

**Oxygen Clean (Class AA) Inspection and Acceptance Requirements**

**4WPI-SW70003**

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**RESPONSIBLE GROUP: Mechanical Engineering**

**Denotes Revision**

**1. PURPOSE**

- 1.1 This fabrication and erection specification defines criteria for the inspection, acceptance of cleanliness, and shipping preparation for piping and equipment classified as **Oxygen Clean (Class AA)**.

**2. SCOPE**

- 2.1 This specification applies to cleaning of equipment, piping, components and systems designed, owned, or operated by Air Products.
- 2.2 This specification is used along with a contract cleaning document that shows the required cleanliness level of the piping and equipment involved.

**3. RELATED DOCUMENTS**

**3.1 Air Products Engineering Documents**

660.500 Pictorial Representation of Allowable Rust  
4WCE-670200 Process Piping  
01.20.10 Selection of Cleaning Agents and Methods for Equipment Used in Oxygen Service

**3.2 American Society for Testing and Materials (ASTM)**

G 93 Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments

**3.3 Compressed Gas Association (CGA)**

G-4.1 Cleaning Equipment for Oxygen Service

**3.4 European Industrial Gases Association (EIGA)**

33 Cleaning of Equipment for Oxygen Service

**3.5 International Organization for Standardization (ISO)**

8501-1 Preparation of Steel Substrates before Application of Paints and Related Products-Visual Assessment of Surface Cleanliness

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#### 4. GENERAL

- 4.1 A surface will be considered to be oxygen clean if it has undergone a cleaning process that can be demonstrated to produce repeatable results that will satisfy the acceptance criteria in this specification.
- 4.2 When individual equipment item inspections for oxygen cleaning are not feasible or practical (for example, for mass produced or commodity items such as cylinders, valves, or gaskets), Air Products might require that the cleaning process successfully pass an audit to the acceptance criteria in this specification. Audits shall be conducted before first use and then periodically and whenever a cleaning process is changed.
- 4.3 Parts of assemblies shall be cleaned separately before assembling or fabricating renders any surface inaccessible for cleaning or inspection. Pipe and fittings shall be cleaned before starting fabrication.
- 4.4 The handling, storage, and use of all chemicals shall be according to guidelines contained in their Material Safety Data Sheets (MSDS). Used chemicals shall be disposed of in a lawful manner.
- 4.5 For additional information on cleaning methods, see CGA G-4.1, EIGA 33, and ASTM G 93.
- 4.6 Any cleaning agent shall be compatible with the materials of construction of the equipment being cleaned. Chloride-free cleaning agents shall be used for stainless steel equipment.
- 4.7 **If Detergent Cleaning is Used**
- 4.7.1 Mechanical input (for example, agitation, scrubbing, pressure washing) is usually necessary for detergent cleaning to be effective.
- 4.7.2 Since detergent residues are not compatible with oxygen, detergent washing must be followed by either thorough rinsing with potable water and thorough drying or by solvent cleaning.
- 4.7.3 For cases where this specification is being used by Air Products personnel for cleaning instruction, a list of acceptable detergents is detailed in Air Products EH&S document 01.20.10.
- 4.7.4 For cases where this specification is being used by third party contractor on behalf of Air Products, no specific detergents are mandated as long as appropriate concerns related to cleaning effectiveness, residue removal, and health effects are addressed by the third party contractor.
- 4.8 **If Solvent Cleaning is Used**
- 4.8.1 Proven methods of solvent cleaning include complete immersion, wiping with clean, lint-free rags saturated with solvent, partial filling and rolling (for piping), and vapor degreasing.
- 4.8.2 Cleaned parts must be free of residual solvent. If for any reason (for example, part geometry, solvent used, cleaning method) the solvent does not readily evaporate from any surface of any part, the part shall be purged with nitrogen [dew point -40°C (-40°F)] until all of the residual solvent has evaporated. If heat is used to help evaporate solvents, precautionary measures shall be taken to avoid damage to seals, gaskets, and other soft goods.
- 4.8.3 Soft goods that could be attacked by solvents shall be removed before cleaning, and then reinstalled after cleaning.
- 4.8.4 For cases where this specification is being used by Air Products personnel for cleaning instruction, a list of acceptable solvents is detailed in Air Products EH&S document 01.20.10.
- 4.8.5 For cases where this specification is being used by third party contractor on behalf of Air Products, no specific solvents are mandated as long as appropriate concerns related to cleaning effectiveness, residue removal, and health effects are addressed by the third party contractor.

