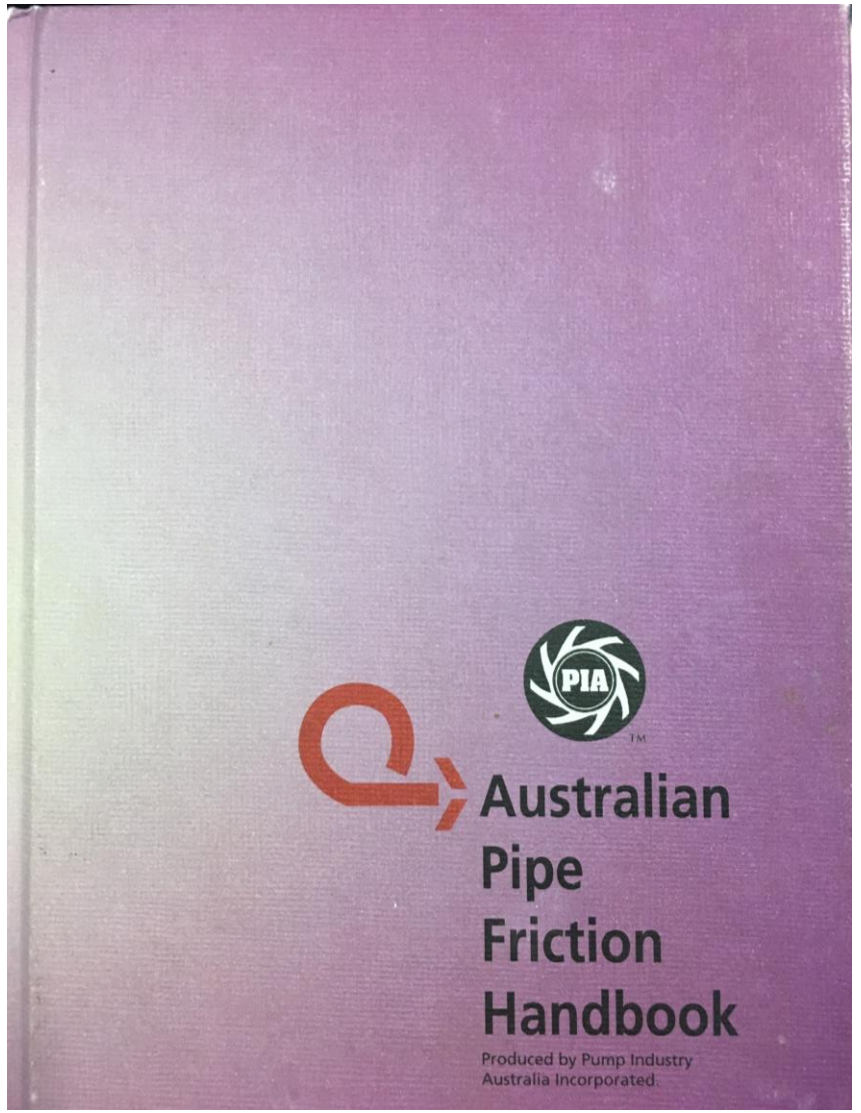
$$H_L=[(3.3 \times 10^6 \times Q) / (d^{2.63} \times C)]^{1.852}$$



Domestic System – Booster System Calculation



Determine the Total Dynamic Head (TDH)

6) Total Dynamic Discharge Head

TDH =	Frictional loss	+	Static Hd	+	Discharge Pressure	
=	2.59	+	5	+	15	
=	22.59 meters					

Domestic System – Booster System Calculation



Sizing of Pressure Vessel

a) Flowrate (Cut-in)	:	5.00	L/s ,	300	L/min
b) Flowrate (Cut-Out)	:	2.00	L/s ,	120.0	L/min
c) Head (Cut-in)	:	10.00	meters ,	1.00	bar
d) Head (Cut-Out)	:	20.00	meters ,	2.00	bar
e) No. of Start/Stop per hour	:	20	s/s per hour		
f) No.of Pump	:	2	pump(s)		

i) Acceptance Factor = $\frac{\text{Cut out} - \text{Cut in}}{\text{Cut out}}$ (absolute pressure)

= $\frac{3.00 - 2.00}{3.00}$

= 0.33

ii) Mean flowrate = $\frac{\text{Cut-in flowrate} + \text{Cut-Out flowrate}}{2}$

= $\frac{300 + 120.0}{2}$

= 210.00 L/min

iii) Mean Time = $\frac{60}{2}$ min (1 hour)
(50% of time running & 50% of time discharge)

= 30 min

Discussion time

Domestic System – Booster System Calculation

Sizing of Pressure Vessel

iv) Mean Time Share by No. of Pump

$$= \frac{30}{2} \text{ min}$$

$$= 15 \text{ min}$$

v) Effective Capacity of the pressure tank

$$= \frac{\text{Mean Time Share by No. of pump(s)} \times \text{Mean flowrate}}{\text{No.of Start/Stop per Hour}}$$

$$= \frac{15 \times 210.00 : 0.25}{20}$$

$$= 39.38 \text{ Litres}$$

iii) Therefore the total capacity of the pressure vessel

$$= \frac{\text{Effective Capacity}}{\text{Acceptance Factor}}$$

$$= \frac{39.38}{0.33}$$

$$= 118.13 \text{ Litres}$$

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Sanitary/WasteWater System

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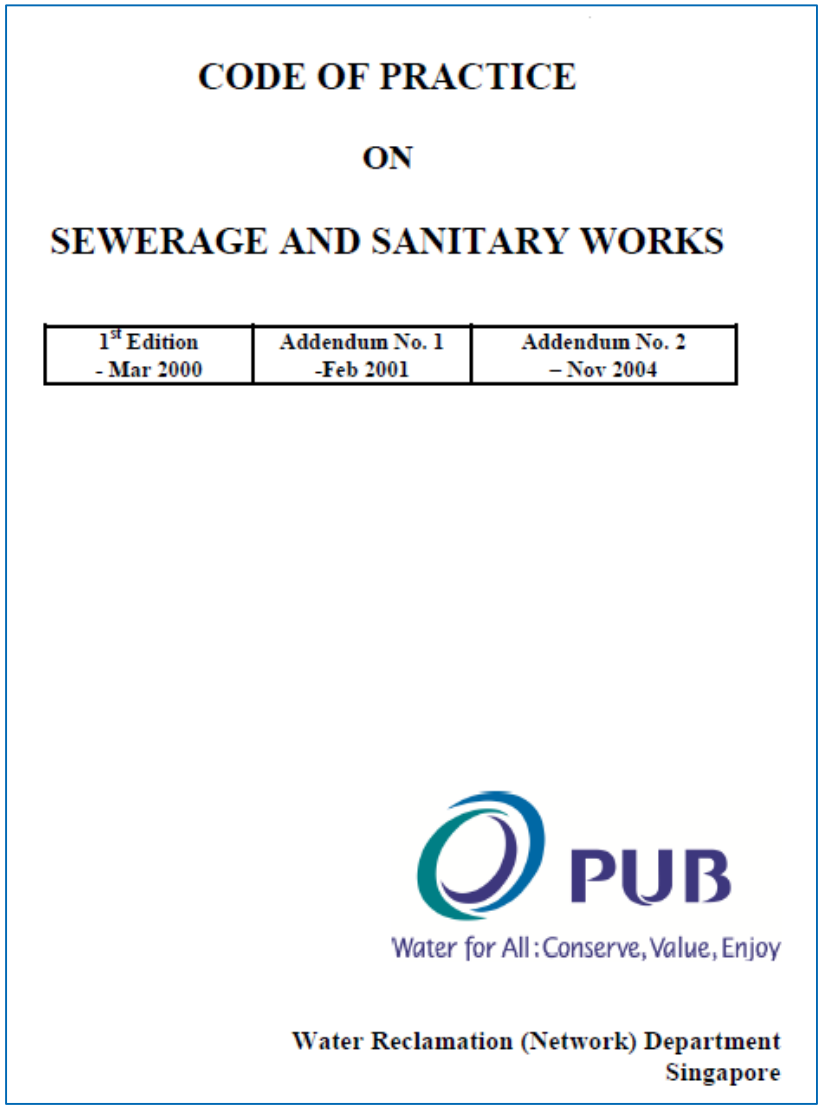
Sanitary/WasteWater System

Code of Practices and Guide Book

- COP – Sewage and Sanitary Works
- Plumbing Engineering Services Design Guide
- Australian Pipe Friction Handbook
- On-Site Stormwater Detention Tank Systems Technical Guide

Sanitary/WasteWater System



CODE OF PRACTICE

ON

SEWERAGE AND SANITARY WORKS

1st Edition - Mar 2000	Addendum No. 1 -Feb 2001	Addendum No. 2 – Nov 2004

PUB

Water for All : Conserve, Value, Enjoy

Water Reclamation (Network) Department
Singapore

Sanitary/WasteWater System - COP – Sewage and Sanitary Works

- Design of Pumping Main
  - Minimum Pipe Diameter

2.2.1 Minimum Size

The minimum size of pumping main shall be 100mm diameter.

