

Manufacturing Capabilities

Air Products is the worldwide leading supplier of gases to the electronics industry. We earned this reputation as performance leader because of our proven ability to respond effectively to the needs of our customers. Our unmatched experience and technical expertise have enabled us to become a full line supplier of:

- Specialty, bulk, pipeline, and on-site gases.
- Gas-to-Chemical Generation (GCG) Systems.
- GASGUARD® Gas Cabinets, valve manifold boxes, and purge panels.
- GASGUARD® Bulk Specialty Gas Supply Systems.
- MEGASYS™ Materials Management Systems.
- QMAC® Plus gas monitoring and control systems.
- MEGASYS Total Gas and Chemical Management Systems.
- Analytical testing, engineering, and technical support.
- Consulting, safety training, and emergency response.

Air Products offers customers total support for process optimization. Device manufacturers and key process tool manufacturers have qualified Air Products as their total gas system supplier to achieve consistently reliable structures, maximum yield, and superior machine utilization. The system includes Manufacturing Capabilities, Process Gas System Expertise, and Technical Support.

Manufacturing and Purification

Air Products currently provides over 80 distinct specialty gases in a variety of purities and packages throughout the world. We offer the world's largest direct fluorination product line that provides higher purities than gases made by indirect methods. In addition to our proprietary fluorine technology, we have developed technology for advanced purification. Vendor alliances are continuously established to supply the highest obtainable purity found throughout the world. Please refer to the Pure Gases section of this catalog for a complete description of products, grades, and specifications.

Our specialty gas facility in Tamaqua, Pennsylvania is certified to the ISO 9002 quality management systems standard by Lloyd's Register of Quality Assurance (LRQA). The certification covers the manufacture of all specialty gases at the plant and selected administration systems, including auditing, contract review, purchasing, and shipping. Specifically, the certification covers 43 plant processes and more than 1,800 documented procedures and work instructions.

UHP Packaging Cylinder Policy

Air Products ensures the purity of your specialty gases during storage, transportation, and usage with Generation I internal cylinder treatment and Class I external packaging. Air Products' cylinder policy is designed to provide a safe, inert, noncontaminating cylinder package. We combine specific cylinder treatments with appropriate materials of construction. Our cylinder packages minimize metallic, particle, and chemical impurities. We provide cylinders constructed of steel, aluminum, nickel, and stainless steel which are tailored to specific requirements.

Steel

We have developed surface treatments and cylinder preparation techniques that result in high-purity steel packages which are comparable to aluminum and stainless steel in surface smoothness, off-gassing, and particle measurements. Steel cylinders are readily available, safe, and very economical. All specialty gases are available in steel cylinders.

Aluminum

Many inert and noncorrosive gases are available in aluminum cylinders. Our policy involving gases that are packaged in aluminum is based on concerns related to potential neck and shoulder cracking, heat sensitivity, and incompatibility with certain products. Ammonia, argon, halocarbon-23, halocarbon-116, helium, hydrogen, nitrogen, nitrous oxide, and tetrafluoromethane are available in aluminum cylinders.

Nickel

These low-pressure cylinders offer significant reduction in metallic and particulate contamination for reactive, low-pressure gases. Hydrogen fluoride and tungsten hexafluoride are available in nickel cylinders.

Stainless Steel

Air Products offers stainless steel cylinders for certain products. Our metallurgy department has investigated stainless steel compatibility with corrosive halides. Corrosion tests determined that chrome-molybdenum steel and stainless steel have approximately the same corrosion rates in HCl. Packaging of other corrosive products in stainless steel cylinders requires a case-by-case evaluation. Silicon tetrachloride is available in a stainless steel cylinder.

Refer to page 8 in the General Information section for a complete list of cylinders and their specifications.

Generation I Internal Cylinder Treatment

Air Products has developed internal cylinder treatments that reduce cylinder-contributed microcontamination and increase shelf life. Generation I Internal Cylinder Treatment is standard for all MEGAClass™ and VLSI grade gases and is available for some ELECTRONIC grade gases.

This procedure involves a thorough quality control program that begins with cylinder manufacturers and carries through to customer delivery. Inspections with gauges, boroscopes, and the scanning electron microscope, in addition to surface, particle, and moisture analyses, ensure cylinder performance. The Generation I internal cylinder treatment process consists of the following steps:

1. Selection and inspection of cylinder.
2. Chemical polishing of internal cylinder walls.
3. Rinsing with solvent and de-ionized water.
4. Drying with hot nitrogen.
5. Valve cleaning and assembly in a clean room.
6. Valving under a laminar hood.
7. Baking, purging, and evacuation with clean vacuum and high-purity inert gases.
8. Analytical confirmation and final inspection.