#### 4.9 If Blast Cleaning is Used

- 4.9.1 The blast medium shall be <1% crystalline silica and hydrocarbon-free. Previously used grit shall not be reused.
- 4.9.2 The propellant shall be clean, dry, oil-free air or nitrogen, with a dew point of -40°C (-40°F).
- 4.9.3 After cleaning, blasted components shall be blown out with propellant to remove all particulates.
- 4.10 Pressure testing of assemblies, if performed after cleaning, shall be performed using filtered potable water (as required to maintain required cleanliness) or dry, oil-free air or nitrogen at ambient temperature. The degree of dryness of the pressure testing medium shall be sufficient to maintain established cleanliness. Equipment that is hydrostatically tested shall be thoroughly dried afterwards. Cleaning inspection and acceptance requirements will be applied after completion of the pressure test, unless waived by the Air Products representative. This can be done where the cleaning, assembly, inspection, and pneumatic pressure tests are closely monitored and inspected after test completion is deemed not necessary.

### 5. INSPECTION METHODS

#### 5.1 Inspection, Cleaning Validation

- 5.1.1 Inspection shall confirm that the piping or equipment has undergone a cleaning procedure that ensures that the components are acceptable for use in oxygen service.

#### 5.2 Inspection, Visual (Accessible surfaces)

**Note:** The inspection must meet **each** of the following **three** criteria unless otherwise agreed by the Air Products representative.

- 5.2.1 Inspection shall be visual under a bright, white light. Recommended light intensity is a minimum of 500 Lux (46.5 foot candles).
- 5.2.2 Inspection shall be visual under ultraviolet (UV) light. UV examination shall be performed in a dark room or under a hood such that no light other than the UV light is present. The UV light source shall be a mercury vapor or halide lamp with a suitable filter that provides light at wavelengths between 325 and 400 nm, with an intensity of at least 5.0 milliwatts per square centimeter at 30 centimeters. Fluorescent tubes are not acceptable.
- 5.2.3 Inspection shall be by wiping, and then visually inspecting the wipe medium under a bright, white light and UV light. The wipe test shall be applied after the bright, white and UV light examinations indicated above. Any areas that appear questionable by the bright, white or UV light techniques shall be wipe tested. In addition, at least one wipe test shall be performed on a representative section of surface examined according to paragraphs 5.2.1 and 5.2.2.
  - 5.2.3.1 Inspection shall be performed by wiping the test area with a clean, white, lint-free cloth; or clean, white, lint-free coffee filter paper. Use a new cloth or filter paper for each area examined. Approximate area to be covered with each wipe test is 0.1 square meters (one square foot). Subsequent examination of the cloths or filter papers under bright, white light and UV light shall confirm the surfaces conform to Section 6.

#### 5.3 Inspection by Wiping of Nonvisible Areas

- 5.3.1 If the surfaces cannot be inspected visually, but hand access is possible, the wipe test from paragraph 5.2.3 shall be used on the nonviewable areas. The coverage of this inspection shall be maximized to the greatest possible extent.

- 5.4 Inspection, Indirect** is required on the entirety of all surfaces that are not visible and not hand accessible. It consists of circulating clean solvent over the surface and then collecting and inspecting the solvent. The quantity of solvent shall be 1 liter per m<sup>2</sup> (10 ft<sup>2</sup>) of surface area.
- 5.4.1** All collected solvent shall be filtered through a clean filter paper, and the filter paper shall be inspected by visual examination.
- 5.4.2** A 100 ml sample of collected solvent shall be compared to a 100 ml control sample of clean solvent by visual bright white light and UV light examination.
- 5.4.3** A 20 ml sample of collected solvent shall be evaporated to dryness in a clean glass beaker. The residue in the beaker shall be inspected by UV light examination.
- 5.4.4** If laboratory analysis is specified, the total or weight of solvent used shall be recorded, as well as the surface area. A 500 ml sample of collected solvent is needed for laboratory analysis, as well as 500 ml of unused solvent.
- 5.5 Laboratory Analysis** is analysis of solvent collected through indirect inspection to determine the level of contaminant present on a surface (see Appendix A).

