SAMSUNG ENGINEERING

DESIGN MANUAL

SEM - 3074E

Piping Design Manual

PUMP PIPING

REV. : 4

DATE : 2006. 11. 10

SAMSUNG ENGINEERING CO., LTD.

CONTENTS

1. GENERAL

1.1 Purpose and Application Scope

The purpose of this manual is to increase efficiency and establish standards for design by providing the basic concept necessary for piping design and the criteria for detailed design relevant to pump on the plant which is designed and/or constructed by Samsung Engineering Co., Ltd. The scope included in this manual is for the normal pumps under room temperature, and it shall not be used for special pumps.

1.2 Relevant Manuals and Standards

1.2.1 Relevant to pump layout decision criteria

(1) SEM-2002 "Plant Layout Standard (for Chemical Plant)"

1.2.2 Relevant to pump surroundings piping

(1) SEM-3039 "Piping Design Criteria"
(2) SEM-3016 "Piping Flexibility Analysis"
(3) API 610 "Centrifugal Pumps for General Refinery Service"
(4) API 686 "Recommended Practice for Machinery Installation and Installation Design"

1.2.3 Relevant to pump surroundings support

(1) SEM-3040 "Pipe Hanging No.1 (Piping Hanging Manual)"
(2) SEM-3043 "Pipe Support Design Data"

1.3 Basic Concept

1.3.1 Definition of pump

Pump is a device which give pressure to fluid passing through it and discharges the fluid to the outside.

1.3.2 Type and specifics of pump

(1) Classification by structure and operation method

Type	Classification by structure	Classification by operation method	Specifics
Positive displacement pump	Reciprocating pump	- Piston pump - Plunger pump - Diaphragm pump	This type of pump sucks in fluid through reciprocating movement of piston or plunger, and discharges fluid by pressing with required amount of pressure. It is used when high pressure is required even though the amount of discharge is small.
	Rotary pump	- Gear pump - Screw pump - Vane pump	This type of pump sucks in fluid through the rotation movement of rotor, and has the advantage of little pulsation due to the special characteristics in operation.
Kinetic pump	Centrifugal pump	- Radial flow - Volute pump - Mixed flow pump - Axial flow pump	This type of pump transfers energy to fluid through centrifugal force by impeller rotation or through the changes of size and direction of section area of passage, and converts velocity energy to pressure energy in volute chamber or diffuser.
	Special pump	- Jet pump - Gas lift pump - Wesco pump	This type of pump has a low efficiency and is not used except for a special purpose.

(2) Other classification

1) Classification by suction type :

- Single suction type
- Double suction type (for big volume pump)

2) Classification by the number of impeller arrangement :

- Single-stage type
- Multi-stage type

3) Classification by the pump installation method :

- Vertical pump type
- Horizontal pump type

1.3.3 NPSH (Net Positive Suction Head)

NPSH is the numerical value expressed by hydraulic head after deducting the vaporizing pressure proper to water temperature from the total pressure (indicated in absolute pressure) loaded on pump suction nozzle. In NPSH, there are NPSH Required (NPSHr) which is required by pump itself and NPSH Available (NPSHa), and care shall be taken when NPSHr is bigger than NPSHa as cavitation occurs in this case. When cavitation occurs, it causes vibration and noise, and casing and impeller can be corroded or pump efficiency is dropped. Therefore, if the difference between NPSHa and NPSHr is less than 0.3 ~ 1.0m at the time of checking vendor data sheet [that is, NPSHa - NPSHr < (0.3 ~ 1m)], decision on NPSH test shall be made according to Engineering Specification SES-GA-201E and API 610.

《 Pump Differential Head 》

$$H = (Po - Ps) \times \frac{10}{Sp.Gr}$$

Where, H : Head (m)
Ps : Pump suction pressure (kg/㎠)
Po : Pump discharge pressure (kg/㎠)
Sp.Gr : Specific gravity at pumping temperature

《 NPSH Required 》

$$NPSHr = \sigma \times H$$

Where, H : Pump differential head
σ : Cavitation coefficient of Thoma

《 NPSH Available 》

$$NPSHa = (P1 - P2) \times \frac{10}{Sp.Gr} - \triangle P + H$$

Where, P1 : Pressure at suction liquid level (kg/㎠)
P2 : Vapor pressure at suction temperature (kg/㎠)
△P : Pressure drop in suction line (kg/㎠)
H : Height between the normal liquid level and pump centerline (m)

2. CRITERIA FOR DETAILED DESIGN

2.1 Criteria for Pump Layout Decision

2.1.1 Requirements

(1) Install suction line to be minimum and straight against suction resource if possible.

