INTERNAL SURFACE TREATMENT OF PIPING PRIOR TO ERECTION

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Rev	Date	Prepared by	Approved by	Revision
A	Oct-04	E. Fraisse	S. Rousse	Initial issue - Replaces SG-395-07/SG-395-08/ ST-273-01
B	10-Dec-10		J. Pacheco	Content of the document reviewed and re-approved
C	23-Nov-11	A.Colson M.El Sarouni	J. Pacheco	Revision Include W-GS-4-0-1 as reference document

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1 INTRODUCTION

1.1 Scope of application

1.1.1 Purpose

The purpose of this document is to provide requirements for internal surface treatment for piping prior to erection.

1.1.2 Scope

This document applies to piping components for air gases applications.

This document does not apply to non metallic piping components

1.2 Definitions

Cleaning	Cleaning is a succession of operation to reach and preserve the required level of cleanliness for the required service
Air	Clean dry and oil-free air according to ISO 8573
MSDS	Material Safety Data Sheet
Rinsing	Rinsing is the elimination of chemical products and/or residue or deposits, using clean water
Corrosion inhibitor	A corrosion inhibitor is used to limit the chemical attack of a metal by an acid solution used for pickling
Passivation or Neutralization	Passivation or neutralization stops the chemical process of pickling after elimination of the acid solution
Drying	Drying is the removal of water or solvent from cleaned surfaces, using dry and clean oil-free air
White Wipe	A clean white lint-free cloth (cotton)
PPE	Personnel Protective Equipment
Purchaser	Air Liquide or entity representing Air Liquide
Detergent	A cleaner that is water soluble water and may require dilution for use
Solvent	A cleaner that is water soluble in water and does not require dilution for use
Cleaning Agent	Chemical product such as detergent or solvent used for surface treatment
Contamination	Includes both organic and inorganic material such as oils, greases, paper, fiber, rags, wood, coal dust, solvents, weld slag, rust, sand, and dirt, which if not removed is not acceptable for the required service or result in a unacceptable product purity
Contractor	Company Contracted to perform all or part of the works

1.3 Applicable Codes and Standards

1.3.1 Industry Codes and Standards

Not applicable.

1.3.2 Associated Air Liquid Documents

W-GS-4-0-1	Cleaning and Cleanliness of Equipment and Piping
E-EP-19-3-1	Internal Treatment Choice for Piping Cleaning Prior Construction
E-FRM-9-5-8	Piping Works Test Pack
E-GS-9-0-15	Management Of The Material On Site
E-GS-9-5-1	Prefabrication and Installation of piping

1.4 Conflicts, Omissions and Alternatives

1.4.1 In case of conflicting requirements between this specification and applicable requirements of the documents listed in section 1.3, the more stringent shall apply.

1.4.2 In case of conflicting requirements, the following items govern in descending order of precedence.

a. Agreements outlined in mutually approved minutes of review meetings subsequent to the issuance of the Purchase Order

b. Purchase Order and subsequent related correspondence

c. Project specific addenda

d. This specification and accompanying documents listed in 1.3.2.

e. Any exceptions, deviations, omissions, or alternatives to the requirements shall be submitted for Purchaser's approval prior to award of Purchase Order.

2 SAFETY AND ENVIRONMENT

2.1 Safety measures

The Contractor in charge of internal surface treatment shall work in compliance with local regulations including personnel safety and environment protection and the AIR LIQUIDE requirements defined in project documents.

The operators shall be informed and trained about specific risks. The MSDS shall be explained and available on site in a comprehensive language by the personnel. Recommendations described in MSDS shall be observed; Recommended PPE shall be worn, as well as exposure limits, storage and handling in accordance to the relative MSDS and any other safety instructions and regulation.

Nitrogen shall not be used in confined space area due to the risk of anoxia. A Work Permit shall be established when required.

2.2 Risk Analysis

A specific risk analysis shall be conducted by the Contractor using the relevant MSDS prior to the execution of any work. This risk analysis shall include at least:

a) Toxicity
b) Potential risk of inflammation or violent reaction (agents used can be volatile and/or flammable in air).
c) The compatibility of agents used with all materials, coming to contact

2.3 Protection of the environment

In the event of a leak or accidental discharge, the products must be immediately recovered after having covered them with inert absorbing material, which shall be kept in reserve in case of an emergency. If an emergency condition for discharge exists, all potential sources of ignition shall be identified and removed, the surrounding area shall be ventilated, and the personnel shall be evacuated. Only trained personnel wearing suitable protective clothing and equipment shall be allowed to enter the area to take control of the situation.