  - Minimum & Maximum Velocity

2.2.2 Minimum and Maximum Velocities Permissible

The minimum and maximum velocities in pumping mains shall be 1.0m/sec and 2.4m/sec respectively.

(f) In addition, the choice of gradient for the branch/main drain-line shall be such as to maintain self-cleansing velocity (0.9 m/sec) and not to exceed scouring velocity (2.4 m/sec) under normal discharge condition.

Sanitary/WasteWater System - COP – Sewage and Sanitary Works

Design of Sewage Plant

Sewage Pump Requirement

2.4.1.2 Sewage Pumps

(a) Sewage pumps shall be capable of passing long fibrous materials.

(b) Sewage pumps of up to 2.2 kW shall be capable of passing solids of 64 mm in diameter without chokage and shall be with discharge pipes of minimum 75 mm diameter.

(c) Sewage pumps above 2.2 kW shall be capable of passing solids of 75 mm in diameter without chokage and shall be with discharge pipes of minimum 100 mm diameter.

Sanitary/WasteWater System - COP – Sewage and Sanitary Works

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Sanitary/WasteWater System - COP – Sewage and Sanitary Works

- Design of Sewage Plant
  - Sewage Pump Room Requirement

2.4.1.3 Sewage Ejector / Solids Divertor

(a) The pit for the sewage ejector or solids divertor installation shall be adequately sized to accommodate the tanks, pumps, dewatering sump pump, valves, pipework etc. and shall include working space for maintenance. Generally, a room shall be provided and the pit shall be of minimum 3m x 3m size. This provision enables the following functional requirements to be met:

Sanitary/WasteWater System - COP – Sewage and Sanitary Works

- Design of Sewage Plant
  - Sewage Plant without a Room

(1) Adequate forced ventilation system shall continue to be provided for the safe working environment of workers operating and working in the sewerage installation;

(2) The pit shall be located away from driveway;

(3) Measures shall be provided all round the pit to prevent water flowing into it and to prevent vehicles or other items from obstructing access and maintenance.

(4) The pit shall be securely covered with lockable doors or covers;

(5) The access opening for the pit shall extend over the whole of the ejector/ divertor tank and pumps;

(6) Lifting equipment shall be provided for the installation.

Sanitary/WasteWater System - COP – Sewage and Sanitary Works

- Design of Sewage Plant
  - Screen Chamber

2.4.1.6 Screening

Screens of suitable corrosion resistant material (e.g. stainless steel) shall be provided to prevent large objects from entering the installation so as not to cause damage to the pumping equipment and disruption to the pumping system.

Sanitary/WasteWater System – Plumbing Engineering Services Design Guide

- Discharge Unit

Not all sanitary appliances will be in simultaneous use. The peak design flow can be assessed by applying a frequency of use K factor (see Table 6) to the total sum of the discharge units, and by using the following equation:

$$Qww = K \sqrt{\sum DU}$$

Where:

Q_{ww} = Wastewater flow rate (l/s)

K = Frequency of use

$\sum DU$ = Sum of discharge units

Before the stack selection can be made, any other continuous or fixed flow must be added to the Qww value. The following equation explains further:

$$Q_{tot} = Q_{ww} + Q_c + Q_p$$

Where:

Q_{tot} = Total flowrate (l/s)

Q_{ww} = Wastewater flowrate (l/s)

Q_c = Continuous flowrate (l/s)

Q_p = Pumped flowrate (l/s)

Once the Q_{tot} value has been obtained, a decision about the stack size, and ventilation principle can be made by referring to Table 7 and 8. The pipe sizes relate to the pipe bores which have traditionally been used in the UK. The theoretical minimum bore for 50, 75, 100 and 150 sizes is 44, 75, 96, and 146mm respectively. Both Table 4 and 5 are based on 'swept entry' equal branches, which are required in the UK.

Table 5

Appliance	DU (L/s)
Wash basin or bidet	0.3
Shower without plug	0.4
Shower with plug	1.3
Single urinal with cistern	0.4
Slab urinal (per person)	0.2
Bath	1.3
Kitchen sink	1.3
Dishwasher (household)	0.2
Washing machine (6kg)	0.6
Washing machine (12kg)	1.2
WC with 6 l cistern	1.2 – 1.7
WC with 7.5 l cistern	1.4 – 1.8
WC with 9 l cistern	1.6 – 2.0

The Water Regulations & Byelaws in the UK do not allow the use of 7.5 or 9 litre WC flushing cisterns on new installations, the information is provided for use in connection with existing systems.

Table 6

Usage of appliances	K
Intermittent use, e.g. dwelling, guesthouse, office	0.5
Frequent use, e.g. hotel, restaurant, school, hospital	0.7
Congested use, e.g. toilets and/or showers open to the public	1.0
Special use, e.g. laboratory	1.2

Table 7 Maximum capacity of PRIMARY ventilated discharge stacks

Min. stack & vent I.D.	Litres/sec
75mm*	2.6
100mm	5.2
150mm	12.4

** No WC's allowed on 75mm stacks*

Table 8 Maximum capacity of SECONDARY ventilated discharge stacks

Min. stack & vent I.D.		Litres/sec
Stack & vent	Vent	
75mm*	50mm	3.4
100mm	50mm	7.3
150mm	50mm	18.3

** No WC's allowed on 75mm stacks*

Example 1

Determine total design flowrate and stack requirements for an 11-storey block of apartments. The each stack will serve one apartment per floor, comprising of bathroom, en-suite shower room and fully fitted kitchen.

DU per flat:

2 WC's × 1.7 =	3.4
2 wash basins × 0.3 =	0.6
1 bath =	1.3
1 shower =	0.4
1 kitchen sink =	1.3
1 washing machine =	0.6
1 dishwasher =	0.2
	7.8

Assume a primary ventilated stack is adequate; therefore the bottom storey must connect separately to drain (see Figure 5).

For 10 storeys, ∑DU: 7.8 x 10 = 78

K = 0.5, so Q_{ww} = 0.5 √78 = 4.42l/s

Q_c & Q_p = zero, so Q_{tot} = 4.42l/s

From Table 7, a 100mm primary ventilated stack has a limit of 5.2l/s, so this size is adequate. Secondary ventilation is not required.

Example 2

Determine total design flowrate and stack requirements for an 11-storey hotel. The stack will serve two en-suite bathrooms on each floor; there will be air conditioning units on the roof with a peak discharge of 0.2L/s, and laundry equipment on the 5th floor with a peak discharge of 0.5l/s.

DU per typical floor:

2 WC's × 1.7 =	3.4
2 wash basins x 0.3 =	0.6
2 baths × 1.3 =	2.6
	6.6

Assume a primary ventilated stack is adequate; therefore the bottom storey must connect separately to drain (see Figure 5).

For 10 storeys, ∑DU: 6.6 x 10 = 66

K = 0.7, so Q_{ww} = 0.7 √66 = 5.7l/s

Q_{tot}: 5.7 + 0.2 + 0.5 = 6.4l/s

There are two options; a 150mm primary ventilated stack, or a 100mm secondary ventilated stack and 50mm secondary vent. Practical considerations would dictate the best choice, for example a proprietary fitting such as the collar boss (see Figure 19) is only available in the 100mm size.

Self-sealing waste valves

The recent introduction to the plumbing market of waste valves to replace the water seal trap offers the installer an opportunity to reconsider his system design, often reducing the amount of pipework required, whilst still meeting the mandatory requirement of Building Regulation ADH.1. These valves and their function are described in Figures 22 to 26.

As the name suggests, these valves open to allow the flow of water from the appliance, or to allow air to enter the pipework system in the case of negative pressure, then closes automatically when the flow stops or the pipework system pressure reaches eqilibrium with atmosphere.

This means that a system fitted with valves in place of water seal traps would be self-ventilating.

The valves are designed to open between 3 and 6mb and will remain sealed against 400+mb back pressure.

These valves are particularly useful for situations where water seals would be lost by evaporation – for example, holiday homes, condensate drains from chillers and air conditioning units. (See manufacturers' detailed instructions.)

The valves are available in 32mm (1¼") and 40mm (1½") body size, together with 87½° knuckle elbow and running adaptor. Universal compression outlets are used for making connections to either push fit BS 5254 or solvent weld BS 5255 waste systems.