1) Minimize pressure drop of suction line.
2) Restrain the cavitation occurrence.

(2) Considering the installation and removal of pump and motor, installation shall be done on the convenient place for maintenance.

(3) Install on the place where access is easy during the operation.

(4) Installation shall be balanced with the overall equipment arrangement.

2.1.2 Pump arrangement

(1) Line-Up for pump discharge nozzle

1) Piping is standardized.
2) Support is convenient.
3) Piping is orderly arranged.
4) Operation and control are easy.

(2) Line-up for the rear of pump foundation

1) Construction of cable pit is easy.
2) Pump motor and switch are lined up, and instruments are orderly arranged.

(3) Line-up for the front of pump foundation

It is convenient for cleaning inside of pump and for the pump which is necessary to discharge internal fluid during the maintenance.

(4) Arrangement for vertical pump

Line-up for the center of shaft shall be done with the consideration of installation and maintenance.

2.1.3 Pump spacing and height of pump foundation

(1) Pump spacing (pump centerline to centerline)

The following table shall be the basis in plot checking, and the detailed dimension shall be decided after piping study.

Suction pipe size (B)	Up to 2	2.1/2~5	6~10	12~14	16~18
Pump spacing (mm)	1500	2000	2500	3000	4000

(2) Height of pump foundation

Height of pump foundation shall be 100~300mm from ground level or floor level if it is on the paving or inside of building, but it shall be 300~500mm for the area where flood is expected.

2.2 Pump Surroundings Piping

2.2.1 Typical arrangement

Refer to Appendix I "Typical Arrangement Drawing (sample)".

2.2.2 Major considerable items

(1) Consideration of pressure loss

1) Piping around pump (specially suction line) shall be simple and with the minimum length so that the pressure loss shall be minimized.

2) Radius of curvature in curve area shall be used with big one (long radius elbow) if possible and short radius elbow shall not be used as a rule.

3) If discharge pipe size is bigger than pump nozzle size, install gate valve and check valve on the line after size is increased. (But, except when it is indicated on P & ID.)

4) If more than 2 sets of pumps are used in a row, each suction piping shall have the same amount of pressure loss so that there will be no drifting but the uniform flow on each pump. (for example, symmetric piping).

(2) Consideration of external force on pump nozzle

1) Piping shall be routed to avoid over-load as vibration and abrasion on axles occur due to eccentricity and a bad effect happens to the function if over-load is loaded on the pump nozzle.

2) For API pump, apply allowable loadings of API 610. And follow the value specified by maker if any.

3) To avoid over-load on pump nozzle due to thermal expansion of piping , the below items shall be applied.

① Absorb thermal expansion by piping route.
② Improve method of support.
③ Install expansion joints. (Avoid this method basically.)

4) Check piping route considering difference in temperature of piping due to the operation method if pump is in stand-by.

(3) Consideration of cavitation

1) Cavitation occurs when NPSHr is larger than NPSHa. Cavitation reduces the performance of pump, causes vibration or noise and corrodes the materials. Therefore, minimize pressure loss on pump piping and, care shall be taken to avoid drifting on the nozzle.

2) Minimum required straight pipe on suction nozzle to prevent drifting

Suction type		Required straight pipe on suction	Remarks
End suction		5D and over	See figure 1.
Side suction	Single suction	5D and over	See figure 2-1 and 2-2.
	Double suction	5D~10D and over or flow straighteners	
Top suction	Single suction	5D and over	See figure 3.
	Double suction	5D~10D and over	