Effluents must be treated before disposal according to local regulation.

The Contractor is in charge of the wastes resulting from sand blasting. They are considered as special waste and shall be disposed of to a classified waste dump area in accordance with the local regulations.

Any acid or basic solution shall be neutralized before disposal.

Solvent containing less than 30% of impurities may be recycled either in the company or by a supplier. Solvents that cannot be recycled and sludge shall be incinerated in specialized centres. The exhaust gases and smoke emitted during the incineration of halogenated solvent needs to be treated.

For any complementary information about disposal, recycle and solvents incineration, the company shall consult competent local organisations.

Note: Disposal of any effluent is not allowed on the erection site.

The Contractor is in charge of safety measures and protection of the environment.

3 SPECIFIC REQUIREMENTS

3.1 Data required

The Contractor shall submit a detailed surface treatment procedure which shall at least include:

- The justification of the choice of the chemical products used in the surface treatment procedure
- Data related to the cleaning operations as mentioned hereunder
  - MSDS
  - Quantity of the products and utilities that would be used
  - Acid, base, inhibitor or detergent content in the products with the corresponding PH
  - Characteristic values of the loss of effectiveness of baths (in case of immersion)
  - Steps of surface treatment process in chronological order

  - Descriptions of each step involved describing the duration, methods, equipment, safety measures, and controls
- Specific PPE
- Treatment of effluents before disposal according to the local regulations
- Inspection methods and measures to preserve pipes cleanliness until its erection.

3.2 Chemical Products Selection and Surface Treatment Procedure

3.2.1 Chemical Products Selection

The procedure shall specify all chemical products selected by Contractor conforming to international and national regulations and shall be chosen taking into consideration the degree of contamination, the compatibility with different materials exposed to the products, the easy handling and safe use of the chemical products, service and treatments before disposal of effluents.

3.2.2 Procedure

The Contractor shall verify that its procedure complies with the Purchaser's requirements and the procedure shall be adapted as necessary to meet these requirements.

This procedure shall be submitted to the Purchaser with the MSDS of chemical products listed for comment one month prior to execution of internal surface treatment. The Purchaser may comment the procedure as necessary 15 days maximum after the procedure has been submitted by the Contractor. The procedure shall be updated based upon comments (if any) and then re-submitted to the Purchaser. The Contractor may consider the procedure for execution in case of no comment within 15 days after the procedure has been submitted or re-submitted. However, the procedure with or without comment does not exclude the Contractor from his responsibility and guaranty of results as per Purchaser's requirements for surface treatment and cleaning.

Unless otherwise specified by the Purchaser, all documents submitted by the Contractor to the Purchaser shall be in English language.

3.3 Surface treatment & Cleaning operations and controls

The Contractor shall:

- Provide qualified personnel, equipment, utilities and products that are necessary for the execution of the surface treatment and quality control
- Execute the surface treatments
- Change baths of chemical products when they are becoming less efficient (in case of immersion).
- Monitor the progress of chemical treatment and effectiveness of the chemical products (in particular those of additives as inhibitor) by analyzing the cleaning solutions (pH, dissolved compounds…)
- Re-clean the pipes that have been observed as unclean during an inspection
- Submit a new method of treatment or control if it is required by the Purchaser.
- Take necessary measures of protection, conditioning and storage to preserve cleanliness until the erection.

- Keep up to date inspection and acceptance certificates related to the implemented treatment as per Purchaser's requirements.

4 DEFINITION OF SERVICES AND SURFACE TREATMENT SELECTION

The lines are classified based upon services, which depend on the type of fluid, the temperature, the pressure, and compatibility with the various surface treatments.

