PIP REIE686A
Recommended Practice for
Machinery Installation and Installation Design
(Supplement to PIP REIE686/API RP686)
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

This Practice is subject to revision at any time.

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# Process Industry Practices
## Machinery

**PIP REIE686A**

**Recommended Practice for Machinery Installation and Installation Design**

*(Supplement to PIP REIE686/API RP686)*

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Introduction

Purpose
This Practice supplements PIP REIE686/API RP686, Recommended Practice for Machinery Installation and Installation Design. Together, this Practice and PIP REIE686/API RP686 provide requirements for installation recommended procedures, practices, and checklists for the installation and precommissioning of new, existing, and reapplied machinery and to assist with the installation design of such machinery.

Scope
This Practice describes additions, changes, and deletions that have been made to PIP REIE686/API RP686. In addition, decisions that have been made regarding options offered by PIP REIE686/API RP686 are also described.

References
Applicable parts of the following Practice and industry codes and standards shall be considered an integral part of this Practice. The edition and addendum in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

Process Industry Practices (PIP)
- PIP RESP002 - Design of ASME B73.1 and General Purpose Pump Baseplates

Industry Codes and Standards
- Gas Machinery Research Council (GMRC)
  - TR 97-2 - Foundation Guidelines
  - TR 97-6 - Compressor Anchor Bolt Design

Requirements
The numbering of the headings and paragraphs in the Requirements section corresponds to the numbering of PIP REIE686/API RP686, which this Practice revises. The type of revision made to a specified heading or paragraph is described after the heading or paragraph identification. Provisions of PIP REIE686/API RP686 that are not revised remain in force.
Chapter 4 - Foundations

3 Definitions

3.9 Addition. New definition:

dynamic analysis

Calculation of the natural frequencies of the foundation and a determination of the response of the foundation to the forces induced by the vibration of the machinery (e.g., amplitudes of vibration, velocities, or acceleration)

4 General Design Requirements

4.2 NOTE Canned motor pumps do not require a foundation block. These pumps do not have a coupling that requires alignment. Horizontal canned motor pumps should be mounted on a stilt mounted baseplate in accordance with PIP RESP002, Figure 4. Vertical canned motor pumps should be installed on a level surface. Pipe fit up requirements are the same as pumps with couplings.

6 Rectangular Block Foundation Design

6.6 Modification. To read as follows:

The top of the finished foundation shall be elevated above the finished elevation of the floor slab or grade to a height that can prevent damage to machinery from a 50-year flood or 20 cm (8 inches), whichever is greater. Other local environmental factors may dictate other top of concrete criteria such as water spouts. Insurance data may be beneficial for determining these criteria.

11 Anchor Bolt and Reinforcing Steel Design

11.6 Addition. Supplement as follows:

For reciprocating compressors, anchor bolt embedment lengths should be a minimum of 1.2 meters (48 inches) and of varying lengths to form a sine wave for stress distribution. See Figure B-5.

11.6 Addition. New note:

NOTE Industry experience shows an anchor bolt embedment depth of 20 diameters to a fully engaged nut improves resistance to cracking the foundation block. See GMRC Technical Reports TR 97-6 and TR 97-2.

11.11 Addition. New section:

For reciprocating compressors, anchor bolt termination plates should have an outside diameter of 3 to 4 bolt diameters, and should be 1.5 bolt diameters thick. Grout thickness of the final pour should not be greater than 11.5 cm (4.5 inches). Leveling pours may be thicker.
Annex B - Typical Foundation and Anchor Bolt Details

Figure B.1  Modification. Modified to include dimension ED and change D Depth above grade with H Height above grade. Replace with the following figure:

Section Through Foundation

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Width</td>
<td>Refer to foundation design section of specification.</td>
</tr>
<tr>
<td>EB</td>
<td>Anchor Embedment</td>
<td>Shall be as required to resist anchor bolt forces.</td>
</tr>
<tr>
<td>D</td>
<td>Depth Below Grade</td>
<td>Shall be adequate to prevent frost heave.</td>
</tr>
<tr>
<td>H</td>
<td>Height Above Grade</td>
<td>Shall be adequate to prevent damage to equipment from water due to runoff (100mm (4&quot;) minimum).</td>
</tr>
<tr>
<td>AS</td>
<td>Area of Reinforcing</td>
<td>Refer to the minimum area of steel requirements of the reinforcing section of foundation design.</td>
</tr>
<tr>
<td>ED</td>
<td>Anchor Bolt Sleeve Edge Distance</td>
<td>Shall be adequate to develop required force on anchor bolt, a minimum of 150mm (6&quot;) or (4) bolt diameters (which ever is greater), or as recommended by anchor bolt manufacturer.</td>
</tr>
</tbody>
</table>

Figure B.1 — Typical Rectangular Block Foundation Detail
Figure B.2  Modification. Modified to include a case drain, and show the grout halfway up the baseplate. Replace with the following figure:

Figure B.2 — Typical Vertically Suspended Can Pump Foundation
Figure B.3  Modification. Modified to include dimension BD, and wrap/coat of anchor bolt with bond breaker. Replace with the following figure:

*Note: ACI 394 may be a possible design reference for anchor head.

Figure B.3 — Typical Anchor Bolt Detail — Option 1, Grout Pour Not to Edge of Foundation
Figure B.5 — Anchor Bolt Length Variation for Reciprocating Compressors

**Chapter 5 - Mounting Plate Grouting**

2 Machinery Grouting Installation Design Requirements

2.4 Selection of Grout

Addition. New note:

NOTE 3 Cementitious grouts are typically not resistant to acid and chemical attack.

2.6 Mounting Plate Design

2.6.9 Addition. New note:

NOTE Vent holes should be added in all corners of each bulk head section of a base plate. Vent holes should be a minimum of 12 mm (1/2 inch) in diameter.

3 Machinery Grouting Installation Requirements

3.10 Direct Grouted Reciprocating Compressors
Annex H - Typical Mounting Plate Leveling Pads

Notes:
1. Materials – Austenitic Stainless Steel
2. Cleanliness – Free of dirt, oil, rust, scale, and burrs
3. Chamfered or radiused corners are required and either is acceptable.
4. Leveling pads with rounded edges minimize the possibility of a crack forming in the grout due to a sharp edge.
5. Drill points are only required if the leveling pad is not embedded in the grout.

Figure H.1 — Typical Mounting Plate Leveling Pads
Chapter 6 - Piping

2 Machinery Piping Installation Design

2.2 Addition. Add new paragraphs:

Accessibility for Operation and Maintenance

2.2.8 Pump seal access should be considered because seal failure is a common cause for maintenance.

2.2.9 Axially split machinery casings should not have overhead obstructions.

2.2.10 Radially split pump casings should have clear access to the end of the pump for maintenance.

2.2.11 Piping should be designed to be self-supporting in a manner that minimizes the need for piping removal during maintenance activities.

2.2.12 If necessary, access to a pump may be provided by designing the piping to be removable.

2.2.13 Block valves requiring attention, observation, or adjustment during normal operation (e.g., discharge block valve) should be located at a convenient operation height and orientation from grade or platform.

2.2.14 Block valves used for operation of the system may be chain-operated if the bottom of hand wheel is more than 2.1 m (7 ft) above the high point of finished surface or operating platform.

2.2.15 Block valves used only for process shutdown, and located less than 4.6 m (15 ft) from an access level, do not need to be chain-operated unless they cannot be reached by a portable ladder.