Note : D = Suction nozzle size

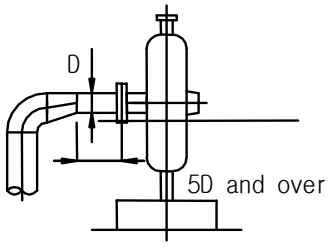


Figure 1. End suction piping

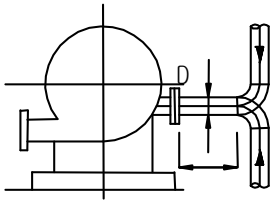
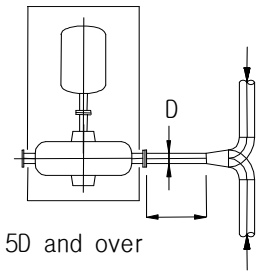


Figure 2-1. Side suction piping (Double suction)



Special caution is required for drifting in case of double suction. If the balance on right side and left side of pump impeller breaks down, pump capacity or efficiency will be reduced and the life of axle shaft due to thrust will be reduced at the same time.

Using flow straightener reduce straight-run. But straight-run reflected is according to vender's requirement.

Figure 2-2. Side suction piping (Single suction)

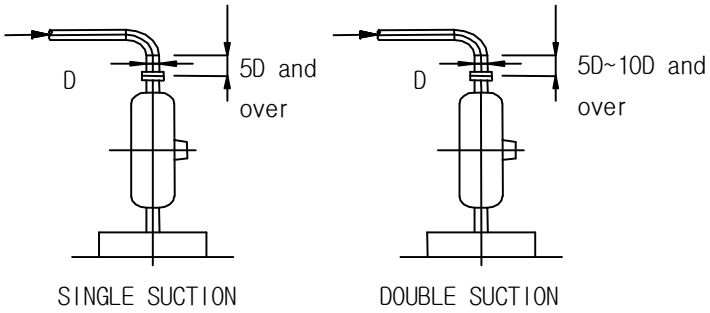


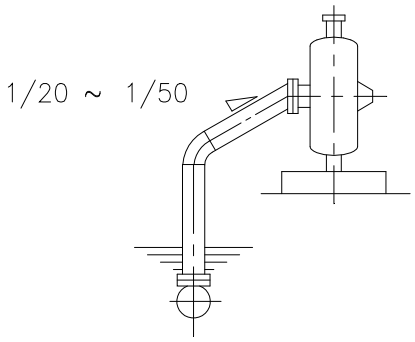
Figure 3. Top suction piping

3) When reducer limited to one pipe diameter is applied, reducer could be attached to companion flange of pump nozzle. in this case, straight rub is based on pipe diameter form pipe end point.

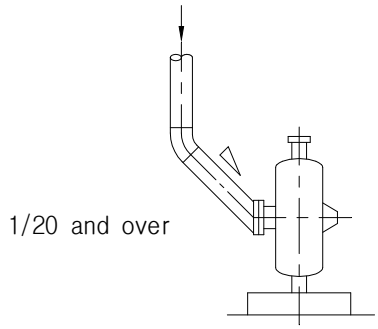
4) Straight-run could be adjusted according to vender's requirement.

(4) Consideration of air pocket on suction line

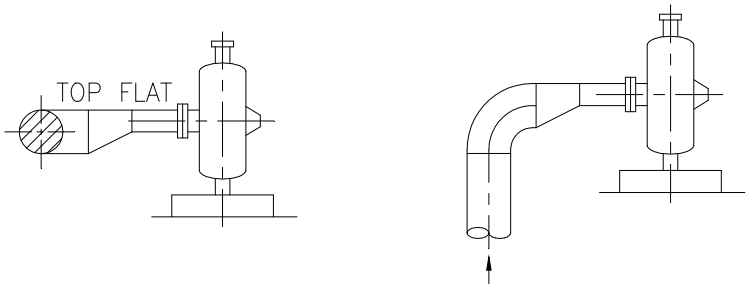
1) Allow approximately 1/20～1/50 of slope on suction line toward suction resource if suction resource is lower than pump suction nozzle.



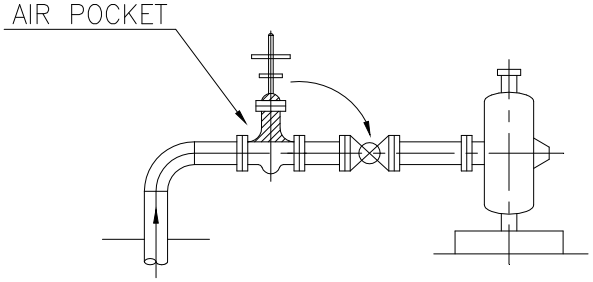
2) Allow 1/20 and over of slope on suction line toward pump at vacuum tower.