The codification for surface treatment uses three digits as per E-EP-19-3-1:

XX-Y

The suitable surface treatment shall be reported in the list of lines (E-FRM-14-1-2 Lines list):

4.1 Applicable services

Digit XX: corresponding to different services:

Untreated Service: **NT**	This service consists of lines that do not require chemical surface treatment or sand blasting. These lines are cleaned through simple cleaning (flushing with clean and dry air) For this service, no treatment distinction is made according to the material This treatment should allow the removal, for example, of contaminants that by blocking small holes or causing moving parts to seize or through solidification at low temperatures may lead to dangerous malfunctions in the equipment
Oxygen Service: **SO**	This service requires complete degreasing The degreasing method depends on the material used (sand blasting, chemical treatment: passivation, degreasing using a water based cleaning agent or solvent) This is necessary, for example, in lines containing more than 23.5% oxygen as organic substances may react violently with oxygen
Machine Service:**SM**	This service consists of pipes for which there is a risk of damage to the equipment downstream following the eroding of the metal through the propulsion, at high speeds, of certain contaminants such as metal particles or chips The possible treatments for this service are grid blasting or chemical treatment and passivation
CO & Steam Services: **NP**	This service includes lines: • whose service is incompatible with a passivation layer (for example, CO lines, because in the presence of iron oxides carbon monoxide breaks down into carbon dioxide and carbon deposit) • For which passivation is pointless (for example: steam import/export lines)

4.2 Concerned materials

Digit Y: corresponding to metallic materials

- I: Stainless steel
- C: Carbon steel
- A: Aluminium
- M: Monel or Inconel

If Y is not referred to, the implementation of the associated treatment is the same for the three types of material. This is the case for the NT service.

As an Example: “SM-I” is used for a stainless steel pipe used for engine service.

5 METHODS FOR SURFACE TREATMENT:

The surface treatments shall be chemical or mechanical.

Chemical surface treatments are applied in three different methods (Not exhaustive):

- Immersion: Surface treatment using Immersion method is achieved when pipes and fittings are immersed into water based Acid or Alkaline solution, for certain duration to achieve the desired treatment. The choice of solution shall be compatible to the materials subjected to the surface treatment.
- Circulation: in this method surface treatment is achieved by circulating chemical product into the pipes either by a closed/ or open loop, until the desired surface treatment is achieved. Regular inspection of circulated liquid is needed to assure its effectiveness. Care must be given to the compatibility of the liquid with pipes and more specifically with the used gaskets.
- Injection: in this method chemical product is sprayed on pipes and fittings, with enough pressure to favor the removal and dissolving of undesired surface materials.

Mechanical surface treatments can be:

- Soft treatment.
- Grid Blasting / Sandblasting
- Using brushing mechanical tools.

The surface treatment procedure may include a combination of different ways to achieve the final treatment level following paragraph 4.

5.1 Chemical Surface Treatment

5.1.1 Acid Pickling:

Principle

Pickling is a chemical attack using an aqueous solution which allows eliminating from the metal surface any carbon deposits, oxides, residuals of thermal treatment or welding material.

Pickling shall be carried out only on carbon steel pipes. Pipes may be pickled with solution that can contain sulfuric acid, hydrochloric acid.

Implementation

- Concentration in acid must be between 5 and 50%.
- Inhibitors must be added to acid solution to avoid an excessive corrosion attack of the metal. The percentage of the inhibitor added to the solution shall be directly proportional to the increase of temperature
- The ferric ion (Fe^{3+}) content and the pH shall be monitored every hours during the execution of pickling
- After pickling, spool pipes are rinsed and subjected to the neutralization process for removal of any acidic traces that would damage the metal

Precautions

- Do not carry out agitation of a bath filled with an acid solution by injecting compressed air to avoid any risk of explosion.
- The Contractor shall ensure that PPE, which are proven worthy for the risks involved while handling the agents shall be worn by all the personnel in charge of the execution of the surface treatment

5.1.2 Passivation:

Principle

This surface treatment with sodium nitrite or phosphoric acid being used most often provides a temporary white gleaming corrosion protection layer on the pickled surfaces.

Precautions

- The passivated layer is not compatible with carbon monoxide
- Any blackish deposits left on the surface which are slightly sticky to touch, shows an indication that draining after the passivation has been incomplete.
- If grinding has to be carried out to eliminate a defect, it shall be performed using a smooth abrasive tool with fine grains to obtain a surface finish similar to the surface roughness of the pipe.
- Ferric ion content in the passivating solution must be lesser than 5g/l.

5.2 Mechanical Surface Treatment:

5.2.1 Soft Treatment:

Principle

This process includes cleaning by hands by means of rubbing, wiping and brushing the surface of pipe.

Advantages

- This method is easy to carry out.

It allows removing stains observed during a control test.

Drawbacks

- Surfaces that are to be cleaned must be accessible.
- Low productivity

Precautions

Any wire brushes previously used on carbon steel mustn't be used on stainless steel surfaces.

Wire brushes manufactured from non-ferrous wire must be used.

Wire brushes shall not be used on aluminum.

