



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS PVV 175

Internal cleaning of piping and vessels

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1. Scope

This Specification applies to cleaning of piping systems and/or vessels or equipment, which would normally be performed on site, but which may also be required to be performed at Manufacturer's facilities in special occasions (Manufacturer skid mounted equipment, for instance).

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Unless otherwise specifically indicated in writing, the Contractor or Vendor shall work in accordance with the requirements of this specification and those of the latest editions at the time of call for tender of the document listed hereafter.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
API Std 614	Lubrication, shaft-sealing and control-oil systems for special purpose applications

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
Not applicable	

3. Cleanliness requirements

3.1 Classification

Two classes of internal cleanliness are defined as follows:

- Class 1: Removal of all loose material, mill scale, rust, welding slag, grease, protective coatings and any adhering foreign material, which could be detached during plant operation
- Class 2: Removal of all loose material and adherent material, which could become detached during plant operation.

3.2 Extent

All process lines and associated vessels, exchangers and equipment shall at least meet the Class 2 requirements.

Class 1 requirements shall apply to the following:

- a) Suction piping, inter-stage piping, inter-coolers and by-pass piping of all compressors.
- b) Suction piping of gas expanders.
- c) Suction piping of all pumps. When a strainer is fitted, Class 1 requirements apply only downstream of the strainer.
- d) All lube oil, seal gas, control oil piping.

Utility lines, other than those listed in d) above, together with any associated vessels, exchangers and equipment shall meet the Class 2 requirements.

4. Main cleaning methods

4.1 Cleaning with air (blowing or air flushing)

Two main methods may be used:

4.1.1 Continuous blowing of air

Air is continuously blown from a source (Air Compressor of a large capacity) at a high velocity through the lines (and vessels) to carry away the foreign matters. Due to the high velocity of the air, light erosion of the walls generally occurs during the air blowing, which is beneficial with regards to cleaning.

4.1.2 Quick decompression

A network is filled with compressed air up to the setting pressure of a rupture disk. When the rupture disk blows out, the source of air is stopped and the pressure inside the network

decreases quickly. This operation is in fact generally made with a "quick opening valve" after having pressurized the network at the desired level of pressure. The quick decompression causes a high velocity of airflow in the pipes, thus removing foreign matters and performing a light erosion on the walls, which eliminates rust and scale as seen here above.

4.2 Cleaning with steam

Wherever steam is available, it can be used like the air for continuous blowing, provided that the lines and vessels are designed to withstand the steam temperature (thermal expansion and material quality). The advantage of steam is the following: between two steam blowing operations, the pipes and vessels cool down, and this variation of temperature embrittles the rust and scale which are more easily removed during the next blowing.

4.3 Cleaning with water (water flushing)

Three main methods may be used:

4.3.1 Circulation of water

The cleaning is made by a circulation of water at high velocity (3-4 m/s) through the pipes. To obtain such a velocity, a special pump has generally to be used (large flow, small pressure).

This method is only efficient to remove foreign matters, but not the rust or scale if their incrustation is important.

Attention is drawn to the fact that water can corrode the pipes walls (chloride ions on stainless steel, seawater on carbon steel) and that special qualities of water have to be used.

4.3.2 Water spray

If there is only dust on the walls of a large vessel, a water spray from a hosepipe might be sufficient.

Note:

In some particular cases, air flushing and water flushing can be applied simultaneously: air (3 bar g) is injected in water in order to increase the turbulence. As the monitoring of such a method is not easy, it should be used with great care and only on special occasions.

4.3.3 High pressure water

This process may be used to remove solid particles of foreign matters from inside walls or inside parts of equipment, in particular where access is a problem.

4.4 Mechanical cleaning

Three main methods may be used:

4.4.1 Hand cleaning

When a man can enter into the network (vessels, large diameter pipes), it is sometimes more efficient to clean the walls with a metallic brush and to remove the rust fallen down with a vacuum cleaner and/or a final blowing.

4.4.2 Pipe cleaning with pigs

When a pipe has been designed to allow pigs to be sent through, a special pig with metallic brushes at its periphery is sent to clean the pipe. This special pig takes rust and scale from the walls but does not remove rust and foreign matters fallen down at the bottom of the pipe; a "normal" pig has then to be sent to remove the rust and the foreign matters which lay at the bottom of the pipe.

4.4.3 Sand blasting

For large vessels, sand blasting may be used to remove rust from the inside walls; in such a case, special instructions shall be given by the Manufacturer.

4.5 Chemical cleaning

Two main methods may be used:

4.5.1 Chemical cleaning without further coating

This type of cleaning is made by chemicals and is mainly used for lubrication lines of rotating equipment. The main steps are:

- Rinsing with water at high velocity
- Degreasing
- Acid treatment with corrosion inhibitors
- Rinsing and neutralisation
- Lubricant filling.

4.5.2 Chemical cleaning with final protective coating

This type of cleaning is also made by chemicals and is used mainly for high-pressure boiler network. The main steps are the following:

- Rinsing with water at high velocity
- Degreasing
- Acid treatment with corrosion inhibitors
- Rinsing and neutralisation
- Magnetite formation and passivation
- Silica chemical removing.

5. Selection of an appropriate cleaning method

5.1 Approval of the cleaning method(s)

The selection of the cleaning method(s) shall be approved by the COMPANY on a case by case basis prior to performing the cleaning of piping and vessels.

5.2 Guidelines

This selection shall be based on the following:

- **The nature of fluids available on site**

Compressed air, steam, seawater, fresh water, inhibited water, etc.

- **The volume of the network**

It determines the quantity of fluid to be used and the time needed to fill in the system at the desired pressure (quick decompression method).

- **The diameter of the lines**

To reach the desired fluid velocity inside the lines, some additional pumps, compressors, or capacities may be necessary.

- **The design conditions of the network**

Some large diameter pipes used for gas service cannot bear their own weight if full of water. Some lines may not withstand the thermal expansion during the steam blowing, etc.