## **6. ACCEPTANCE CRITERIA**

### **6.1 Bright, White Light Inspection of components shall indicate:**

- 6.1.1** No moisture.
- 6.1.2** No cleaning agents. Particular care shall be taken to ensure that no residuals of cleaning agents are left in dead ends or low spots of the system.
- 6.1.3** No corrosion, scale, particulate matter, weld spatter, flux residue from welding or brazing, cutting chips or foreign material such as sand or site debris. In general, it is intended that "If you can easily see the particle, the surface is not clean enough."
- 6.1.4** No paint, crayon, or mill lacquer (unless painted surfaces are required by the job specification).
- 6.1.5** No hydrocarbon or organic material such as oil, grease, nonapproved adhesives and sealants. Oxygen-compatible halocarbon lubricants are acceptable only if they are approved in writing by Air Products. Excessive accumulations of oxygen compatible lubricants shall also be avoided.

### **6.2 Visual inspection of surfaces under UV light shall show:**

- 6.2.1** No evidence of hydrocarbon fluorescence or significant quantities of textile fibers [greater than 75 particles per 0.1 square meter (1 square foot)]. Areas of low intensity fluorescence must be re-examined visually and with a wipe test to determine acceptability. Certain materials such as some metal oxides, lint, and Oakite 444 fluoresce to a limited degree, but are not harmful for Class AA cleanliness. Repeated examination and wiping should establish whether the questionable material is innocuous and can remain or is harmful and must be removed. (Some small fibers may resist repeated cleaning and continue to fluoresce under UV light. Such a case shall be referred to the Air Products inspector.)
- 6.2.2** Not all contaminants fluoresce under UV light. It might be necessary to determine the nature of the contaminants likely to be present by virtue of the manufacturing or finishing processes and perform control tests to determine whether such contaminants are detectable by UV light. If they are not detectable, other methods (for example, laboratory tests) must be used.

### **6.3 Visual inspection by wipe test shall show:**

- 6.3.1** No particles of any size or discoloration of the wiping medium, except that caused by oxidation of the parent metal (that is, rust "blush," gray or black aluminum oxide, or oxides of copper). Surfaces of cast iron may also discolor the wiping medium because of the carbon element of cast iron.

6.3.2 No evidence of oily residue on the wiping medium.

#### 6.4 Indirect Inspection

6.4.1 Residues collected on filter paper from a test of inaccessible surfaces (see paragraph 5.4) shall be examined under a bright, white light and shall indicate no accumulation of visible particles. The surface of the wiping medium in contact with the solvent shall not be discolored, nor shall it fluoresce.

6.4.2 If laboratory analysis is the method of choice for a specific project, a level of 200 mg/m<sup>2</sup> (20 mg/ft<sup>2</sup>) is considered an acceptable maximum for oil films (See Appendix A).

#### 6.5 Pictorial Standards

6.5.1 The interior of newly cleaned carbon steel or alloy pipe and equipment shall meet the minimum requirements of the pictorial standard of ISO 8501-1, B Sa 2.

6.5.2 There shall be no rust in excess of that shown in Air Products specification 660.500 before installation of the component.

### 7. POST CLEANING PROTECTION AND PRESERVATION

7.1 Immediately after acceptance, all equipment, piping, and component openings shall be provided with durable, weather-tight seals such as commercially available plastic pipe caps or plugs to prevent contamination.

7.2 Flange faces shall be protected from contamination and damage that might result from handling and shipping. This may be accomplished by affixing a commercially available flange protector, placing a 0.1 mm (4 mil) polyethylene bag over the flange (provided that the outer surface of the flange is clean), and sealing the bag to the pipe with tape. When there is potential for the bag to be damaged during shipping, handling, or storage, flanges shall be fitted with bolted, 3 mm (1/8 in) thick metal covers with rubber gaskets.

7.3 No tape or other adhesive shall be applied to any cleaned surface, including flange faces.

7.4 All items used to seal openings shall be as clean as the item being sealed.

7.5 Small items may be sealed in 0.1 mm (4 mil) thick polyethylene bags. Each item shall be individually bagged. Bagging and packing shall be such that all identifying marks on the item or affixed to the item (for example, manufacturer's part numbers, serial numbers, lot or heat numbers, Air Products' tag numbers, purchase order numbers) can be read without opening the sealed bag.

7.6 Items that might rust if left exposed to the atmosphere shall, if practical, be purged of atmospheric air and pressurized with nitrogen [dew point -40°C (-40°F)] to 0.07 bar g (1 psig) immediately after acceptance. If dry, oil-free nitrogen is not available or not permitted by the supplier for safety reasons (for example, asphyxiant hazard), dry, oil-free air may be used if the dew point can be guaranteed to be less than -40°C (-40°F). All openings (depending on the connection type) shall be sealed with welded pipe caps/blanks, threaded plugs, or blind flanges to hold the pressure. The item shall be clearly identified as being pressurized with the pressurization medium also noted.