Sanitary/WasteWater System – Plumbing Engineering Services Design Guide

- Discharge Unit

Code of Practice on Sewerage and Sanitary Works (1st Edition – Mar 2000) (Updated: Nov 2004)

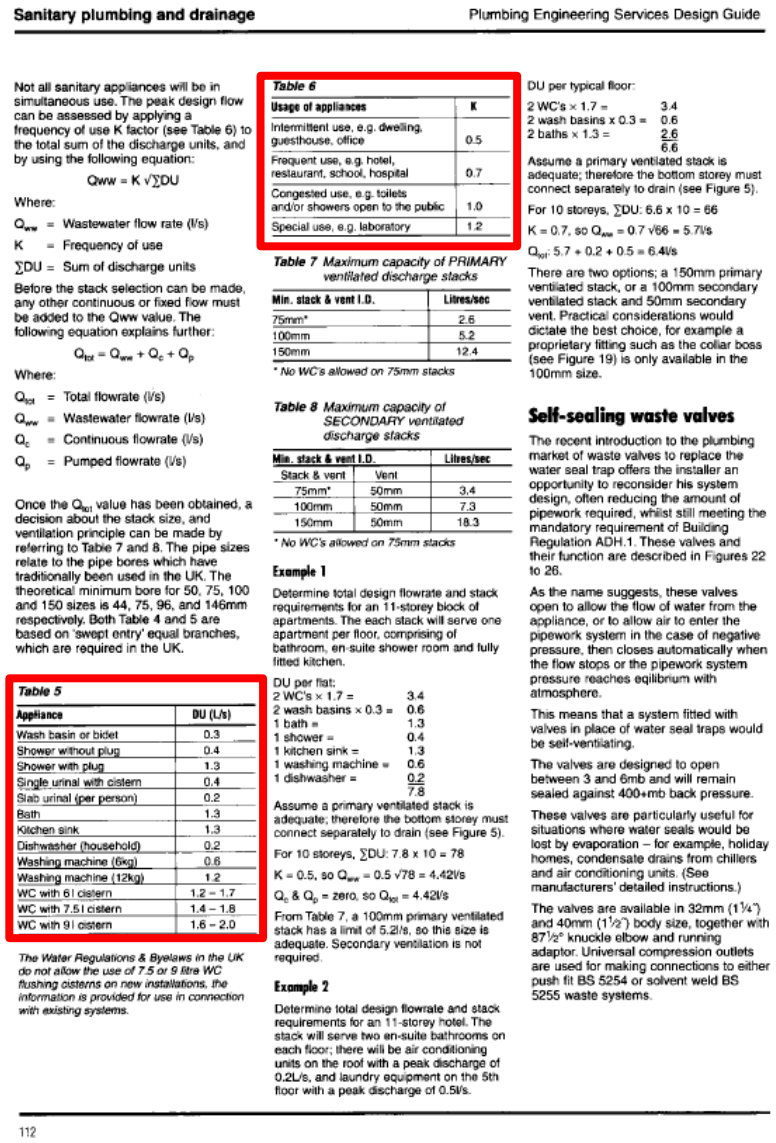
3.3.3.4 Flush Valve (3-26)

(a) The flush valve shall conform to the requirements in the SS CP 48 - Code of Practice for Water Services.

[Note : Under the Public Utilities (Water Supply) Regulations, (1) a flush valve for a water closet shall deliver not more than 4.5 litres of water per flush and a flush valve for urinal shall deliver not less than 1.5 litres and not more than 2.5 litres of water for individual urinal unit; (2) Flush valve shall not be used in residential premises.]

Sanitary/WasteWater System – Plumbing Engineering Services Design Guide

- Discharge Unit



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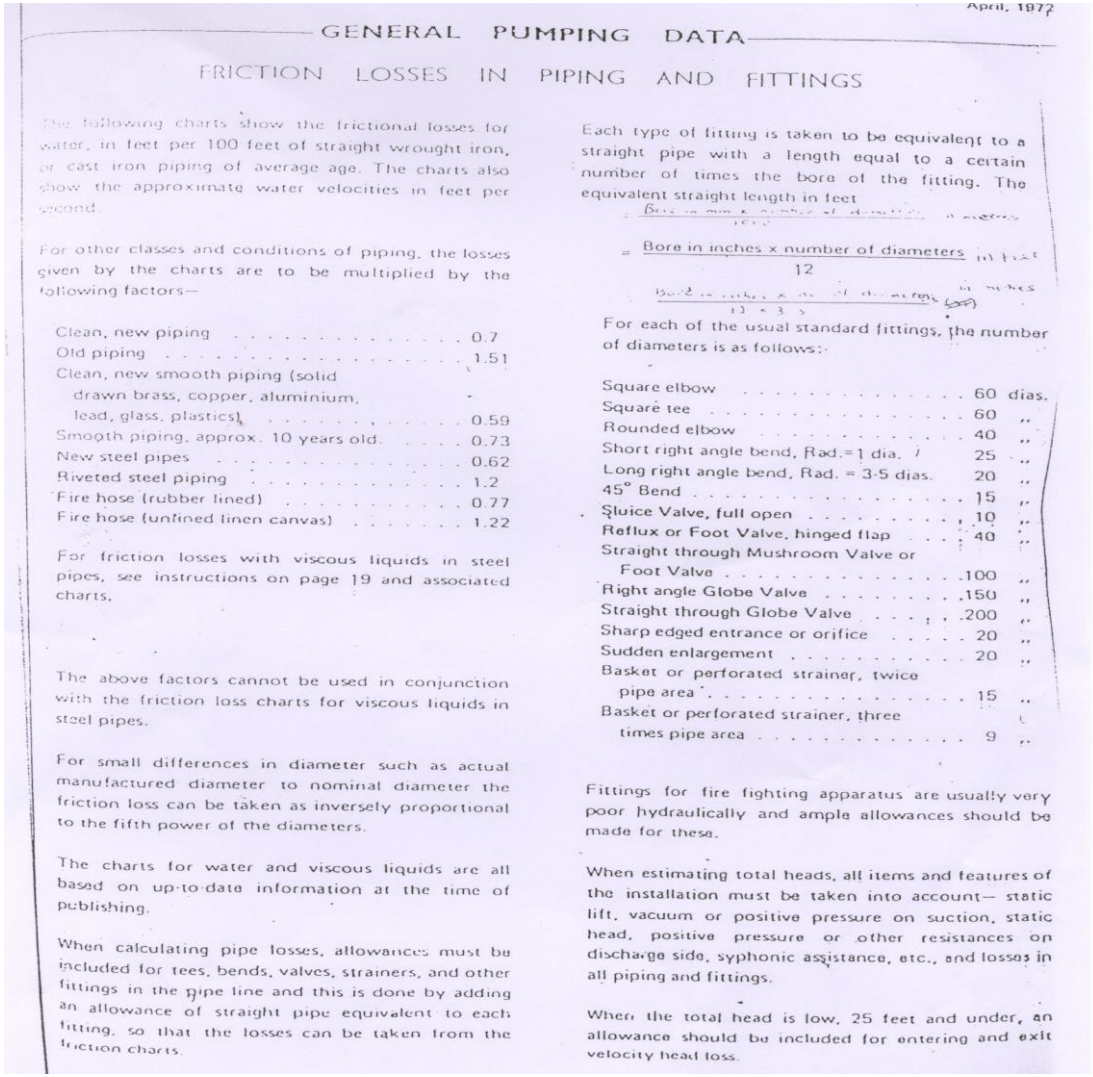
Sanitary/WasteWater System – Plumbing Engineering Services Design Guide

- I.O.P. – Friction loss in fittings



April, 1972

GENERAL PUMPING DATA

FRICTION LOSSES IN PIPING AND FITTINGS

The following charts show the frictional losses for water, in feet per 100 feet of straight wrought iron, or cast iron piping of average age. The charts also show the approximate water velocities in feet per second.

For other classes and conditions of piping, the losses given by the charts are to be multiplied by the following factors—

Clean, new piping	0.7
Old piping	1.51
Clean, new smooth piping (solid drawn brass, copper, aluminium, lead, glass, plastics)	0.59
Smooth piping, approx. 10 years old	0.73
New steel pipes	0.62
Riveted steel piping	1.2
Fire hose (rubber lined)	0.77
Fire hose (unlined linen canvas)	1.22

For friction losses with viscous liquids in steel pipes, see instructions on page 19 and associated charts.

The above factors cannot be used in conjunction with the friction loss charts for viscous liquids in steel pipes.

For small differences in diameter such as actual manufactured diameter to nominal diameter the friction loss can be taken as inversely proportional to the fifth power of the diameters.

The charts for water and viscous liquids are all based on up-to-date information at the time of publishing.

When calculating pipe losses, allowances must be included for tees, bends, valves, strainers, and other fittings in the pipe line and this is done by adding an allowance of straight pipe equivalent to each fitting, so that the losses can be taken from the friction charts.