3) Install eccentric reducer with top flat on suction nozzle.



4) If gate valve is to be installed on the line whose suction resource is located lower than the pump suction nozzle, valve stem shall be horizontal.

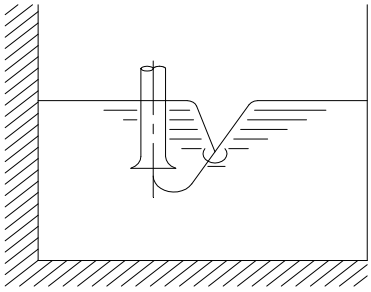


(5) Caution on air suction (local turbulence, total turbulence)

1) If turbulence occurs around suction piping, it causes vibration and noise as the air infiltrates.

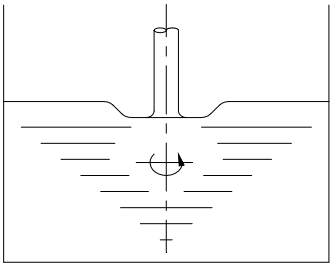
2) Local vortex flow :

This is the vortex rotating while the water surface is locally sucked in, its occurrence and extinction are commonly repeated, and air is sucked in when a column of air at the center area reaches to the suction intake.

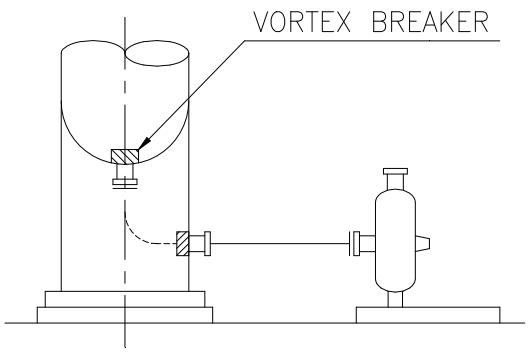


3) Total vortex flow :

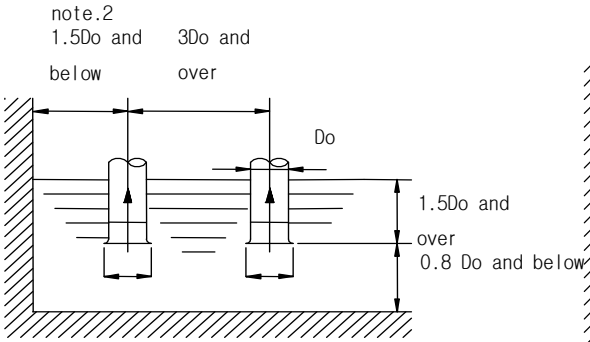
When water surface around suction intake lowers down, the surface fluctuates and revolves fast around suction intake and a lot of air is sucked in.

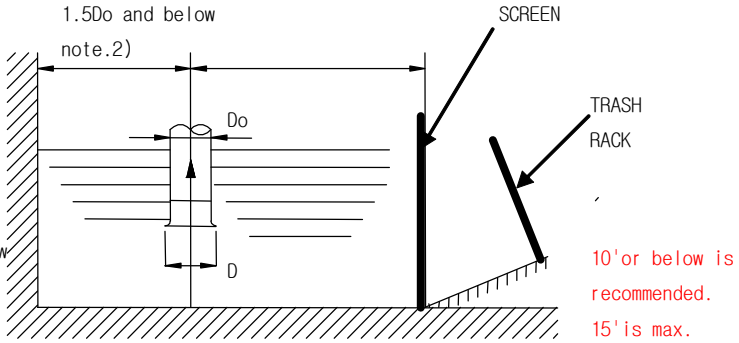


4) Suction piping on tower or vessel :
Vortex breaker is installed on tower or vessel nozzle connected to pump nozzle.