Verification check for any leftovers of the metal wires from the brush shall be done

Implementation

- Surfaces to be cleaned must be accessible by a brush or a wipe and an aspergillum may be used in the case of small diameter.
- Hand cleaning may be improved by adding solvent or detergent solution on the wipe. Then, drying shall be done after elimination of solvent or detergent solution and rinsing by wiping with a dry clean white lint-free wipe.

5.2.2 Sand / Grid blasting:

Principle

This mechanical treatment may be described as the use of abrasives (sand SA 2.5, grit, or glass) sprayed with the appropriate apparatus against the surface of pipe by means of compressed dry air or water.

Advantages

- This method helps in removal of varnish, paint or any solid undesired residues adhering to the surface of the pipe
- This method is useful for removal of mill scales, weld spatters and hydrocarbon deposits and in particular this method helps perform a better cleaning without depositing contaminants that cannot be removed by subsequent cleaning
- This treatment is an alternative to both degreasing and pickling
- It allows pipes to be internally and externally blasted in only one step, which means less of handling

- Grid blasting is a commercially viable method of cleaning if diameter of the pipes exceeds 4”

Drawbacks

Pipes must be submitted to a complete white light inspection.

Implementation

All carbon steel fittings must be grid sand blasted according to E.GS-9-5-1 to remove varnish and paint.

After blasting, the pipes must be blown with compressed oil free dry air to remove sand or grid that has remained on the surface of pipes.

Grid blasting shall be carried out in better temperature conditions and humidity (temperature exceeding 10°C and relative humidity below 70%).

Precautions

- This cleaning method shall not be used on the surfaces that cannot be seen visually.
- Sandblasting requires the implementation of a protective method to avoid the dispersal of sand blasting materials
- It is necessary to take care not to erode or significantly reduce the wall thickness of spools that have elbows, tees or any other piping component. In case of doubt a thickness test can be performed using UT. .
- This treatment must not be applied for stainless steel or aluminum surfaces.
- Caution Boards which mention: «FORBIDDEN ACCESS – GRIDBLASTING »shall be displayed.
- Mark out the work area (Ray of 10 m between the jet and the work area).
- The sand/grid injection shall work only with a manual action of the operator.
- Use flexible devices equipped with anti whipping cable.
- The power feed for TBT monitoring shall be less than 50 volts.
- Wear appropriate PPE (impermeable boiler suit, gloves with cuffs, boots with non-skid soles, helmet with eyeshade, anti noise device, coat of mail or leather apron).

5.3 Carbon Steel and Low Alloyed Steel Treatment:

Table 1: Treatment of carbon steel piping

	Service Type	**SO-C Oxygen Service**		**SM-C Machine Service**		**NP –C Non Passivated**	**NT Untreated**
	Cleaning Method	Grid Blasting (4)	Chemical Treatment	Grid Blasting	Chemical Treatment	Grid Blasting	Simple cleaning
Cleaning Operation							
Simple cleaning		No	Yes	No	Yes	No	Yes
Grid blasting		Yes	No	Yes	No	Yes	No
Air Blowing		Yes	No	Yes	No	Yes	No
Acid pickling		No	Yes	No	Yes	No	No
First water rinsing		Yes	Yes	No	Yes	No	No
Passivation		No	Yes	No	Yes	No	No
Second Water rinsing		No	Yes	No	Yes	No	No
Use of Degreasing Agent.		Yes	Yes	No	No	No	No
Fresh water rinsing		Yes	Yes	No	No	No	No
Drying		Yes(2)	Yes(2)	No	Yes(2)	No	Yes(3)
White light test		Yes(1)	Yes(1)	Yes	Yes	Yes	Yes
White wipe test		Yes(1)	Yes(1)	Yes	Yes	Yes	No
UV (wood) lamp test		Yes(1)	Yes(1)	No	No	No	No

(1) See W-GS-4-0-1.

(2) Drying may be done in open atmosphere if local ambient conditions are favorable and after the piping components have been totally drained to avoid any liquid retention.

(3) Drying is only needed when the simple cleaning is made with water flushing

(4) Grid blasting shall be used only when the surface of the piping requires a mechanical cleaning.