Each type of fitting is taken to be equivalent to a straight pipe with a length equal to a certain number of times the bore of the fitting. The equivalent straight length in feet

$$= \frac{\text{Bore in inches} \times \text{number of diameters}}{12} \text{ in feet}$$

For each of the usual standard fittings, the number of diameters is as follows:—

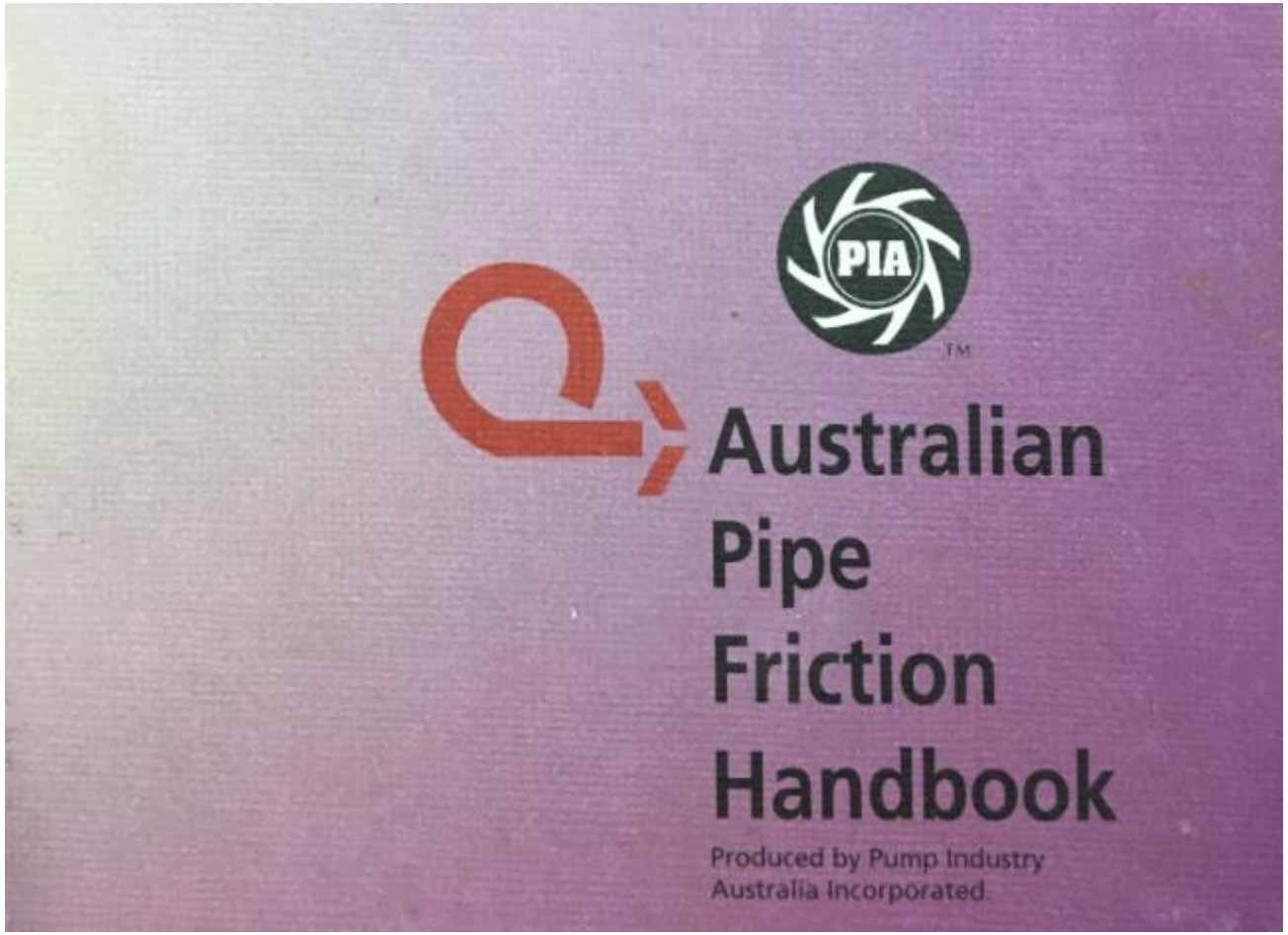
Square elbow	60 dias.
Square tee	60 ,,
Rounded elbow	40 ,,
Short right angle bend, Rad. = 1 dia.	25 ,,
Long right angle bend, Rad. = 3·5 dias.	20 ,,
45° Bend	15 ,,
Sluice Valve, full open	10 ,,
Reflux or Foot Valve, hinged flap	40 ,,
Straight through Mushroom Valve or Foot Valve	100 ,,
Right angle Globe Valve	150 ,,
Straight through Globe Valve	200 ,,
Sharp edged entrance or orifice	20 ,,
Sudden enlargement	20 ,,
Basket or perforated strainer, twice pipe area	15 ,,
Basket or perforated strainer, three times pipe area	9 ,,

Fittings for fire fighting apparatus are usually very poor hydraulically and ample allowances should be made for these.

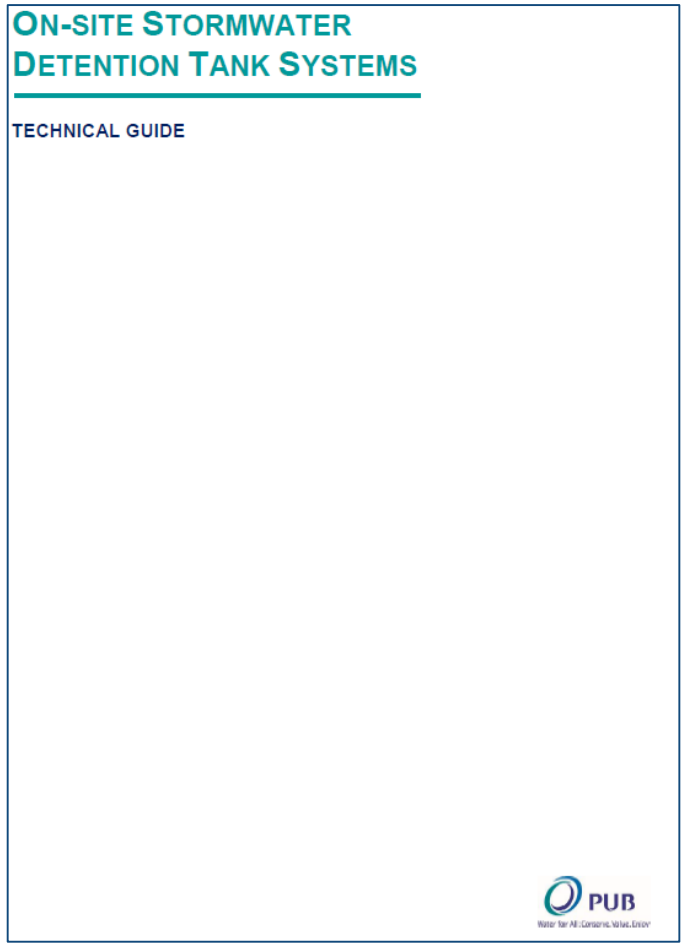
When estimating total heads, all items and features of the installation must be taken into account— static lift, vacuum or positive pressure on suction, static head, positive pressure or other resistances on discharge side, syphonic assistance, etc., and losses in all piping and fittings.

When the total head is low, 25 feet and under, an allowance should be included for entering and exit velocity head loss.