- **The type of dirtiness**

If there is no scale or rust on the walls of a vessel, a brush-type cleaning may not be necessary.

- **The material specification**

For stainless systems, an air blowing is preferable (if the other conditions allow it) to water cleaning, in order to avoid the possibility of corrosion by chloride ions. A reactor coated with refractory bricks shall never be washed with water.

- **The process function of the system**

Cryogenic lines, for which water is to be avoided, shall be air blown whenever possible.

In some special cases, cleaning of the network may imply very large quantities of air or water, and/or very large compressors or pumps, which are not available on the site. Accordingly, these special cleaning operations have to be studied and if necessary, the consequences of "cleaning" versus "no-cleaning" shall be evaluated by the COMPANY.

5.3 Rules for cleaning method selection

As a general rule, water flushing method shall be used. Where possible, this should be preceded by mechanical cleaning to remove adherent matters.

As an alternative to the above, and with the COMPANY prior approval on a case-by-case basis, air flushing may be considered if water flushing is deemed undesirable (for example, due to the difficulty of drying out the relevant system). Where possible, this should also be preceded by mechanical cleaning to remove adherent matters.

Plant air and nitrogen systems shall be cleaned by air flushing.

Where Class 1 cleanliness is required, chemical cleaning shall be undertaken after flushing if inspection shows that the required degree of cleanliness cannot be achieved by flushing.

Lubrication oil, seal oil and control oil piping shall be cleaned and proven in accordance with **API Std 614**.

6. Application to a specific network to be cleaned

The following principles shall apply:

- Whenever possible, the cleaning fluid shall flow from top to bottom.
- The diameter of the outlet pipe shall be at least as large as the diameter of the inlet pipe, and, in any case, as large as possible.
- The diameter of the outlet pipe shall be at least two thirds of the diameter of the line to be cleaned.
- Main headers shall be cleaned first (i.e. before their connecting lines).
- Large diameter pipes shall be cleaned before small diameter ones.
- Dead ends shall be avoided or, if not possible, cleaned separately.
- Protection of the devices included in the network (control valves, turbine-type flowmeters, orifice restrictions, etc. shall be carefully studied (see section 7).
- Protection of the devices in the vicinity of the network shall be carefully studied, in particular near the water (or air) outlet, in order not to damage electric motors or instruments with water or dirty air (see section 8).
- Existing block-valves on the lines to be cleaned shall not be used to control an air (or steam) flow as they could be damaged by erosion (due to the high velocity of the fluid).
- A special care shall be taken for vessels designed only for an atmospheric pressure service, in order not to create, during washing, a high pressure due to a water head.
- Whenever a vessel full of water has to be emptied, a special note shall be issued to state that a vent will have to be opened previously in order not to create vacuum in the vessel.
- Generally, the cleaning fluid shall not flow through a conventional exchanger (use the bypass, if any, or "break" the line before the exchanger). It shall never flow through a plate exchanger.
- The cleaning fluid shall never flow through pumps or compressors: the line shall be disconnected before the equipment or a "jumper" shall be installed.
- For large diameter pipes, some temporary supports, hangers, pads, etc., may have to be added to withstand the weight of valves when a line is disconnected.
- During flushing, the spring supports, spring hangers, etc., shall be blocked according to the Manufacturer 's instructions.
- When a couple of flanges has to be opened to allow the flow to flush out, the distance between the two flanges shall be at least 1/6 of the pipe diameter.

7. Protection of the devices included in the network

During the flushing or the blowing of a line, some particles such as sand, rust, etc. are carried away at high velocities and may either damage some devices when an impact occurs, or clog small diameter pipes. Accordingly, fragile devices have to be removed from the pipe before flushing/blowing.



Are considered as fragile devices:

- Control valves and check-valves
- Safety valves
- Calibrated orifices
- Turbine type flowmeters
- Pitot tube flowmeters
- Venturies
- Rotameters
- In-line flow totalizers
- Nozzles of ejectors
- Traps
- Bellow valves
- Internals of filters and strainers.

The list is not exclusive and shall be revised according to local necessities.

Process impulse lines for instruments shall be isolated by means of the block valve located on the impulse pipe itself and shall be disconnected whenever possible. This operation shall be made by an instrument specialist.

Thermowells may remain installed if the pipe is not too dirty.

Butterfly valves and full bore valves shall be completely opened.

"S"-type valves shall be removed and replaced by dummy spools.

When a couple of flanges have to be opened to allow the flow to flush out, it shall be checked that this operation does not create any stress on a pump flange or a compressor flange upstream or downstream.

The flushing is generally not carried out through columns or drums. But if it is necessary to go through such equipment, or if the vessel is used as an air reservoir, the removable internals have to be dismantled prior to starting the flushing, in order not to damage them.

Any column or drum to be used as an air reservoir must have its associated relief valve(s) in normal operation before pressurising starts.

8. Protection of devices in the vicinity of the network

During flushing and blowing operations, large quantities of dirty water and dirty air are spread out in the units. This water or air generally contains sand, particles of rust, etc., and might damage the equipment (for example: breaking of the glass of a pressure gauge). Additionally, the water itself may damage the insulation materials, the electrical motors, etc. Accordingly, the following actions shall be taken where necessary:

- To put a tarpaulin on the motors, on the insulation, on the instruments near the flow outlet
- To direct the outlet flow towards a place where there is no (fragile) equipment
- To change the direction of a flow by rotating an elbow

- To connect a hose pipe at the outlet to drive the flow to a desired location (for water flushing only)
- To add a dummy spool to get the outlet farther
- To install a sheet of metal (insulation cover sheet for example) perpendicularly to the flow, in order to break the flow impact
- On platforms, to protect the equipment and the people on the deck underneath
- Drains, which are generally not designed for such large flows, should not be used to evacuate water, as they might be flooded.