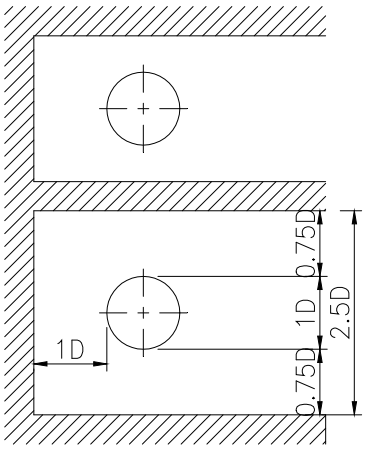


5) Details for suction piping installation :





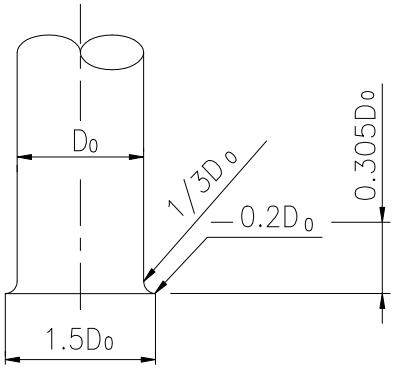
Suction nozzle diameter is generally D = 1.5 DO.

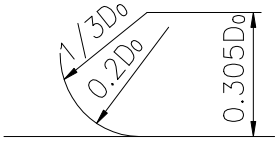


Note.1) These Dim. is recommended
Note.2) These Dim. could be adjustable according to customer's requirement or constructibility.

6) Details of suction nozzle :

Refer to KS B 6302 for the manufacture of suction nozzle, and procurement shall be executed as a special order.





(6) Others

1) By-pass line which is installed on pump discharge line shall be routed without pocket.

2) For pump suction piping from storage tank, consideration shall be given so that pump suction nozzle shall not be higher than the outlet nozzle of tank.

3) Avoid installation of chemical or water supply line near the suction nozzle of reservoir so that air shall not be sucked in.

2.2.3 Method for strainer installation

(1) Type of strainer

1) Temporary strainer :

This type of strainer is to be installed on pump suction line during the pre-commissioning in order to protect pump from entering of earth/sand and pieces of iron in the pipelines through the construction.

2) Permanent strainer :

This type of strainer is to be installed to protect pump from slurry included in the fluid during the normal operation.

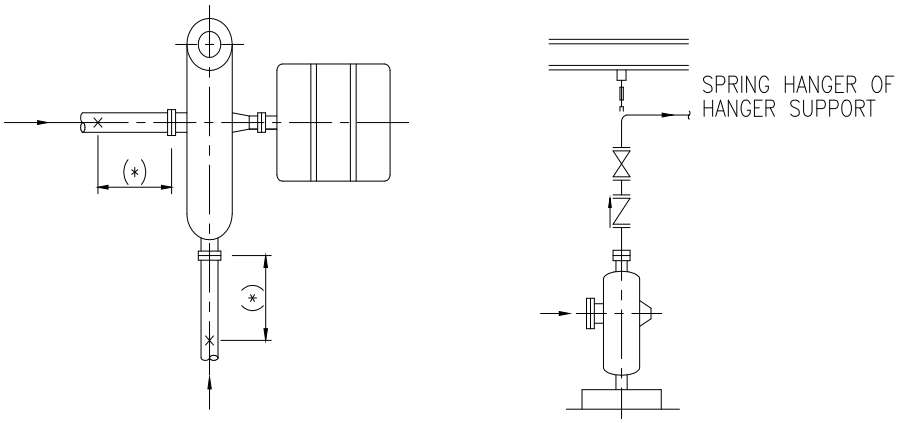
(2) Installation location for strainer

1) Install on the place where cleaning and access are convenient.
2) Consider about piping route and support for simple installation and easy removal.
3) Temporary strainer shall be installed on the largest flange between pump suction nozzle and block valve.

2.3 Pump Surroundings Support

2.3.1 Support regarding of eccentricity of pump :

(1) Support shall be installed so that pipe and valve may not load on the pump nozzle.



(*) Support nozzle surroundings. (But, about 1m.)

(2) Suction line and discharge line shall be supported respectively.

(3) If support is installed right close to suction or discharge nozzle, it shall be minutely adjustable type so that centering can be convenient.

2.3.2 Support installed around suction or discharge nozzle

A support installed around suction or discharge nozzle shall be such a type that piping can be removed and pump can be dismantled easily.