Sanitary/WasteWater System – Australian Pipe Friction Handbook



📚 Sanitary/WasteWater System – On-Site Stormwater Detention Tank Systems Technical Guide



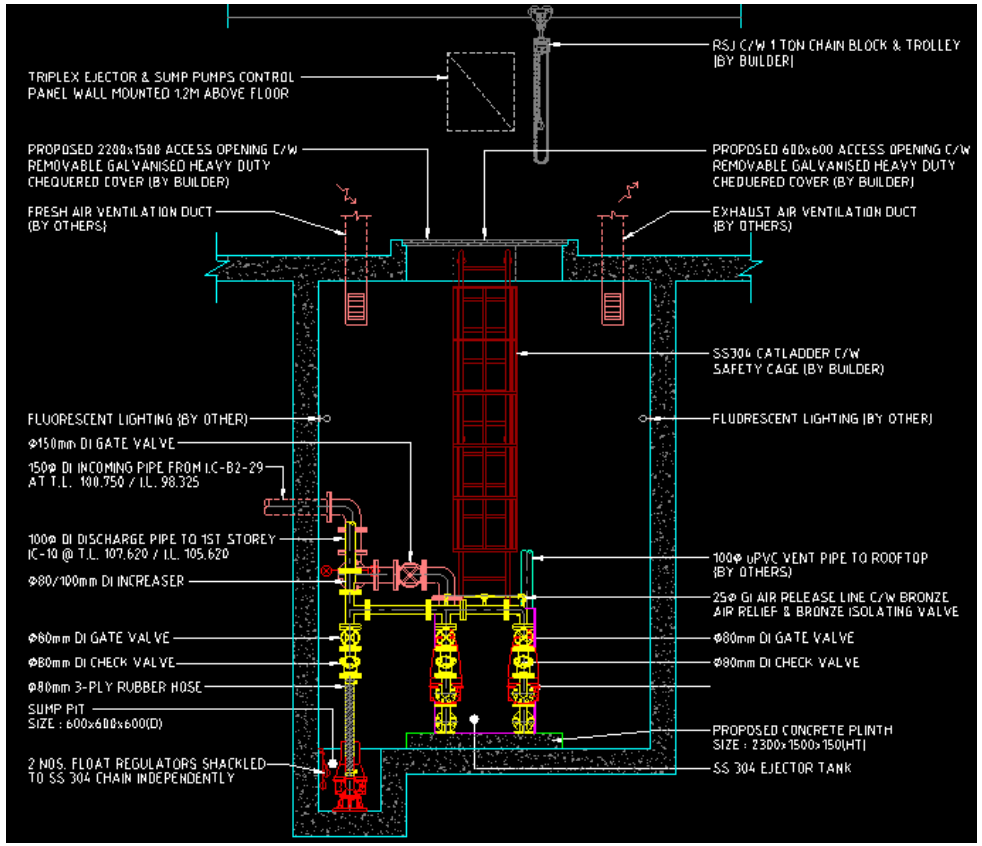
Type of Sanitary/Wastewater Systems

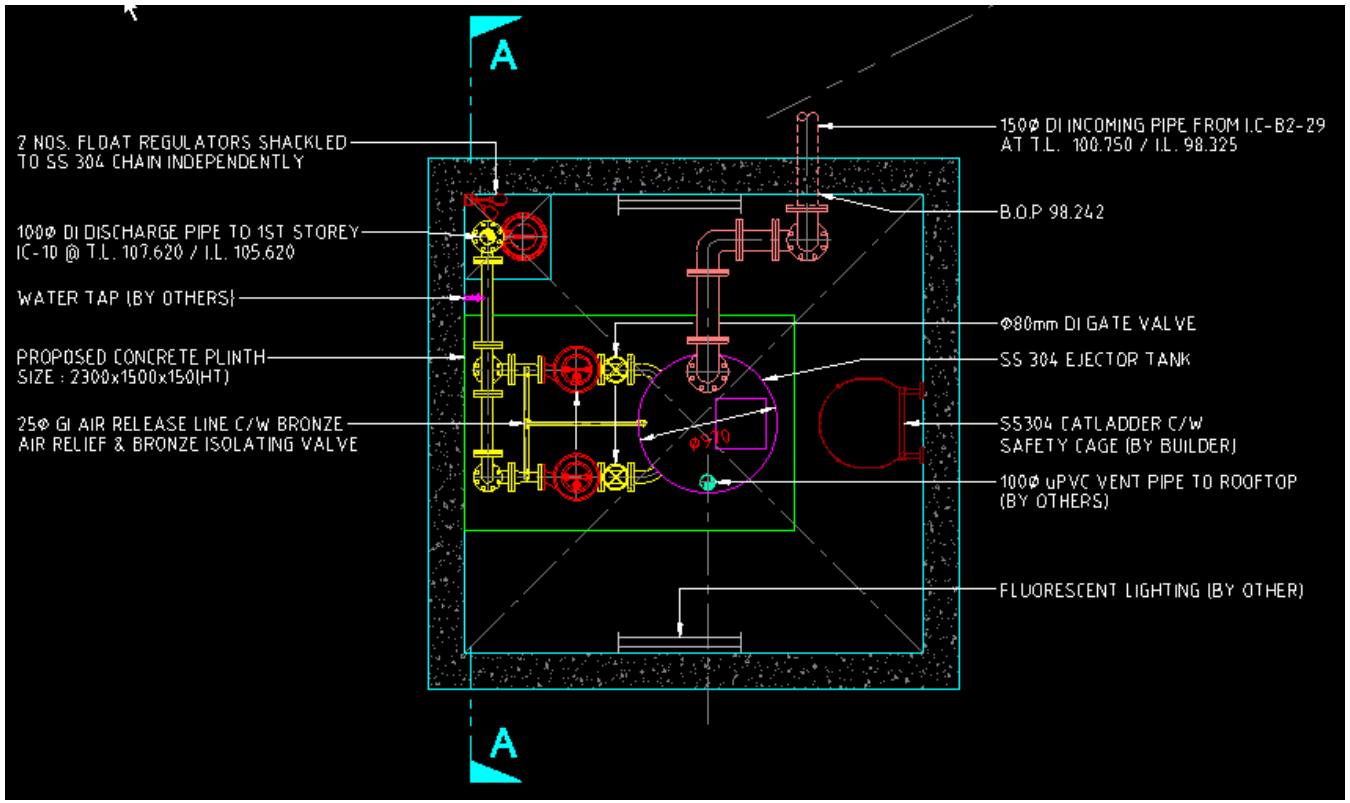
Sanitary/Wastewater System – Type of Systems

- Sewage Ejector System
- Detention Tank Sump Pump System
- Carpark Sump Pump System

Sanitary/Wastewater System – Sewage Ejector System

Sewage Ejector System





Sanitary/Wastewater System – Sewage Ejector System

- What is included in a Sewage Ejector Pit?

Standard Of Practice (SOP) for Ejector System (Pit)

NO.	REQUIREMENTS
1	Cat Ladder : Ejector Pit high is above 3m need to provide safe cage
2	Hoisting (I Beam) for Chain Block
3	Supply and Exhaust air Ventilation
4	Lighting
5	Chequered Plate c/w Pad Lock or Fencing around
6	Tap Point

Sanitary/Wastewater System – Sewage Ejector System

- What is included in a Sewage Ejector Room?

Standard Of Practice (SOP) for Ejector System (Room)

NO.	REQUIREMENTS
1	Supply and Exhaust air Ventilation
2	Lighting
3	Tap Point

Sanitary/Wastewater System – Detention Tank Sump Pump System

- When it is required

Industrial, commercial, institutional and residential developments greater than or equal to 0.2 hectares (ha) in size are required to control the peak runoff discharged from their sites. The maximum allowable peak runoff to be discharged to the public drains will be calculated based on a runoff coefficient of 0.55, for design storms with a return period of 10 years and for various storm durations of up to 4 hours (inclusive).

- What is Detention Tank?
  - Collect and Store Stormwater, and release at controlled flow

Sanitary/Wastewater System – Detention Tank Sump Pump System

- Type of Detention Tanks
  - Online System
  - Offline System

Sanitary/Wastewater System – Detention Tank Sump Pump System

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  - Online System
    - Entire catchment is routed to the system
    - Bigger Tank
  - Offline System
    - Portion to Open Drain, Portion routed to the system
    - Smaller Tank

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Sanitary/Wastewater System – Detention Tank Sump Pump System

- Discharge from System
  - Gravity
  - Pumped
  - Within 4 hours **after** a storm
  - Offline System more complex due to the correlation between tank and drain

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Sanitary/Wastewater System – Detention Tank Sump Pump System

- Pumped System
  - Prevent backflow via gooseneck
  - Discharge to internal drain, direct discharge to public drain is not permissible
  - Recommend 2+1 pump system
  - Rain Sensor, water sensor is recommended

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Sanitary/Wastewater System – Detention Tank Sump Pump System

- Maintenance of System
  - Inspection once a month / after significant storm
- What to inspect
  - Any structure damage
  - Stagnant water
  - inlet/outlet clogging
  - Sedimentation
  - Pumps

Sanitary/Wastewater System – Detention Tank Sump Pump System

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Sanitary/Wastewater System – Carpark Sump Pump System

- Floorwaste or Floortrap directing waste water from underground carpark to waste sump
- Access opening provided above pump for ease of maintenance
- Intermediate platform shall be provided for sump above 6m

Sewage Ejector System Calculation

Calculation – Sewage Ejector System

- Determine the inflow

Location / Sty	WB	Tap	SH	UR (Cistern)	Slab UR	LB	SK	Dishwasher	WM	WC (6 L)
	15	15	20				15		15	15
Total	15	15	20	0	0	0	15	0	15	15

Calculation of Inflow

Plumbing Engineering - Sanitary Plumbing and Drainage - June 2002 Pg 112 (Table 5)