9. Water flushing

9.1 Specific problems of water flushing

- **Slow velocity**

The water velocity through the pipe is normally only about 3 to 4 m/s, seldom higher, which is much lower than air blowing velocity.

- **Volume and flow rate of water**

For large diameter pipes, the flow rate of water needed to reach an acceptable level of velocity is very high. For example, a 24 inch pipe would need a flow of about 3000 m³/h to reach a velocity of 3 m/s. If the flushing operation lasts 10 minutes, the volume of water required would be 500 m³!

- **Dirty water disposal**

As the drains are generally not designed for high water flow rates, additional temporary piping and connection, as well as intermediate storage, might be required.

- **Weight of water**

For lines designed for gas service, the weight of pipes full of water may be too heavy for the hangers, supports. (This has to be checked prior to any water flushing).

- **Corrosion factor**

Raw water or seawater can corrode the materials under certain conditions. Chloride ions have to be avoided in stainless steel pipes or vessels. Seawater has to be inhibited. Ordinary seawater may be used for the first flushing operations, but the final one (rinsing) has to be carried out with inhibited seawater.

- **Quality of the water**

Only clean water shall be used. Raw water or seawater shall be filtered through a 100 microns filter.

9.2 Guidelines for the preparation of a water flushing

9.2.1 Definition of the network to be cleaned

A first selection shall be made according to geographical or functional criteria (e.g. drains of the north area, hot oil network, etc. Then it shall be adapted to suit the site requirements, depending

in particular of the pumps available on site, the devices to be removed, the configuration of the lines (low points, high points, lengths, heights).

9.2.2 Calculation of the necessary flow in the main header of the network

The water velocity shall be the lowest figure between 3 m/s and the velocity obtained at 1.5 time the maximum process flow rate (for liquid process lines). Gas process lines are generally blown; if they have to be flushed, a flow rate of 3 m/s shall be used and the design of the supports shall be checked.

9.2.3 Estimate of the maximum head loss

At the velocity calculated as in § 9.2.2 here above, estimate the head loss for a flow going through the main header, and add the static head (if any).

9.2.4 Application of the requirements to the existing facilities

The existing water networks (cooling water and fire water systems) should be used wherever possible.

If several pumps are available, a combination of pumps in parallel or in series may be used to meet the flow rate or head loss requirements.

If the flow rate and the head loss required cannot be obtained from the pumps available on site, cleaning by air blowing should be considered as an alternate.

9.2.5 Sketch of the network to be cleaned

A sketch of the network to be cleaned shall be drawn specially for the cleaning operation (P & ID or system sketches may be used for this purpose).

It is suggested to use a color code as follows:

- Yellow: lines to be flushed
- Red: items to be removed and replaced by dummy spools
- Green: blinds to be installed
- Blue: item to be isolated by valves and "jump-over" to be installed

9.2.6 Location of water inlets and outlets

A site review, or at least, a model review shall be done to determine the possible water inlets and outlets, the water source, the pump(s) location, the additional pipes or hose pipes layout from the source to the pump and from the pump to the network; this shall be noted on the sketch of the network. The water disposal problem (flood risk) and the protection of the equipment and people nearby shall be carefully studied.

9.2.7 Additional material and pieces of equipment required

The isometric drawings for the additional pipes to be manufactured and erected by commissioning team or erection team (to be defined) shall be drawn. The required material (pipes, valves, gaskets, etc.) and the means (monorails, cranes, pulleys blocks), tools, gaskets, grease for bolts, nuts required to carry out the removal and/or re-assembly, the needs for the dummy spools (flanges, pipes, etc.) shall be determined.

9.2.8 Fragile devices to be removed

The "fragile" devices to be removed shall be identified. The removal possibilities shall be investigated on site (or, at least, on the model if applicable). The required dummy spools to be fabricated shall be drawn on sketches. Attention shall be mainly paid to:

- Heavy devices (control valves, check-valves)
- Supports, hangers, pads, spring supports, etc.
- Possible stresses on pump's flanges.

All these removal operations shall be marked-up on the sketch of the network.

9.2.9 Quality of water

Whenever possible, the flushing shall be made from the beginning to the end with a good quality water. However, if the quantities involved are very important, and except for stainless steel materials, it is allowed to carry out the first flushing operations on a given network with raw water and to perform only the last one (rinsing) on the same network with a good quality water. If the quantities of chemicals involved are also too important for a rinsing, the pipes may be filled in with inhibited water only, subject to the COMPANY prior approval.

The quality of the water shall comply with the following:

9.2.9.1 Stainless steel materials (pipes or vessels)

Water to the following specification shall be used exclusively:

- Resistivity: 100,000 Ohm x Cm (before addition of Na NO₃).
- Chloride ions Cl⁻: 15 ppm maximum
- Additiv: Na NO₃ (three times the ion Cl⁻ content)

9.2.9.2 Carbon steel materials (pipes or vessels)

Sea (or raw) water may be used with the following additives:

- Corrosion inhibitor: 150 ppm
- Oxygen scavenger (optional): 10 times the oxygen content (typically: 100 ppm)
- Bactericide: 500 ppm

9.3 Water flushing procedure

Before performing the water flushing, the following shall be verified:

- The additional pipes or hose pipes and the dummy spools required specifically for the flushing operation
- The supports, hangers, pads, pump's flanges, etc.
- The environment protection at the water outlet.

If the required flow rate is important and if the cooling water system or the fire water system is intended to be used, ask the people in charge of the operations on these networks when it is possible to perform the flushing in order not to disturb the other users.



Then allow the water to enter the network to be flushed by opening a valve near the inlet. Proceed slowly in order to check that there is no mistake (opened vent creating a geyser for example). When all seems to be correct, open the valve to get the desired flow.

To check the flow rate:

- If the cooling water network is used as feeder, the flowmeter on this network will give the flow rate used for the flushing (by difference: before and during flushing)
- If an other source is used, a pressure gauge shall be installed at the inlet of the network to be flushed (downstream the inlet valve) and the flow shall be adjusted by acting on the inlet valve till the head loss equals the one corresponding to the velocity calculated in 9.2.2 here above.