7.7 To minimize rerusting and with the written approval of Air Products, carbon steel equipment may be treated with Oakite NRP, a rust preventative for steel (see 4WCE-670200 for details).

- 7.8 Items that might rust that cannot be pressurized shall be bagged or otherwise sealed to prevent the entry of atmospheric air and shall contain packets of silica gel, activated alumina, or a similar moisture-adsorbing agent secured inside the item preferably attached to shipping blanks (if possible). The adsorbents shall contain a color indicator. Packets shall be connected in groups so they can be removed together. The item shall be clearly labeled as containing moisture adsorbents, and the number of packets and their location shall be stated.

**Exception:** Adsorption packets are **not** required for packaged, control or manual valves.

## 8. TAGGING

- 8.1 In addition to the tagging required in Section 7, equipment and components cleaned according to this specification shall be tagged as follows:

<b>OXYGEN CLEAN CLASS AA</b>	
Supplier: _____	Date: _____
By: _____	
<b>KEEP SEALED UNTIL REQUIRED FOR USE</b>	

## 9. SUMMARY

9.1 An abbreviated summary of Class AA Cleaning is in Table 1 of this specification.

**Table 1**  
**Abbreviated Summary**

	<b>Comments</b>
<b>Inspection Methods</b>	
Bright White Light	
Ultraviolet (UV) Light	
Wipe Test	
Solvent Flush	Inaccessible surfaces only.
<b>Acceptance Criteria</b>	
No Moisture	
No Clean Agent/Flux Residue	
No Loose Rust, Scale, Foreign Material, Weld Spatter, Cutting Chips, etc.	
No Adherent Rust, Scale, Foreign Material, etc.	See 660.500
No Oil, Grease, Hydrocarbons, Paint	
No Fluorescence Under ULTRAVIOLET (UV) Light	
ISO 8501-1/B Sa 2	Applies to ferrous material only
Rust Allowed per 660.500	Applies to ferrous material only
<b>Protection</b>	
Closures/Caps/Protection/Individual Bagging	
Purge or Silica Gel or Equal	Applies to ferrous material only
Inhibitor per Air Products Specification 4WCE-670200	Applies to ferrous material that is likely to rust.
<b>Tagging</b>	
Protection and Preservation Labels	
Cleaning Level-Oxygen Clean (Class AA)	

**Note:** See text for full explanation of cleaning requirements.

## Appendix A

### Laboratory Analysis of Contaminated Solvent

#### A1. PREPARATION

A1.1 Clean and weigh each of two glass laboratory sample beakers.

#### A2. PROCEDURE: CONTROL SAMPLE

A2.1 Decant 500 ml of unused solvent into a beaker.

A2.2 Evaporate the control sample to dryness and reweigh the beaker. Using the original weight of the clean beaker, calculate the weight of the residue for the control sample, denoted  $m_1$ .

#### A3. PROCEDURE: CONTAMINATED SAMPLE

A3.1 Decant 500 ml of the solvent collected from the cleaned surface into a beaker.

A3.2 Weigh the beaker and solvent. Using the original weight of the clean beaker, calculate the weight of the contaminated sample, denoted  $M_s$ .

A3.3 Evaporate the contaminated sample to dryness and reweigh the beaker. Using the original weight of the clean beaker, calculate the weight of the residue for the contaminated sample, denoted  $m_2$ .

#### A4. CALCULATION OF CONTAMINANT LEVEL

A4.1 The contaminant level  $L_c$  is calculated as

$$L_c = M_T ( m_2 - m_1 ) / ( M_s A )$$

where

- $L_c$  = weight of contaminant per unit area, mg/m<sup>2</sup>
- $M_T$  = total weight of solvent circulated over the surface, mg
- $m_2$  = weight of residue, contaminated sample, mg
- $m_1$  = weight of residue, control sample, mg
- $M_s$  = weight of contaminated sample, mg
- $A$  = surface area over which the solvent was circulated, m<sup>2</sup>

#### A5. ACCEPTANCE CRITERION

A5.1  $L_c$  shall **not** exceed 200 mg/m<sup>2</sup>.

#### [Basic Considerations](#)