			No. of fittings		DU (L/s)		
a)	WB	=	15	x	0.3	=	4.50
b)	Tap	=	15	x	0.3	=	4.50
c)	SH	=	20	x	1.3	=	26.00
g)	SK	=	15	x	1.3	=	19.50
i)	WM	=	15	x	1.2	=	18.00
j)	WC(6 L)		15	x	1.7	=	25.50
					Sum of discharge units, SDU	=	**98.00**

Usage of appliances	K
Intermittent use, eg dwelling, guesthouse, office	0.5
Frequent use, eg. Hotel, restaurant, school, hospital	0.7
Congested use, eg.toilet and/or showers open to the public	1
Special use, eg. Laboratory	1.2

Wastewater flowrate Qww = **K √ΣDU** = 0.7 x √ 98.00 = 6.93 L/s

Calculation – Sewage Ejector System



Determine the Static Head

Calculation of Total Estimated Head for Ejector Pump

Top level of Discharge Chamber	IC	:	TL	124.597
Top level of Ejector pit		:	TL	118.062
Depth of Ejector pit		:		3.000
Swan Neck		:		1.00
GIVEN STATIC HEAD, (SH)		:		**10.54** m

Calculation – Sewage Ejector System

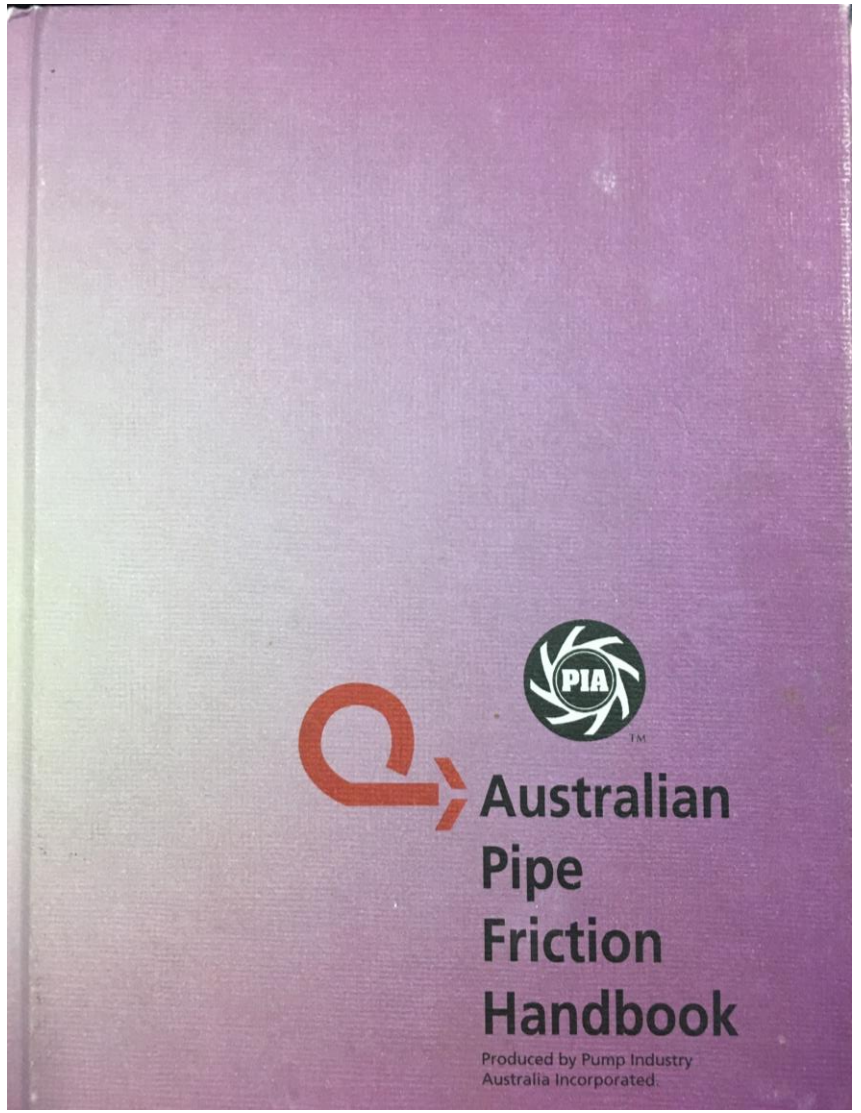
- Determine frictional losses along horizontal pipe and fitting losses

No. of dia.	100	mm fittings			Fitting Equivalent Length (m)			Pipe Size (m)		Pipe length (m)
a)	nos. elbow		=	1	x	40	x	0.1	=	4.0
b)	no. gate valve		=	1	x	40	x	0.1	=	4.0
c)	no. check valve		=	1	x	10	x	0.1	=	1.0
d)	no. tee (St.)		=	1	x	60	x	0.1	=	6.0
e)	no. of increaser		=	1	x	20	x	0.1	=	2.0
f)	Approx. length of straight pipe								=	4.0
TOTAL EQUIVALENT LENGTH OF DIA.				**100**	**MM**	**PIPE**			=	**21.0 m**

Calculation – Sewage Ejector System

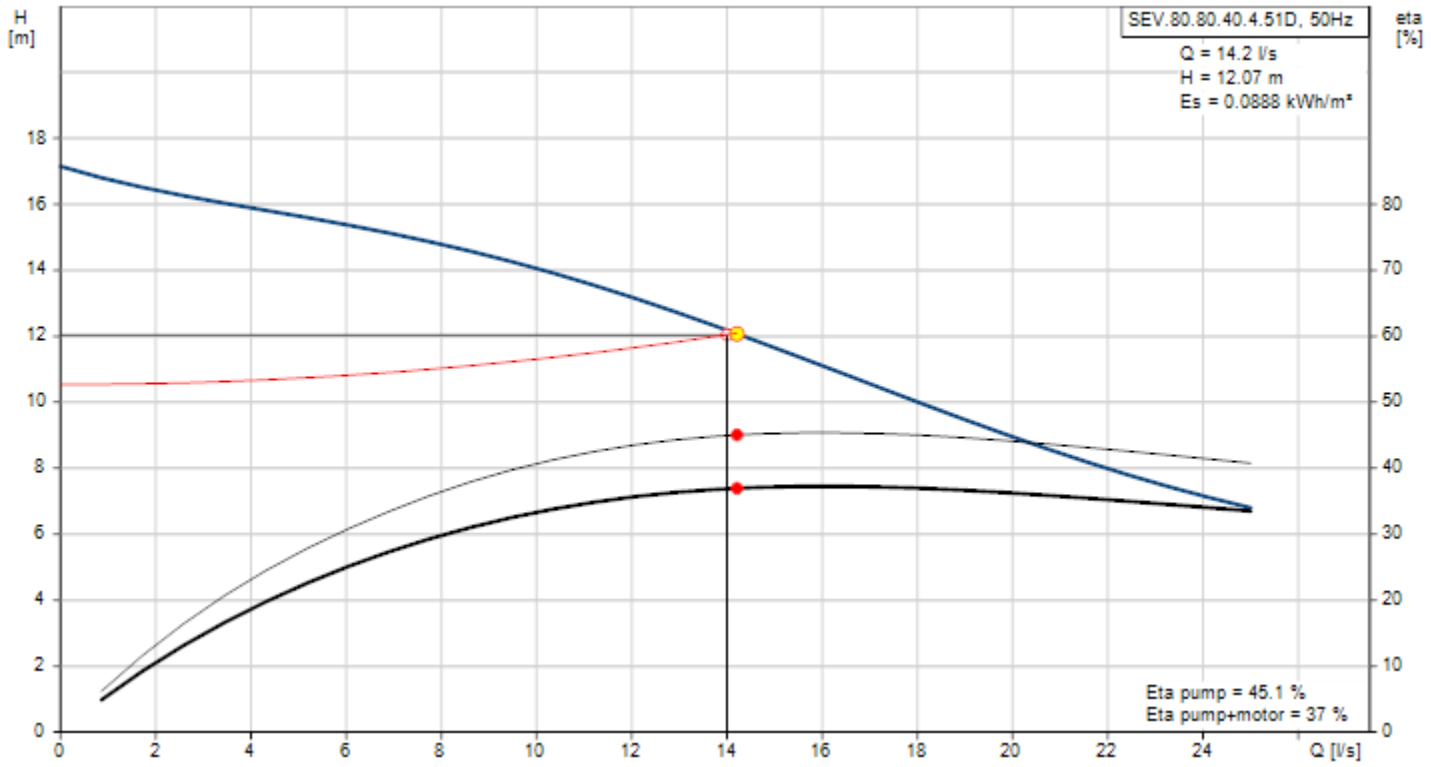
- Determine the fictional losses across pipe and fittings
- Using Hazen Williams Law

$$H_L=[(3.3 \times 10^6 \times Q) / (d^{2.63} \times C)]^{1.852}$$



Calculation – Sewage Ejector System

- Selection of pump



Detention Tank Sump Pump Calculation

Calculation – Detention Tank Sump Pump System



Determine the pump capacity

Given detention system configuration				Remarks
Detention tank volume	Vt (m^3)	79.87	m^3	
Tank depth	dt (m)	1.3	m	
Tank bottom area	At (m2)	61.44	m^2	
Target peak discharge	Q_{target} (m^3/s)	0.115	m^3/s	