Duration of the flushing:

- At least, time needed to open all the vents, drains, impulse lines (when the instruments are disconnected)
- Normally: time needed for the outlet water to be as clean as it is at the inlet (take two samples into glass bottles and compare).

When the main header of the network is deemed clean, stop the water flow and prepare the network to flush the connections and derivations.

When the complete network has been flushed satisfactorily, the circuit shall be rinsed if necessary. Then the removed devices shall be reassembled (take care not to dirty the lines during this operation) and, if necessary, fill in with inhibited water.

9.4 Particular cases: water systems

As they are the first systems to be started in the plant, a particular method shall be used for such networks: they shall be cleaned by circulation of water using the installed circulation pumps to obtain the highest possible velocities.

Prior to flushing, a mechanical cleaning shall be performed as far as possible, and strainers shall be installed in as many points as possible. Strainers positions shall be such that they can be removed without excessive water loss (avoid non-isolable positions, in low points for example), and that dirt will not fall into the network when the circulation stops. The strainer hole size will be at least 3 mm along the network.

The strainers at the pumps section shall be covered with Mesh having smaller holes than pump impeller clearances and not larger than 0.3 mm in any case. If pump seals have supplies from the pumps bowl or discharge, a temporary strainer with holes size less than 0.5 mm shall be inserted in the supply lines to the seal.

When filling in the system, wetting agent and oil dispersant are generally added with normal biological and corrosion inhibitors. It is important that any grease is removed and dispersed.

Dispose the network so that the velocity in the branch chosen is higher than the design velocity. Start the pumps (see particular procedure). After 10 min, stop the pump and clean the filters, then restart for 30 min and clean again. When the strainers are found clean at the end of a circulation, remove the temporary ones and prepare the network to flush an other part.



10. Air flushing

10.1 Specific problems of air flushing

10.1.1 High velocities and large flows

The air velocities through the pipes have to be 30 to 70 m/s. If the continuous blowing method is used for an 18 inch pipe, the required flow rate is about 17,000 m³/h for a velocity of 30 m/s. This large continuous flow rate of air is seldom available on site, and temporary site compressors of such range cannot be found easily.

10.1.2 Large volumes of air

If the quick decompression method is used, large volumes of air are required, and lengthy time may be necessary to rise the pressure in the network to the desired value.

10.1.3 Air flushing is a hazardous operation

Very high forces are generated at the air outlet. Therefore, specific safety procedures must be closely adhered to; it is generally recommended that air flushing operations should be undertaken during the night or when all other work has been stopped on site.

10.1.4 Air quality

For some operations, oil-free air and/or dry air might be needed (temporary drier and oil extractor may be necessary).

10.2 Guidelines for the preparation of an air flushing

10.2.1 Definition of the network to be cleaned

A first selection shall be made according to geographical or functional criteria (e.g. compressor suction line, main transfer line, north area air service system, etc.). Then, it shall be revised to suit the site requirements, depending in particular of the compressors available on site, the devices to be removed, the configuration of the lines, etc.

10.2.2 Calculation of the necessary flow rate in the main header

The velocity shall be the lowest figure between 60 m/s and the velocity obtained at 1.5 time the maximum process flow rate (for gas process lines). Liquid process lines are generally water flushed; if they have to be air flushed, a velocity of 30 m/s shall be used.

10.2.3 Application of the requirements to the existing facilities

If the required flow rate is too important for the compressor available on site, the continuous air flushing method is not suitable (the quick decompression method should be considered as an alternate). Practically, continuous air flushing may be used up to and including 6" pipe. Beyond this limit, the quick decompression method should be used. The cleaning of piping 18" diameter and larger shall not be made by air flushing but by hand with wire brushes or hose pipes, and blasting.

If the quick decompression method seems to be suitable, the total volume of the network shall be estimated, and the time required to rise the pressure up to 6 bars with the compressor(s) available on site shall be calculated (**check also that all pipes and vessels of the network are designed to withstand a pressure of 6 bars**). If the time previously found is too important,

hand cleaning should be considered, or the network should be divided into several parts: some being air flushed and some others being hand cleaned.

10.2.4 Sketch of the network to be cleaned

When the appropriate cleaning method has been selected, a sketch of the network to be cleaned shall be drawn (using P&ID's or system sketches and a color code as proposed in 9.2.5). The possible air inlets (continuous flushing) and possible outlets and temporary pipes shall be determined (avoid hosepipes). Isometric drawings shall be drawn if necessary, and the required equipment (pipes, valves, gaskets) shall be determined.

10.2.5 If the quick decompression method has been selected, the pressure release can be obtained by:

- A quick opening valve
- A rupture disk.

In the first case, the flow rate may be roughly adjusted if necessary and the valve may be closed in case of emergency; in the second case, no control is possible.

Due to the high velocity involved, the quick opening valve might be eroded if it is used in an intermediate state (i.e. not completely opened). Therefore, whenever possible, the valve shall be completely open.

10.2.6 Fragile devices to be removed

The "fragile" devices to be removed shall be identified. The removal possibilities shall be investigated on site or at least on the model (if applicable). Sketch the dummy spools to be made. Determine the means (monorails, cranes, pulley blocks, tools, gaskets for re-assembly, grease for bolts, nuts, etc.) to carry out the removal and re-assembly. Determine the need for dummy spools (flanges, pipes, etc.).

Attention shall be mainly paid to:

- Heavy devices (control valves, check valves)
- Supports, hangers, pads, spring supports, etc.
- Possible stresses on compressor's flanges
- Tray manholes and other internals of the vessels used as air capacities (quick decompression method).

10.2.7 Safety

Due to the high forces generated at the air outlet, the following particular precautions shall be taken for blowing operations:

- **Period of time for blowing**

It is recommended that air blowing should take place after normal working hours.