2.3.3 Unnecessary support with respect to the load on pump nozzle

Although support would not seem to be necessary with respect to the load on pump nozzle, indicate it on the drawing considering the temporary support of piping during the time of pump maintenance.

3. HISTORY OF THIS MANUAL

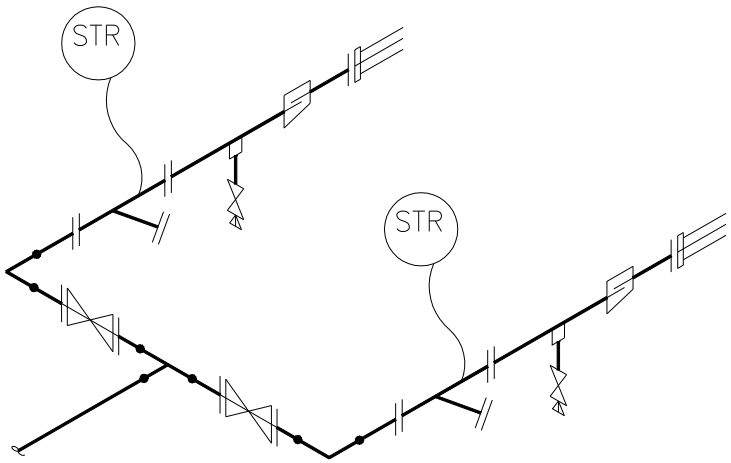
Rev.	Date	Description
3	1996. 11. 15	(1) Progress of Enactment This manual is enacted in accordance with Engineering Division Strategic Plan, regarding the work of the pump piping. (2) Written by : (Piping Engineering Team) Koh Bong Hwan, Lee Joo Sang Editorial Supervisor : Jeong Kyung Hwa
4	2006.11.10	(1) Matters in related with stress are revised. (2) Straight-run in pump suction line is adjusted Written by : Sihong Shin Editorial Supervisor: Piping Standard Supervisor Department Approved by : H.M Im

Appendix I: Typical Arrangement Drawing

1. PUMP SUCTION LINE

1.1 Horizontal

(1)



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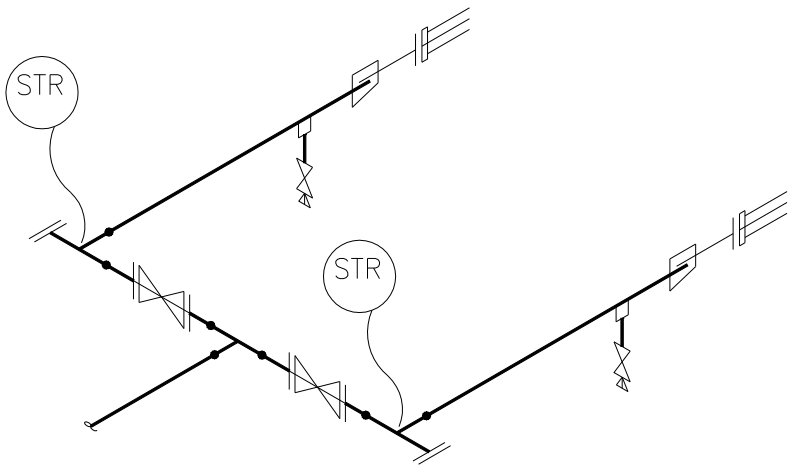
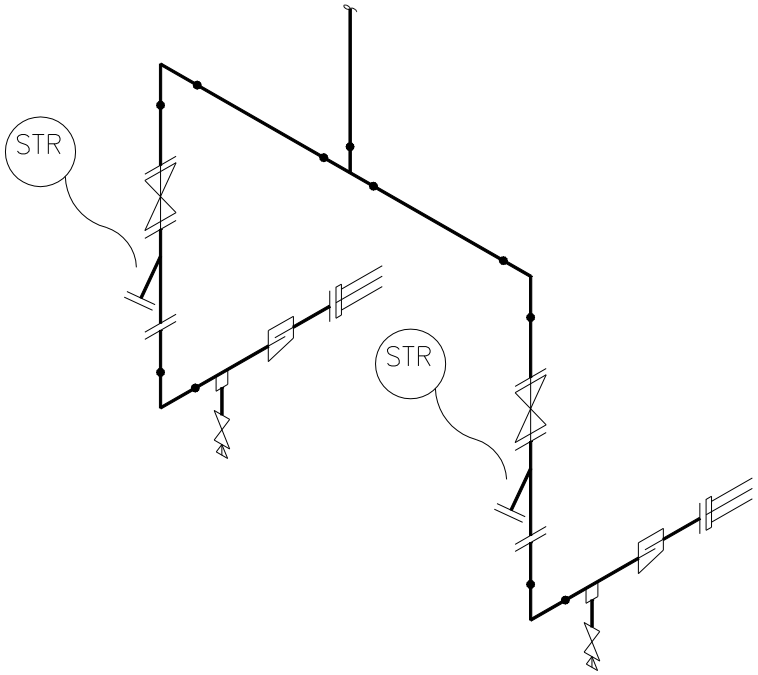