2.2.16 Chain wheels should not be permitted on valves smaller than 80 mm (NPS 3).

2.2.17 A hammer-type chain wheel should not be permitted on valves smaller than NPS 4.

2.2.18 Stems of globe and gate valves with solid wedges should be oriented above the valve body centerline.

2.2.19 Stems of gate valves with split or double disc-type gates should be oriented vertically upward.

2.2.20 Stems of valves in hot service (e.g., heat transfer fluids) should be oriented in the horizontal position.

2.2.21 Sufficient space should be permitted for the operation of handles or levers on valves, including stems.

2.2.22 Hand-operated control valves should be located so that they can be adjusted while associated instruments are readable from the valve.
2.4 Supports

2.4.2 Addition.

The dead weight of the piping, insulation, and process fluid should be entirely supported by pipe hangers or supports.

2.4.3.1 Addition. Springs

2.4.3.1.1 Supports should be designed to provide the required support for the weight of the pipe, the insulation, and the contents during operation.

2.4.3.1.2 Support should direct the piping forces away from the machinery and permit free thermal expansion of the pipe.

NOTE Spring supports should be designed with 10% or less variation.

NOTE Spring supports for liquid-filled piping systems require special consideration at the time of installation because the system is empty at the time of installation and the spring design load reacts against a liquid-filled system.

NOTE Spring supports should be avoided on the horizontal section of suction piping immediately upstream of the suction nozzle.

2.4.3.2 Addition. Adjustable or Rigid Supports

2.4.3.2.1 Adjustable supports should be used to account for field variations in installed dimensions and for changes over time.

2.4.3.2.2 The first piping support next to a horizontal nozzle should accommodate the anticipated movement of the machinery and should be vertically adjustable.

2.4.3.2.3 Rigid supports may be used to limit the movement of a line to prevent excessive deflection.

2.4.3.2.4 A rigid support should not be provided if thermal expansion can cause the pipe to move away from the support.

2.4.3.3 Addition. Restraints

2.4.3.3.1 Restraints should be provided to control deflections in the machinery piping system and avoid excessive loads on machinery nozzles caused by induced loads (e.g., thermal expansion, wind, etc.).

2.4.3.3.2 Restraints should be used to direct the pipe thermal movement away from the machinery and into portions of the piping system that have sufficient flexibility to absorb the movement without becoming overstressed or overloading other connections.

2.4.3.3.3 A guide should be used to permit only axial movement while preventing lateral movement of the pipe.

2.4.3.3.4 An axial stop should be used to permit lateral movement while preventing axial movement.
2.5 Provision for Field Welds

2.5.1 Modification. Replace with following:

For all piping 50 mm (NPS 2) or larger, the piping engineering designer should include provisions for multiple final piping field welds on the suction and discharge, one horizontal and one vertical, to facilitate piping installation in accordance with the machinery flange fit-up requirements.

2.8.1.3 Add. New note:

Use of a single simplex strainer on each machine can result in loss of service if one machine is down and the operating strainer plugs.

2.10 Modification. Vents, Drains, and Gauge Connections

2.10.2 Addition. Add new section:

2.10.2.1 Depending on service, process integrity may require double block and bleed valves on vents and drains.

2.10.2.2 Drains should be located at the lowest point in the piping near the machinery.

2.10.2.3 Drain connections should not be placed in reducers.

2.10.2.4 Dead legs in piping should be avoided. If a dead leg is unavoidable, it should be provided with drains.

2.10.2.5 Gauge and vent connections shall be a minimum of NPS 3/4.

2.13 Piping Systems in Pulsating Service

2.13.13 Addition. Add new section:

Inline liquid filled pulsation dampeners for positive displacement pumps minimize maintenance requirements. Pulsation dampeners shall comply with the requirements of API 674, or API 675 as appropriate.

3 Machinery Specific Piping Installation Design

3.1 Pumps

3.1.1 General Requirements

3.1.1.5 Addition. Add new section:

Pumping system curves shall be developed for all flow paths, piping configurations, and process flow characteristics. Operation in each of the specified flow paths shall be evaluated for viability. The off-design operating cases and the amount of time in each operating case shall be identified.