- **Restricted area**

An area of at least 30 meters around the outlet points will be roped off during the release of the air.

- **Work permits**

Any air flushing operation shall be subject to specific work permits from the safety department.

- **Space between flanges at the outlet**

To obtain the desired space without hammering, spacers (pieces of tube of a diameter slightly larger than the bolts), or pile of washers, shall be installed on bolts fixed by two nuts between the two flanges in two holes diametrically opposed (see Figure A).

- **Restraints**

The flange(s) at the air outlet shall be fixed by means of shackles and cables or slings. For diameters larger than 4", at least four cables shall be used. The second end of the cable shall be fixed rigidly to the structures (see Figure B).

- **Clamps, tie bars, rigid struts, shims, U bolts, etc.**

Wherever necessary, the pipes shall be rigidly fixed with clamps, tie bars, rigid struts, U-bolts, etc., to avoid damage to the lines, equipment, and nearby people.

- **Blanks**

Blanks shall be rigidly fixed to the flanges by bolts and nuts in order to prevent them to fly off when opening the quick opening valve or when the rupture disk blows out.

- **Environment protection**

The large quantities of dirty air released during the flushing carry particles of sand, rust, welding rods, etc., which could damage the nearby equipment. Therefore, adequate protection has to be installed.

10.3 Air flushing procedure

Before performing the air flushing, the following shall be checked:

- Additional pipes, and dummy spools (where required)
- Supports, clamps, restraints, etc.
- Environment protection

and the safety department shall be asked for an authorization to start the air flushing operation.

10.3.1 Continuous blowing method

- Start the compressor (see particular procedure and Manufacturer requirements).
- Open the valves on the main header to be air flushed.
- Allow the airflow to enter the network up to the calculated flow rate (check by difference at the outlet of the compressor, before and after).
- If the valve between the compressor and the network to be flushed is a globe valve, and if the compressor allows for quick changes of flow rates (contact Manufacturer's representative), **changes of flow rates** in the line may be made, thus changing the velocity and removing more quickly the rust and scale incrustated on the surfaces. (This method may be attempted if the incrustation is important and/or if the pipe has to be very well cleaned). For normal dirtiness, a continuous blowing at a constant speed should be sufficient.

10.3.2 Quick decompression method

Check that the network is isolated.

- If a quick opening valve is used, and if the network is designed for a pressure of at least 6 bars, allow the air to enter the network and have the pressure risen up to 6 bars; then check that all safety measures have been adhered to, and open the valve. If necessary, this operation shall be repeated several times, until cleanliness criteria are met.

(If the network cannot withstand a pressure of 6 bars, the pressure shall be carefully checked (add a pressure gauge if necessary) in order that the maximum allowable pressure in the system be never exceeded).

- If a rupture disk is used, after having checked that safety measures have been taken, allow the air to enter the network; check continuously the pressure rise, and when the rupture disk blows out, stop the air inlet in the network. If necessary, the operation shall be repeated several times, until cleanliness criteria are met.

10.4 Cleanliness criteria

They depend upon the final use of the pipe or the vessel. Compressor's suction lines for instance, have to be far cleaner than drains.

The main criteria are:

- **Color of the cloud at the air outlet**

At the beginning of the blowing, the cloud is brown (rust colour); it becomes brighter and brighter as long as the blowing lasts.

- **Color of a blank fixed perpendicularly to the flow at the outlet:**

An aluminum plate or galvanised metal plate is generally used. After the first blowing, the plate colour is brown/gray, due to the multiple impacts. The colour becomes brighter and brighter after each further blowing. (The plate has to be changed after each blowing).

- **Number of impacts on a standard plate**

When lines have to be very well cleaned (lines upstream a turbine, for example), a plate is placed on a "tail pipe", and the number of impacts (see an example of standard plate in figure C) are counted after 3 minutes of blowing.

11. Cleaning with steam

The differences between air flushing and steam blowing are mainly:

- **The temperature**, which induces thermal expansion/stresses. Therefore, supports, pads, etc. and material quality have to be checked carefully to ensure they are able to withstand such temperatures.
- **The vacuum pressure** induced by steam when it cools down and becomes liquid, if the network is isolated.

The advantage is the embrittlement of rust, scale, welding slag, etc., created by this change of temperature.

The steam blowing shall begin by a slow rise of temperature to allow for thermal expansion of the system (don't forget to drain the condensates at every low point). When the steam temperature is roughly reached in the pipe, allow the steam to flow at a rate calculated for the

velocity given in section 10.2.2. At the end of the steam blowing (after 5 min to 15 min), the cleanliness shall be checked according to section 10.4. If another blowing operation is necessary, let the network cool first (take care of the thermal expansion, and prevent it from vacuum, drain all low points); the cooling time may be reduced by blowing air through the system.

When the cleanliness of the pipe meets the requirements, let the system cool down; drain all low points and, if necessary, dry the network and reassemble (see section 14).

12. Chemical cleaning

This general specification does not address the chemical cleaning of particular process lines for which special studies have to be undertaken by specialized Contractors.

The chemical cleaning of lubrication or seal systems of rotating machines is generally carried out under the Manufacturer's representative supervision.

In some cases, a hot oil circulation only is suggested by the Manufacturer; in some other cases, carbon steel pipes only shall be chemically cleaned, etc.

The present specification shall be used when no other requirements are specified by the Manufacturer. His agreement shall be obtained prior to performing the operation.

12.1 General

Degreasing, pickling and neutralization-passivation operations shall be carried out by immersing the parts to be cleaned into a tank containing the chemical solution or by filling in them with the chemical solution without circulation. Generally, pipes are totally disconnected from their equipment and are assembled together in order to form one single line (with intermediate connection spools if necessary).

All accessory equipment such as coolers, pumps, filters, tanks, etc., shall not be chemically treated. Chemical cleaning is only applicable to carbon steel and stainless steel pipes. Copper or brass parts, if any, have to be removed or isolated.