Appendix I: Typical Arrangement Drawing

1.2 Vertical

(1)



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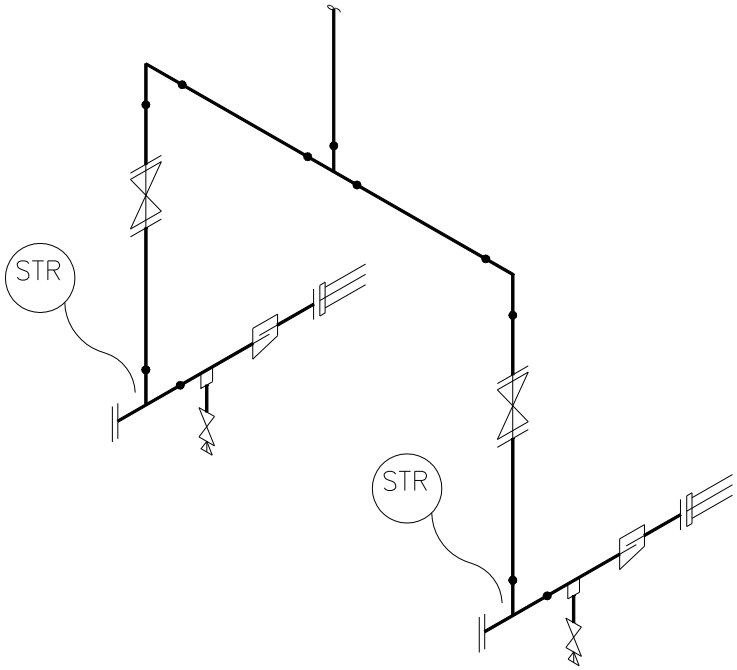
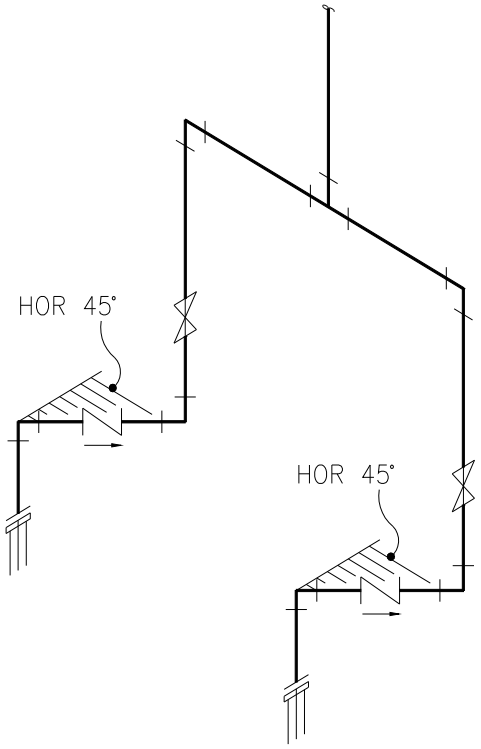