3.1.1.6 Addition. Add new section:

Pumps with flat-faced flanges shall have mating flat-faced flanges with full-faced gaskets.

3.1.1.7 Addition. Add new section:

Design data verifying that the design of the pumping system is in accordance with the design principles in Section 3 of this Chapter shall be developed by the piping
system designer. This data shall be subject to a formal review by the purchaser before release of the design for procurement and construction. Data and the formal review documentation shall become a permanent record for project, operations, and maintenance purposes.

3.1.1.8 **Addition. Add new section:**

Design NPSHA shall be calculated assuming the following:

a. 110% of rated pump capacity
b. Lowest liquid level in the suction vessel
c. Operating condition with the lowest NPSHA

*Comment:* The operating condition with the lowest NPSHA typically has the highest temperature, vapor pressure, and viscosity and typically has the lowest liquid level.

d. Vessel height for flooded suction pumps shall be determined using Figures A-3 and A-4.

*Comment:* Failure to provide this minimum level of NPSHA will necessitate a vertical turbine pump or reduce reliability because of excessive cavitation.
Note: When using this curve for double suction pumps, divide the flow rate by 2.
Customary US Units

Note: When using this curve for double suction pumps, divide the flow rate by 2.

Figure A-6
3.1.2 Pump Suction Piping

3.1.2.1 Addition. Supplement with following sentence:
To reduce turbulence, pump suction piping should not form more than two planes within 3 meters (10 feet) or 20 pipe diameters of the suction nozzle, whichever is greater.

3.1.2.2 Modification. Replace second sentence with the following:
For centrifugal pumps, NPSHA shall be greater than NPSH3 (NPSHR) in accordance with PIP REEP006, Pump Selection Guidelines.

3.1.2.4 Addition. Add new Note 3:
NOTE 3 Slurry applications should have the flat side on the bottom to avoid accumulating solids.

NOTE 4 The piping should preferably be sloped continuously upward towards the pump to facilitate venting.

NOTE 5 Non-Newtonian fluids have special piping requirements. Consult the pump manufacturer for guidance.

3.1.2.6 Addition. Add another Note:
NOTE The suction piping for slurry applications should be designed to maintain enough turbulence to keep the solids suspended. The pump manufacturer should be consulted for guidance.

3.1.2.12 Addition. Add new section:
For double suction pumps, the last pipe elbow in the suction line to the pump should be perpendicular (i.e., not in the same plane) to the impeller shaft. The piping between the elbow and individual suction flanges should be symmetrical. See Figure 5.

3.1.2.13 Addition. Add new section with note:
Pump suction line size is typically designed for fluid velocities from 1 to 2 meters per second (3 to 6 feet per second). Acceptable velocities may increase or decrease depending on NPSH margin for the pump selected and system economic analysis.

NOTE Suction piping in slurry service shall be sized to maintain sufficient velocity to keep the particles suspended.

3.1.3 Modification. Pump Minimum Flow Bypass/Recycle

3.1.3.3 Modification. Replace second sentence with the following:
Recirculation routed to the pump suction line shall be connected at a point that is a minimum distance of 10 pipe diameters upstream of the pump suction flange.

3.1.3.5 Addition. Supplement with new sentence and note:
Flow control systems shall ensure control of the flow within the allowable operating region of the pump in accordance with Annex E, Figure E-1 or E-2.

NOTE Adequate protection shall be provided to prevent or minimize the impact of operating the pump dry or dead-headed. Protection may include re-circulation,
power monitors, or other instrumentation to detect or prevent dry and dead-head operation.

3.1.3.6 **Addition. Add new section and note:**

Arrangement of suction and discharge piping for pumps in wet pit sump installations shall provide adequate submergence (i.e., not permit gas entrainment), and shall facilitate maintenance of the pump.

NOTE See Hydraulic Institute standards for more information about wet pit sump design.