12.2 Chemical cleaning of carbon steel pipes

This operation shall be carried out according to the following procedure:

12.2.1 Cold degreasing

Cold degreasing is only requested if pipes have been delivered prefabricated by the Vendor or if they have been prefabricated on site, or, if for other reasons, they have to be degreased.

- Chemical composition of the solution:
 - Sodium carbonates Na_2CO_3 : 3 g/l
- Or
- Sodium tripolyphosphate $\text{P}_3\text{O}_{15}\text{Na}_5$: 2 g/l
- And trisodium phosphate Na_3PO_4 : 1 g/l
- Duration: about 12 hours (if the amount of grease is too important, the degreasing process may be activated through mechanical means such as by wire brushing).

12.2.2 Rinsing

With clear water (in all cases, even if no degreasing has taken place).

(Refer to section 9.2.9 for quality of water).

12.2.3 Cold pickling (ambient temperature)

- **Chemical composition of the solution**

- Hydrochloric acid (HCl): 200 g/l
(solution 33% wt concentration, specific gravity 1.165)
- Ammonium bifluoride $\text{NH}_4 \text{F}_2$: 10 g/l
- Inhibitor Rodine 213
or Armohib 28: 2 g/l
or equivalent

- **Operation**

In a 200 liters plastic drum containing 100 liters of demineralized water, pour in the following order:

- The inhibitor
- The ammonium bifluoride
- The hydrochloric acid.

Prior to introducing the solution in the line or the vessel, it shall be tested for inhibitor effectiveness. The test shall be undertaken as stated in section 13.1. Then, introduce the solution into the line, wait for 10 hours and empty the pipe. (The effluents shall be properly drained off after this operation).

12.2.4 Rinsing by circulating demineralized water with a hose

12.2.5 Neutralization (ambient temperature)

Chemical composition of the fluid: sodium nitrite Na NO_2 : 10 g/l

Pour the sodium nitrite into a 150-liter drum containing 100 liters of demineralized water, introduce the solution into the lines, and wait for about 12 hours. Then, drain the lines (the effluents shall be properly drained off after this operation).

12.2.6 Blowing

Drain all low points if any, and dry the network with compressed air to remove water traces.

12.2.7 Oil flushing

Fit back the pipes with new gaskets according to the Vendor 's drawings.

Check the cleanliness of the oil tank (the cleaning of this tank shall be made by hand).

Fill in the oil in the tank (see Vendor 's recommendations).

Set the valves and start the oil pumps (refer to particular specification).

12.3 Chemical cleaning of stainless steel pipes

This operation shall be carried out as per the following steps:

12.3.1 Degreasing is generally not necessary except if the quantity of grease is too important and cannot be removed by hand

12.3.2 Rinsing with clean water and hosepipe (refer to section 9.2.9: quality of water)

12.3.3 Cold passivation (at ambient temperature)

- **Chemical composition of the solution**

- Nitric acid (HNO_3)

Solution at 65% wt concentration: 310 g/l

- Hydrofluoric acid (HF)

Solution at 40% wt concentration: 37 g/l

- **Operation**

In a 200 liters plastic drum containing 100 liters of demineralized water, pour the acid solutions and mix.

Pour the solution into the pipes and wait for 3 hours.

(The effluents shall be properly drained off after this operation).

12.3.4 Rinsing

With demineralized water and a hose.

12.3.5 Blowing

Drain all low points if any, and dry the network with compressed air to remove water traces.

12.3.6 Oil flushing

Refer to section 12.2.7.

12.4 Staff protection

Elementary protections have to be taken by the people involved in the chemical cleaning operations. They must wear some safety equipment such as gloves, boots, aprons, and goggles.

In case of splitting:

- On skin:
 - **Acid:** rinse and clean with a 10 g/l sodium carbonate solution
 - **Alkaline products:** rinse and clean with a 20 g/l citric acid solution.
- In the eyes use a 10 g/l boric acid solution.

In any case, see a doctor.

13. Quality control

13.1 During cleaning

If chemical cleaning is carried out, the cleaning solution shall be tested for inhibitor effectiveness prior to its introduction to the relevant system. This test shall be undertaken as follows:

A degreased carbon steel coupon shall be immersed in the solution, which is maintained at the intended cleaning temperature and stirred. Effective inhibition is indicated by the absence of hydrogen evolution.

During chemical cleaning, samples of the cleaning solution shall be removed at a frequency suited to the cleaning process and as agreed with the COMPANY. The samples shall be tested for ferric iron content and total iron content. If the ferric iron content exceeds 0.4%, or if the total iron content exceeds 1.5%, the solution shall be immediately drained and the system flushed through with clean water. Constant iron content and acid strength indicate the completion of the cleaning operation.

13.2 Inspection after cleaning

Visual inspection shall be made at all accessible points to assess the degree of cleanliness achieved.

Lube oil, seal oil and control oil systems shall be inspected as noted in [API Std 614](#).

14. Reassembly

After the cleaning operations, pipes, fragile devices, etc. have to be reassembled. A great care is necessary in this operation.

The construction specifications have to be complied with, with a particular emphasis on the following points:

- Gaskets, ring joints, etc. have to be carefully cleaned.
- Spring supports, sliding pads, etc. have to be installed according to the drawings and released when the re-assembly is completed.
- Threads shall be checked and wrapped with PTFE.
- Stuffing boxes and packing of valves shall be checked and changed if necessary.
- Absence of stresses on pumps and compressors flanges has to be checked.
- The orientation of check valves, globe valves, etc. shall be checked (according to their arrow) against the direction of flow.
- In-line instruments such as flow orifices, restriction orifices, rotameters, shall be installed by instrument specialists.
- Expansion bellows shall be freed according to the Manufacturer's instructions.

Tightness tests, followed by functional tests shall be made after re-assembly.