Appendix I : Typical Arrangement Drawing

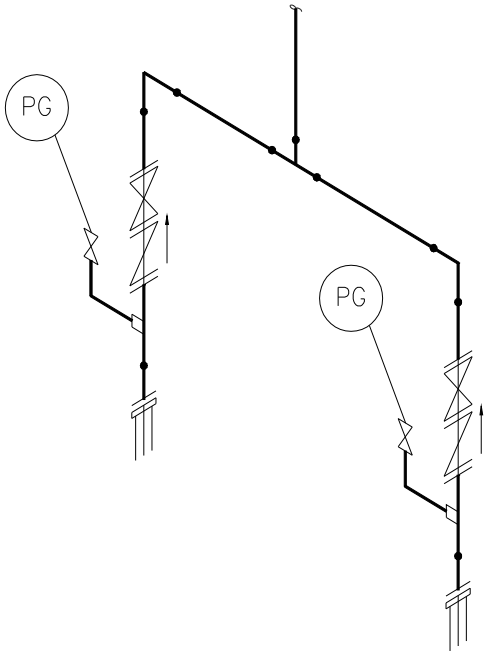
2. PUMP DISCHARGE LINE

1.1 1.1/2B and Under



1.2 2B and Larger

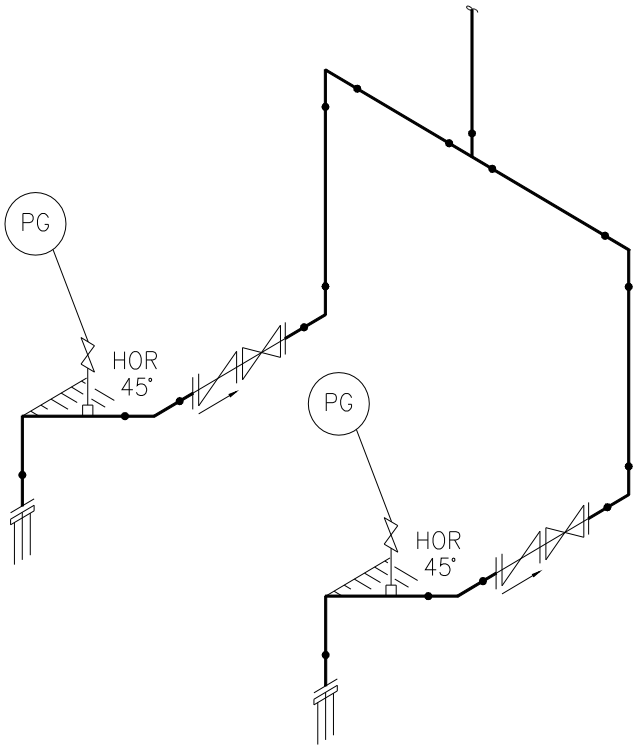
(1)



When check valve is installed in 6" and over size discharge line, it is recommended to be installed horizontally to prevent vibration caused by shut-down of pump.

Appendix I: Typical Arrangement Drawing

(2)



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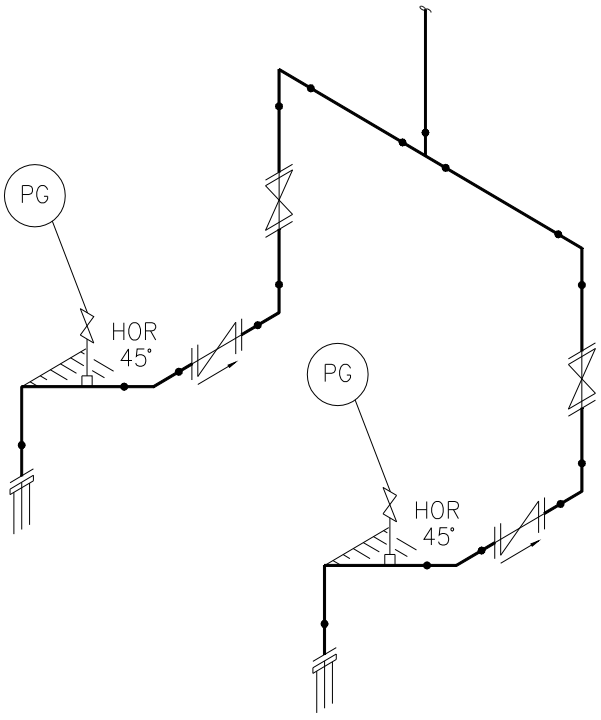

Appendix I: Typical Arrangement Drawing

(4)