3.1.3.7 **Addition. Add new section:**

Pumps used in parallel operation shall have the same pipe size, and line loss shall be maintained between each pump and the point where the pumps tie together. Design of the piping shall provide equivalent suction and discharge pressures. Pumps operated in parallel that require minimum flow recycle lines should have separate recycle lines, not a common line.

3.1.3.8 **Addition. Add new section and note:**

If a flow orifice is used to increase the slope of a pump curve as seen by the system, the orifice shall be installed in the piping downstream from the pump.

NOTE Because the orifice is subject to wear because of high pressure drop, the installation should be designed for ease of inspection and replacement.

3.1.3.9 **Addition. Add new section:**

Pump discharge line size should be designed for fluid velocities from 1 to 3 meters per second (3.5 to 10 feet per second) to minimize friction losses. Life cycle cost analysis should be used to determine line size.

3.1.6 **Addition. Add new section:**

**Self-Priming Pumps**

3.1.6.1 Suction piping for self-priming pumps should be designed to minimize friction loss and the volume of air to be evacuated from the suction pipe.

3.1.6.2 The number of piping elbows and suction piping lengths should be minimized.

3.1.6.3 The suction pipe size should be the same size as the pump suction nozzle.

3.1.6.4 If a discharge piping system incorporates a check valve to prevent backflow or to stop water hammer, an air bleed line or vent should be installed between the discharge flange and the check valve to enable the pump to prime. The air bleed line should not be installed below the liquid level, and should not contain any liquid traps to impede airflow from the pump. An air release valve may be installed to permit the air to escape and seal once the pump is primed.
3.1.7 Addition. Add new section:

**Figure 1**
End Suction, Top Discharge, Overhung Centrifugal Pump Preferred Installation

**Figure 2**
End Suction, Top Discharge, Overhung Centrifugal Pump Alternate Installation
Notes – Figures 1 & 2

1. Suction valves should be full port and of the same size as the pump nozzle unless adequate NPSH margin is not available (4.1.1.1).
   Comment: If there is not adequate NPSH margin for the specified pump application, consideration may be given to placing the reducer before the suction block valve.

2. Last pipe elbow in the suction line should be standard long radius elbow.

3. Suction line straight run requirement. The pump suction piping shall have a straight run of five pump nozzle diameters between the suction flange and the first elbow, tee, valve, reducer, permanent strainer, or other obstruction sufficient to ensure stable and uniform flow at the pump suction nozzle (PIP REIE686/API RP686, Chapter 6, paragraph 3.1.2.6).

4. The pipe supports on the suction piping should not rigidly tie down the suction line close to the pump suction nozzle prior to pipe to pump alignment. After pipe to pump alignment, the suction pipe should be secured.

5. A permanent or temporary start-up inlet strainer is required.

6. Pressure measurement connection. Provisions shall be made for the installation of a pressure gauge on the suction piping between the inlet strainer and the pump suction flange.

7. Reducers shall be eccentric and installed with the flat side on top (for use in horizontal suction lines).

8. Isolation block valves are required in the suction and discharge piping and should be accessible from grade near the machinery. The centerline elevation of the discharge block valve should be kept at a convenient operation height and orientation.

9. A pressure indicator should be installed on the discharge piping between the check valve and block valve with gauge isolation and bleed valve.

10. A discharge check valve is required.

11. Discharge piping should be properly supported to remove excessive weight from the pump casing. It is preferable to support the discharge piping from overhead structural steel whenever possible to allow for proper removal of discharge piping for maintenance.

12. Drains must be located at the lowest point in the piping located near the pump. Drain connections should not be placed in the angle sections of reducers.

13. Process integrity may require double block and bleed valves on vents, drains, or other auxiliary piping connections depending on the specific service.