15. Preservation of cleaned systems

Generally, all stainless steel lines and lines requiring Class 1 cleanliness shall be left full of treated water or completely drained and dried further to the cleaning operations. Any additional necessary precautions shall be taken to avoid the subsequent formation of rust or any other corrosion, by the incorporation of a desiccant, by coating the system with an approved protective film, or by nitrogen blanking, if necessary.

For Class 2 systems, and in other instances, subject to prior approval of the COMPANY, systems that operate in a water-wet condition may be kept full of water to which a corrosion inhibitor has been added. This option shall not apply if there is a possibility of freezing prior to commissioning.

Cleaned systems shall be blanked off by metal closures until required for commissioning.

16. Documentation

16.1 Prior to cleaning operations

The Vendor or the Contractor responsible for the cleaning/flushing work shall review the list of lines and/or equipment in his scope of work, as defined in the Purchase Order and shall submit to the COMPANY the following for approval:

- Detailed description of the proposed cleaning methods
- A marked up copy of the list of lines/equipment showing the areas where the proposed methods are intended to be used.

The Vendor/Contractor shall identify any exceptions or deviations to this specification.

Any alternative methods of cleaning to those defined in this specification shall not be used except if specifically approved by the COMPANY.

16.2 Cleaning performed by Vendors

The Vendor shall issue a report or a certificate detailing the actual cleaning method used, in the Equipment Dossier and Production data Book, for each related item or equipment.

16.3 Cleaning performed at site

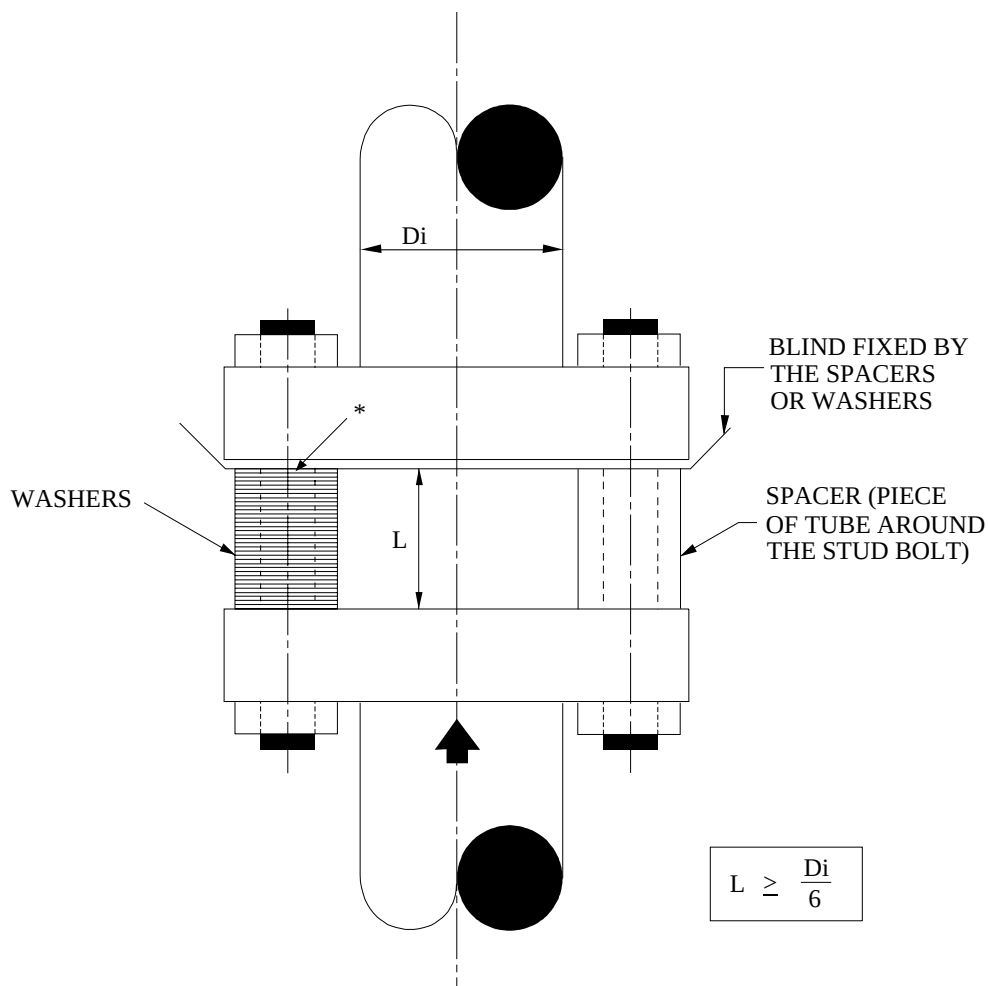
The Contractor shall keep continuous records of the cleaning operations performed, which shall include at least the following information:

- Methods used
- Nature, concentration, temperature and circulation rate of any chemicals used
- Test methods and results
- Level of cleanliness achieved
- Measures taken to preserve the cleaned system.

The Contractor shall issue these records to the COMPANY upon completion of each system cleaning operation.

16.4 Flushing performed at site

Flushing operations at site shall normally be performed under the supervision of the COMPANY representative, who will determine whether any documentation is necessary for such operations.