5.4 Stainless steel surface treatment:

Table 2: Treatment of stainless steel piping

	Service Type	OS-I Oxygen Service	NT-I Untreated
Cleaning Operation			
Simple cleaning		Yes	Yes
Use of Degreasing Agent		Yes	No
Hot water rinsing		Yes	No
Drying		Yes[(1)]	Yes [(3)]
White light test		Yes [(2)]	Yes
White wipe test		Yes [(2)]	No
UV (wood) lamp test		Yes [(2)]	No

[(1)] Drying may be done in open atmosphere if local ambient conditions are favorable and after the piping components have been totally drained to avoid any liquid retention

[(2)] See W-GS-4-0-1

[(3)] Drying is only needed when the simple cleaning is made with water flushing.

5.5 Aluminum Surface Treatment:

Table 3: Aluminum treatment

	Service Type	OS-I Oxygen Service	NT-I Untreated
Cleaning Operation			
Simple cleaning		Yes	Yes
Use of Degreasing Agent		Yes	No
Hot water rinsing		Yes	No
Drying		Yes[(1)]	Yes [(3)]
White light test		Yes [(2)]	Yes
White wipe test		Yes [(2)]	No
UV (wood) lamp test		Yes [(2)]	No

[(1)] Drying may be done in open atmosphere if local ambient conditions are favorable and after the piping components have been totally drained to avoid any liquid retention

[(2)] See W-GS-4-0-1

[(3)] Drying is only needed when the simple cleaning is made with water flushing.

WARNING: a specific attention shall be paid for the selection of suitable chemical products for surface treatment of aluminum as well as the corresponding procedure for the elimination of any residues.

6 CLEANING, CLEANLINESS CONTROL AND PRESERVATION

The final cleaning procedure and cleanliness control shall be selected and implemented according to W-GS-4-0-1.

7 STORAGE, HANDLING AND WORKING AREA

7.1 Storage and handling of piping components

- The storage area shall be located in closed premises protected against atmospheric influences, with a treated homogenous floor that is not susceptible to generate dust. The equipment is placed on supports (wood pallets or cradles)
- Stainless steel piping components storage shall be separated from carbon steel piping components
- Any piping component is kept in its protected or conditioned state during the entire storage time and during transportation, except during inspection. After inspection, the protections or conditioning are put back in place

- All handling shall be carried out with non-rigid straps or tools
- The cleanliness of handling tools is ensured

7.2 Working area

The working area shall be clean and organized in such a manner to prevent an accidental mix-up of clean and unclean parts. For this purpose, a separate surface, located at practical distance from other manufacturing operations, in particular welding operations, is required.

7.3 Storage of chemical products

Except during usage, the containers intended to receive solvents shall be closed and labeled. In the event of splitting up of packing, it is necessary to ensure with the suppliers of containers the compatibility between the product and its package and has to be relabeled.

Storage area of solvent containers shall be in accordance with the measures of prevention bellow:

- Efficient ventilation and protection from any source of heat or ignition (sun rays, flames, sparks...).
- Impermeable ground surface and forming retention dike, so that in the event of accidental discharge the liquid cannot be spread outside.
- Electric material used in the area adapted to potential risk of explosion and compliant with the applicable regulation
- Extinguisher(s), shower and a safety wash eye installed in the vicinity. The lanes must be sufficiently broad for the passage of people

To ensure a safe storage of solvent containers, it is required:

- To separate incompatible products
- To store full and upright packing
- Not to pile up on more than 2 heights
- To follow all other precautions mentioned ion MSDS's.

8 UTILITIES

The necessary utilities shall be listed by the Contractor.

Air used for purging and drying shall be as defined in 1.2. Air may be supplied by a dry air piping network or a dry compressor equipped with an efficient controlled oil demister system. The inspection of dry air supply is required by the Purchaser before the execution of the surface treatment.

The Contractor shall carry out a water analysis. The analysis report shall be attached to the procedure sent to Purchaser for comment. The characteristics of the water used for the surface treatment shall be as follow:

- For Stainless Steel cleaning: Halogenated ion (Cl, Br, F) < 25 ppm, with a temperature not exceeding 35°C, or 10 ppm for a temperature not exceeding 70°C
- For Aluminum or copper alloys cleaning: Nitrate ion < 12 ppm

- For aluminum, copper alloys, stainless steel and carbon steel: 6 < PH < 9

If the contractor wants to use water that does not comply with the characteristics mentioned above, an alternative may be submitted by contractor to Purchaser (such as a procedure of water purification). The contractor is allowed to implement the alternative if it has been accepted by writing by the representative of the site.

Table of Revisions

Section	Description
All	Content of the document reviewed and re-approved