14. When differential settlement is a problem, the pump foundation should be extended to support the suction piping.
TYPICAL PIPING ARRANGEMENTS FOR TOP SUCTION, TOP DISCHARGE CENTRIFUGAL PUMPS

Figure 3
Top Suction, Top Discharge Centrifugal Pump Preferred Installation

Figure 4
Top Suction, Top Discharge Centrifugal Pump Alternate Installation for Large Diameter Piping
**Notes – Figures 3&4**

1. **Suction valves should be full port and of the same size as the pump nozzle unless adequate NPSH margin is not available (4.1.1.1).**
   
   Comment: If there is not adequate NPSH margin for the specified pump application, consideration may be given to placing the reducer before the suction block valve.

2. **Last pipe elbow in the suction line should be standard long radius elbow.**

3. **Suction line straight run requirement.** The pump suction piping shall have a straight run of five pump nozzle diameters between the suction flange and the first elbow, tee, valve, reducer, permanent strainer, or other obstruction sufficient to ensure stable and uniform flow at the pump suction nozzle *(PIE686/API RP686, Chapter 6, paragraph 3.1.2.6).*

4. **The pipe supports on the suction piping should not rigidly tie down the suction line close to the pump suction nozzle prior to pipe to pump alignment. After pipe to pump alignment, the suction pipe should be secured.**

5. **A permanent or temporary start-up inlet strainer is required.**

6. **Pressure measurement connection.** Provisions shall be made for the installation of a pressure gauge on the suction piping between the inlet strainer and the pump suction flange.

7. **Reducers shall be concentric for overhead piping into a top suction pump. For horizontal suction lines, reducers shall be eccentric and installed with the float side on top.**

8. **Isolation block valves are required in the suction and discharge piping and should be accessible from grade near the machinery. The centerline elevation of the discharge block valve should be kept at a convenient operation height and orientation.**

9. **A pressure indicator should be installed on the discharge piping between the check valve and block valve with gauge isolation and bleed valve.**

10. **A discharge check valve is required.**

11. **Discharge piping should be properly supported to remove excessive weight from the pump casing. It is preferable to support the discharge piping from overhead structural steel whenever possible to allow for proper removal of discharge piping for maintenance.**

12. **Drains must be located at the lowest point in the piping located near the pump. Drain connections should not be placed in the angle sections of reducers.**

13. **Process integrity may require double block and bleed valves on vents, drains, or other auxiliary piping connections depending on the specific service.**

14. **When differential settlement is a problem, the pump foundation should be extended to support the suction piping.**
Figure 5
Side Section, Side Discharge
Centrifugal Pump Preferred Installation

Figure 6
Side Suction, Side Discharge Centrifugal Pump
Alternate Installation for Suction Piping with Elbow
Installed in the Same Plane as the Shaft
Notes – Figures 5&6

1. Suction valves should be full port and of the same size as the pump nozzle unless adequate NPSH margin is not available (4.1.1.1).

   Comment: If there is not adequate NPSH margin for the specified pump application, consideration may be given to placing the reducer before the suction block valve.

2. Last pipe elbow in the suction line should be standard long radius elbow.

3. For double suction pumps, the last pipe elbow in the suction line to the pump should be perpendicular (not in the same plane) to the impeller shaft.

4. Suction line straight run requirement. The pump suction piping shall have a straight run of five pump nozzle diameters between the suction flange and the first elbow, tee, valve, reducer, permanent strainer, or other obstruction sufficient to ensure stable and uniform flow at the pump suction nozzle (PIP REIE686/API RP686, Chapter 6, paragraph 3.1.2.6).

5. The pipe supports on the suction piping should not rigidly tie down the suction line close to the pump suction nozzle prior to pipe to pump alignment. After pipe to pump alignment, the suction pipe should be secured.

6. A permanent or temporary start-up inlet strainer is required.

7. Pressure measurement connection. Provisions shall be made for the installation of a pressure gauge on the suction piping between the inlet strainer and the pump suction flange.

8. Reducers shall be eccentric and installed with the flat side on top (for use in horizontal suction lines).

9. Isolation block valves are required in the suction and discharge piping and should be accessible from grade near the machinery. The centerline elevation of the discharge block valve should be kept at a convenient operation height and orientation.