* BLIND HOLE DRILLING DIAMETER LARGER THAN BOLT DIAMETER .
SMALLER THAN WASHER OUTSIDE DIAMETER

Figure A

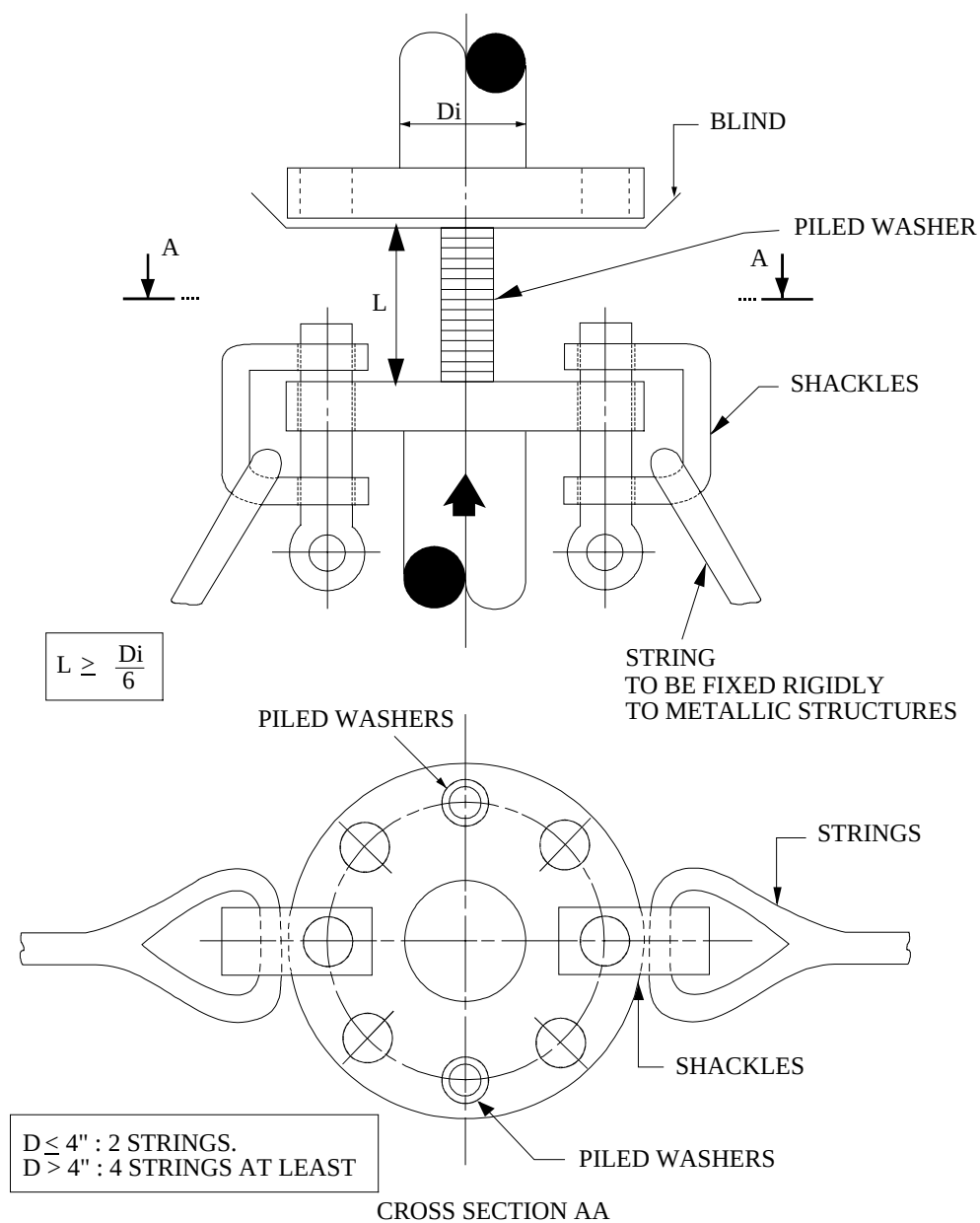
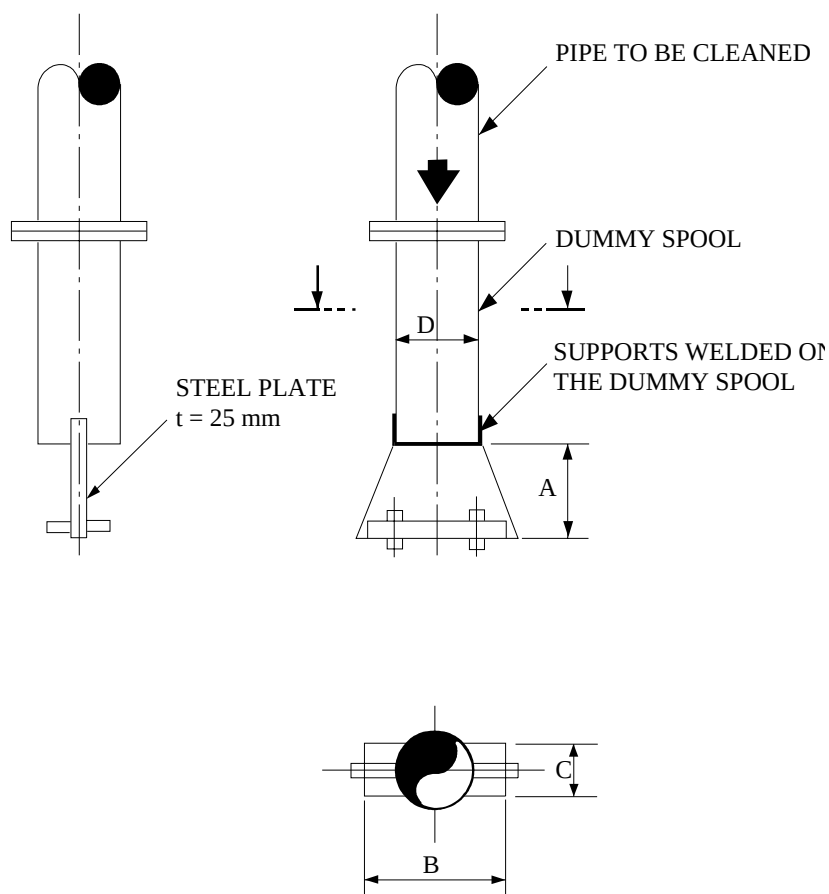


Figure B



$$B = \frac{5}{4} D$$

$$C = \frac{3}{4} D$$

$$A = 2 D (= 3D \text{ for diameters 3 inches and below})$$

Figure C