Specify pump operation						Remarks
Detention tank volume	Q_{p1} (m^3/s)	79.87	÷	4		based on 4.0 hrs discharge.
		=		19.9675	m3/h	
		=		0.00554653	m3/s	$Q_{p1} < Q_{target}$

Calculation – Detention Tank Sump Pump System



Determine the Static Head

Calculation of Total Estimated Head for Overflow Sump Pump

Open Drain Level	:	TL	109.60
Top level of sump pit	:	TL	105.10
Depth of sump pit including dewatering pit	:		1.50
Swan Neck	:		1.00
STATIC HEAD, (SH)	:		**7.00 m**

Calculation – Detention Tank Sump Pump System

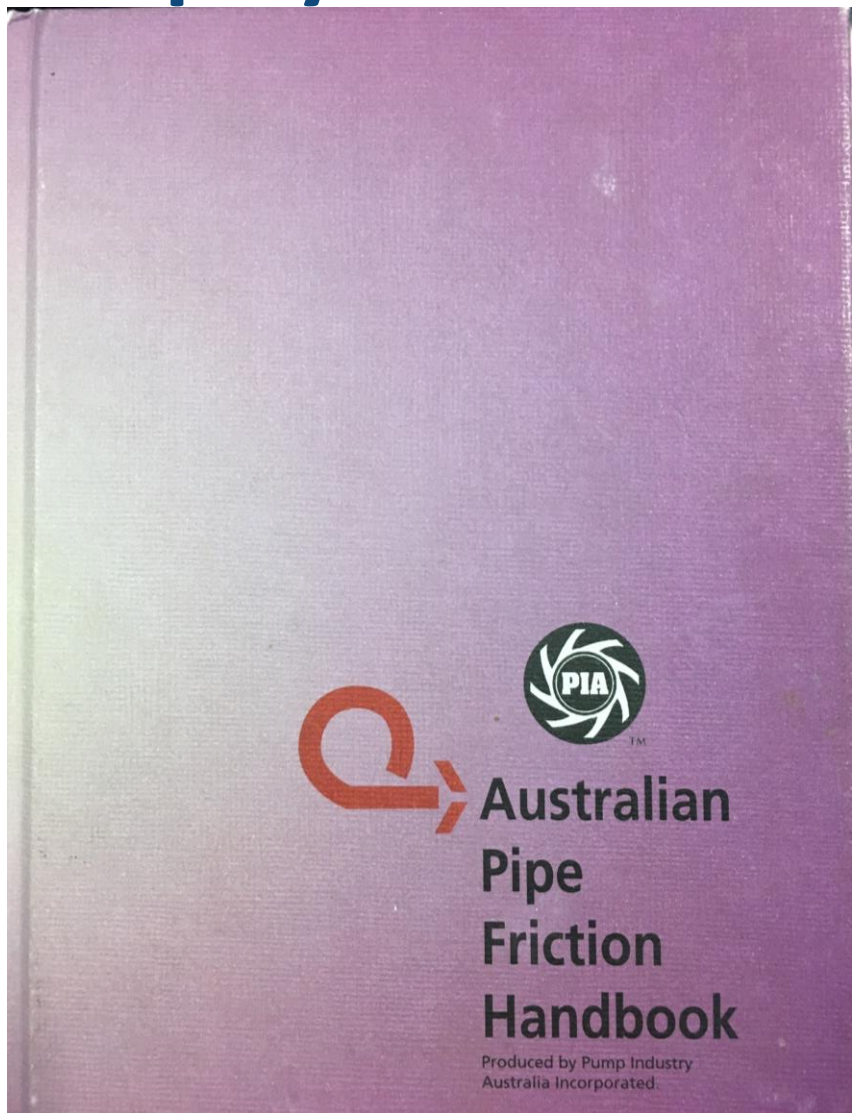
 Determine frictional losses along horizontal pipe and fitting losses

No. of dia.	100	mm fittings								
a) nos. elbow	=	1	x	40	x	0.10	=	4.0
b) no. gate valve	=	1	x	40	x	0.10	=	4.0
c) no. check valve	=	1	x	10	x	0.10	=	1.0
d) no. tee (St.)	=	2	x	60	x	0.10	=	12.0
e) no. 80 x 100 mm increaser	=	1	x	20	x	0.10	=	2.0
f) Approx. length of straight pipe							=	3.0
TOTAL EQUIVALENT LENGTH OF DIA.		**100**	**MM**	**PIPE**			=	**26.0 m**

Calculation – Detention Tank Sump Pump System

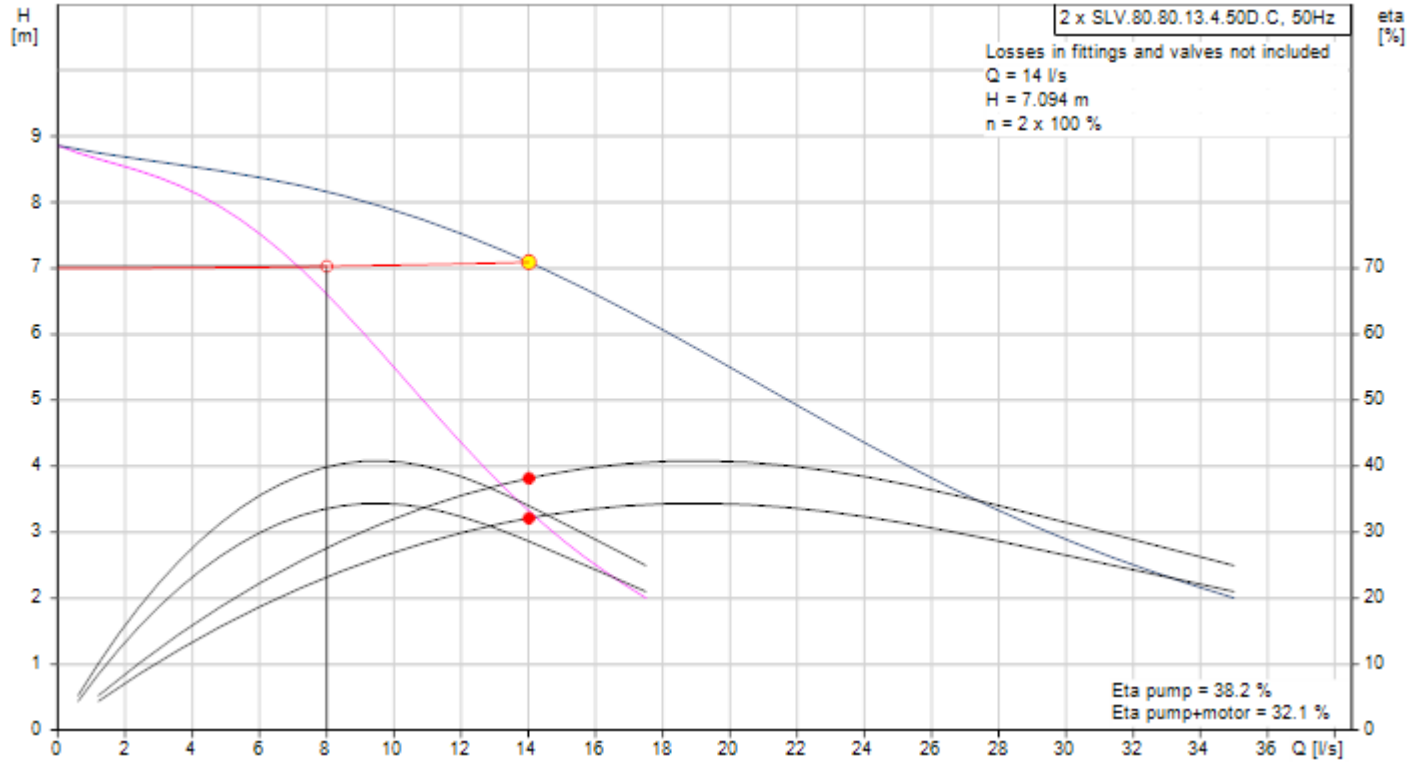
- Determine the fictional losses across pipe and fittings
- Using Hazen Williams Law

$$H_L=[(3.3 \times 10^6 \times Q) / (d^{2.63} \times C)]^{1.852}$$



Calculation – Detention Tank Sump Pump System

- Selection of pump



Carkpark Sump Pump Calculation

Calculation – Carpark Sump Pump System

- Determine the inflow
- Best practice, based on total tap install at carpark

Total number of Tap Points		6				
TOTAL INFLOW	=	6	*	0.14	=	**0.84 Lit/Sec**

Based on CP48

Table 1 – Flow rates at various fittings or appliances

Fitting or appliance	Maximum flow rate (cold water or hot water) litres per minute	Best water conservation flow rate litres per minute
Wash basin tap	6	2 (public / staff toilets) 4 (other areas)
Shower (Hotel)	12	7
Shower (Others)	9	7
Sink / Kitchen and other taps (except bathtub taps)	8	6
Bib tap	8	6