10. A pressure indicator should be installed on the discharge piping between the check valve and block valve with gauge isolation and bleed valve. Note: Installing the pressure indicator between the pump nozzle and the check valve may provide a more accurate reading of the pump discharge pressure because of the restriction of the check valve.

11. A discharge check valve is required.

12. Discharge piping should be properly supported to remove excessive weight from the pump casing. It is preferable to support the discharge piping from overhead structural steel whenever possible to allow for proper removal of discharge piping for maintenance.

13. Drains must be located at the lowest point in the piping located near the pump. Drain connections should not be placed in the angle sections of reducers.

14. Process integrity may require double block and bleed valves on vents, drains, or other auxiliary piping connections depending on the specific service.

15. When differential settlement is a problem, the pump foundation should be extended to support the suction piping.
TYPICAL PIPING ARRANGEMENT FOR

VERTICAL INLINE CENTRIFUGAL PUMPS

Figure 7
Vertical Inline Side Suction, Side Discharge
Centrifugal Pump Preferred Installation

Figure 8
Vertical Inline Side Suction, Side Discharge
Centrifugal Pump Alternate Installation
### Notes – Figures 7&8

1. Suction valves should be full port and of the same size as the pump nozzle unless adequate NPSH margin is not available (4.1.1.1).
   
   Comment: If there is not adequate NPSH margin for the specified pump application, consideration may be given to placing the reducer before the suction block valve.

2. Last pipe elbow in the suction line should be standard long radius elbow.

3. Suction line straight run requirement. The pump suction piping shall have a straight run of five pump nozzle diameters between the suction flange and the first elbow, tee, valve, reducer, permanent strainer, or other obstruction sufficient to ensure stable and uniform flow at the pump suction nozzle (PIP REIE686/API RP686, Chapter 6, paragraph 3.1.2.6).

4. The pipe supports on the suction piping should not rigidly tie down the suction line close to the pump suction nozzle prior to pipe to pump alignment. After pipe to pump alignment, the suction pipe should be secured.

5. A permanent or temporary start-up inlet strainer is required.

6. Pressure measurement connection. Provisions shall be made for the installation of a pressure gauge on the suction piping between the inlet strainer and the pump suction flange.

7. Reducers shall be eccentric and installed with the flat side on top (for use in horizontal suction lines).

8. Isolation block valves are required in the suction and discharge piping and should be accessible from grade near the machinery. The centerline elevation of the discharge block valve should be kept at a convenient operation height and orientation.

9. A pressure indicator should be installed on the discharge piping between the check valve and block valve with gauge isolation and bleed valve.

10. A discharge check valve is required.

11. Drains must be located at the lowest point in the piping located near the pump. Drain connections should not be placed in the angle sections of reducers.

12. Process integrity may require double block and bleed valves on vents, drains, or other auxiliary piping connections depending on the specific service.

13. When differential settlement is a problem, the pump foundation should be extended to support the suction piping.
Example of Reduction at Pump Suction for Side Suction Pump Piping

Example of Reduction at Pump Suction for End Suction Pump Piping
### Typical Suction and Discharge Valve Orientations

**Figure 11**  
Examples of Suction and Discharge Valve Orientation
3.2 Compressors and Blowers

4 Machinery Piping Installation

4.2 Field Installation of Auxiliaries

4.2.7 Addition. Add new section:

Oil sample points in forced lubrication systems should be located in the oil drain returns between the bearing housing and the oil reservoir in a live area of flow.

4.11 Miscellaneous Requirements

4.11.7 Addition. Add new section:

Steam turbine gland sealing and leak-off systems should be piped to prevent condensate from entering the carbon ring housing.

Chapter 7 - Shaft Alignment

5.4.4.1 Addition. New section:

Preliminary soft foot check should be made after base plate is leveled and before grouting.