Calculation – Carpark Sump Pump System



Determine the Static Head

Calculation of Total Estimated Head for Carpark Sump Pump

Top level of Discharge Chamber	:	TL	109.60
Inlet level of Sump Pit	:	IL	105.10
Depth of Sump Pit	:		1.50
Swan Neck	:		1.00
STATIC HEAD, (SH)	**:**		**7.00 m**

Calculation – Carpark Sump Pump System

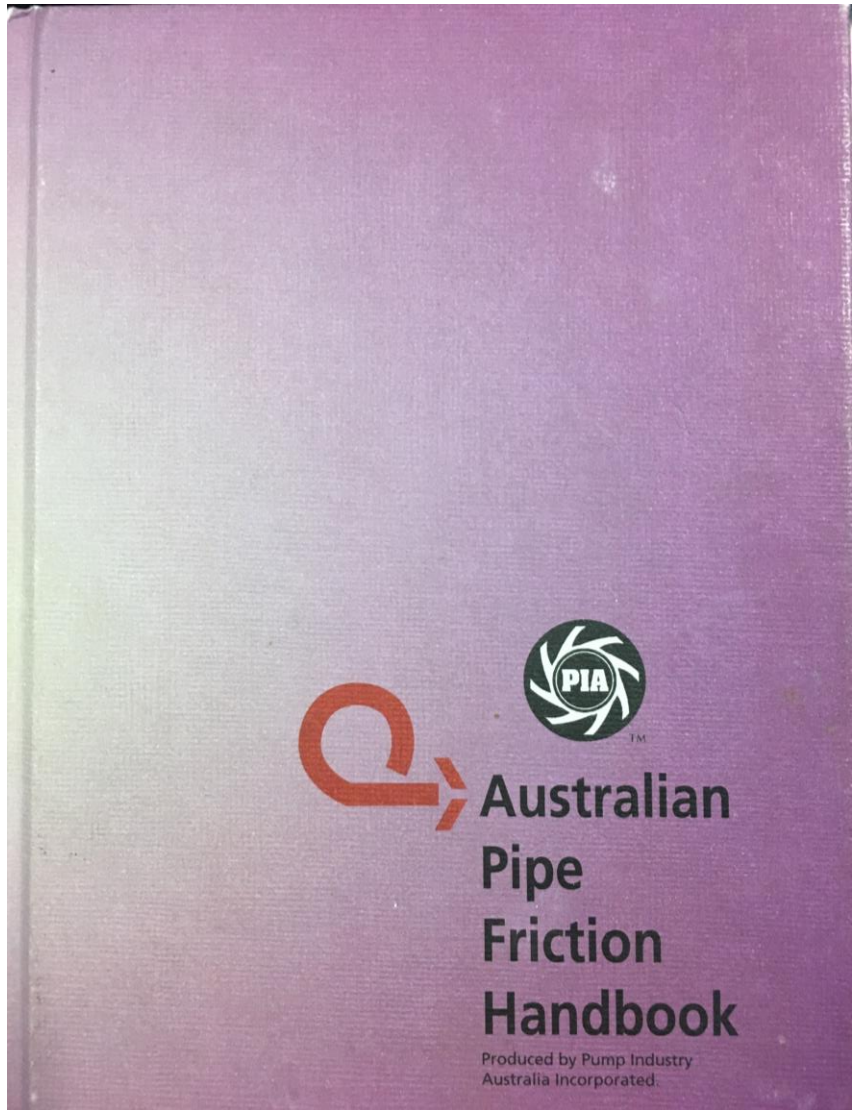
- Determine frictional losses along horizontal pipe and fitting losses

No. of dia.	50	mm fittings							
a) nos.elbow	=	1	x	40	x	0.05	=	2.00	
b) no. gate valve	=	1	x	40	x	0.05	=	2.00	
c) no. check valve	=	1	x	10	x	0.05	=	0.50	
d) no. tee (St.)	=	1	x	60	x	0.05	=	3.00	
e) no. 65 x 80mm increaser	=	1	x	20	x	0.05	=	1.00	
f) Approx. length of straight pipe							=	3.00	
TOTAL EQUIVALENT LENGTH OF DIA.		**50**	**MM**	**PIPE**			**=**	**11.50**	**m**

Calculation – Carpark Sump Pump System

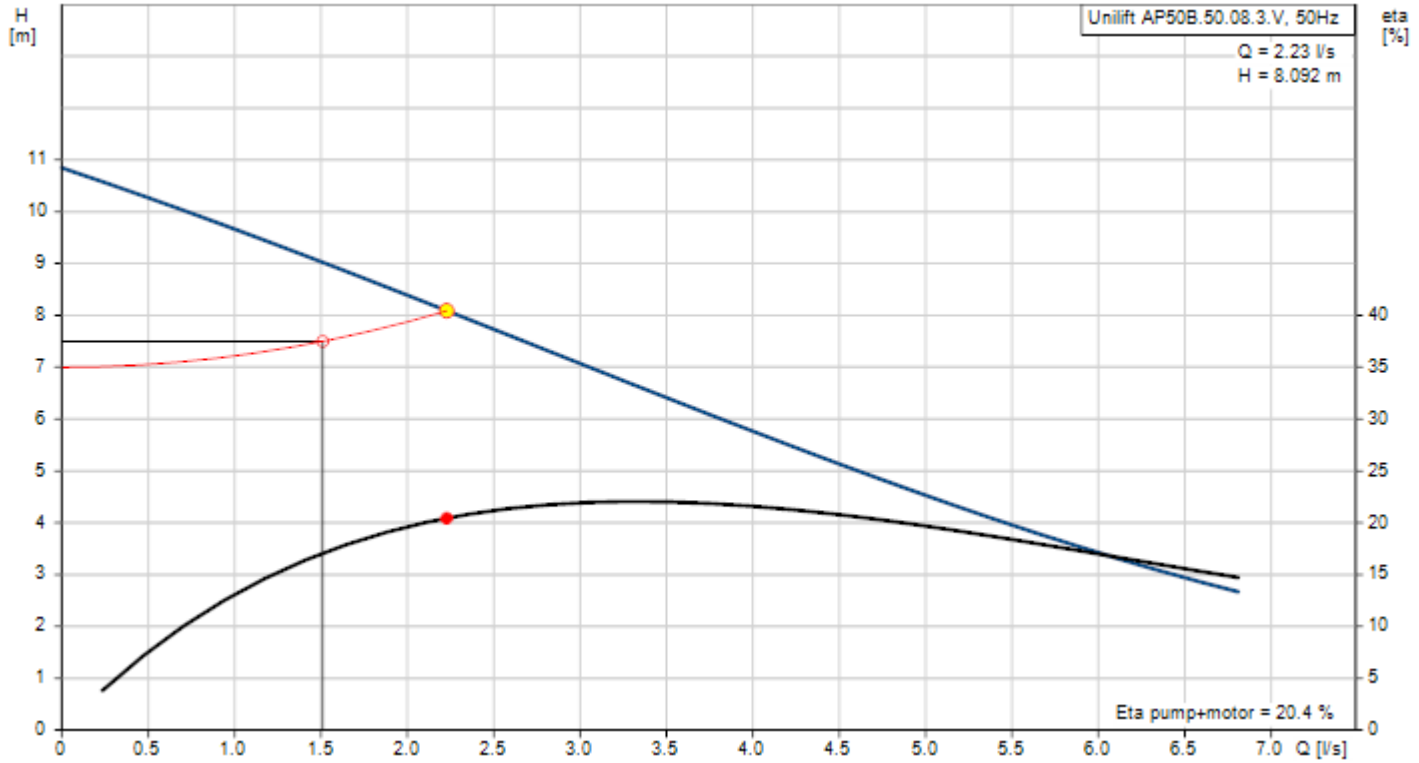
- Determine the fictional losses across pipe and fittings
- Using Hazen Williams Law

$$H_L=[(3.3 \times 10^6 \times Q) / (d^{2.63} \times C)]^{1.852}$$



Calculation – Carpark Sump Pump System

- Selection of pump



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