Manufacturing Capabilities *Continued*

Quality Cylinder Packaging

Our commitment to quality also extends to product packaging. Air Products introduced Quality Cylinder Packaging as a standard for our electronic grades of Specialty Gases. Quality Cylinder Packaging is designed to protect the cylinder's exterior during storage and transport. This prevents contamination of valve outlets and threads. Before each cylinder is shipped, it is leak checked and subjected to final inspection.

The following cylinder and valve preparation procedures constitute Quality Cylinder Packaging:

1. Paint and labels applied.
2. Plastic netting on the cylinder.
3. Valve cleaned and inspected.
4. Valve outlet cleanliness verified.
5. Valve outlet cap installed with a new gasket where applicable.
6. Leak integrity of the package verified.
7. High-quality cylinder cap attached.
8. Quality of overall cylinder appearance confirmed.

Package quality is verified and controlled throughout the entire production process.

Valve Policy

General

Air Products tied-diaphragm cylinder valves are high-quality, high-integrity components designed to meet the demanding needs of the electronics industry.

Standard offerings include:

- CGA and DISS (Diameter Index Safety System) outlets
- Manually or pneumatically actuated valves
- Materials of construction – 316L stainless steel, Hastelloy, Nickel 200, and Monel (ClF₃)

Extensive valve testing has permitted Air Products to be in a leadership role with valve designs that meet industry needs. Testing includes: product compatibility, particle generation, abuse testing, failure mode analysis, cycle testing, and corrosion-resistance testing. Joint developments with our customers and valve manufacturers have enabled us to establish ourselves as a market leader in cylinder package technology.

At any time should you have a specific need, we'll have the specific solution.

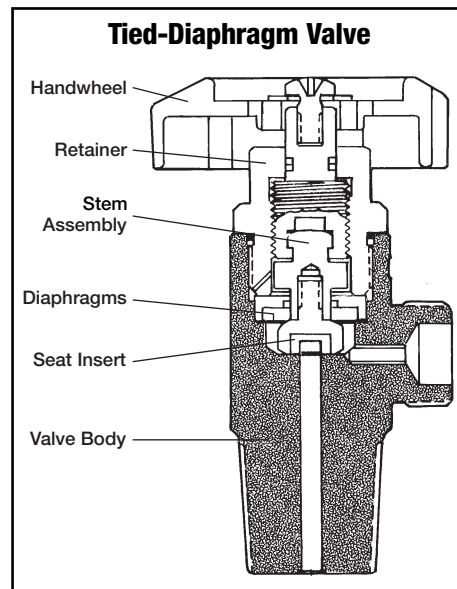
Leak Integrity

When leak integrity is a concern or a requirement, DISS (Diameter Index Safety System) outlet valves achieve the goal. DISS outlet valves meet the requirements of the Compressed Gas Association (CGA) pamphlet V-1, with leak rates to be less than 1X 10E-09 scc (He)/sec inboard and less than 1X 10E-07 scc (He)/sec at 2,000 psig Helium outboard, when the connection is tightened to 35 ft-lb. When leak integrity is of a lesser concern, standard CGA connections can be utilized. The leak-rate specification for a standard CGA connection is less than 1X 10E-04 scc (He)/sec outboard at 2,000 psig when the connection is assembled to the requirements of CGA Technical Bulletin, "Torque Guides for Sealing CGA Outlet Connections."

Valve Stewardship

Valve stewardship is an important requirement of Air Products' commitment to the electronics industry. Valves can account for a large portion of the preparation costs associated with an electronic package. Ensuring that valves are fit for use and reuse is in the best interest of all parties. Just as you expect a clean, pristine, functional valve at your location, Air Products requires that returned packages meet the same standards. The condition of returned valves is a shared responsibility between the customer and Air Products. Inspection of the cylinder valve at the time of removal from the customer's process usually ensures that the interests of both parties are met.

Air Products can help with any and all of your valve stewardship concerns.



Analytical Verification

Air Products maintains a comprehensive Quality Assurance program to ensure the purity and consistency requirements of the electronics industry. Statistical Quality Control is an integral part of the Air Products quality process. Actual batch analytical data is extracted, and the mean, standard deviation, and other statistics for each analyzed impurity are calculated. Our Laboratory Information Management System (LIMS) enables our chemists to automatically qualify specialty gases to meet guaranteed specifications and provide the analytical results for certification.

Our goal is to provide our customers with the highest purity specifications backed by statistical data. For further evaluation and control of product consistency, we have implemented SQC/SPC in production areas in the analytical laboratory and in the traceability, bar coding, internal cylinder preparation, and external cylinder packaging.

Manufacturing Capabilities *Continued*

Specification Policy

Air Products believes that customers need accurate information in order to compare products and make appropriate purchasing decisions. Specialty gas purities documented in this catalog reflect guaranteed specification limits as opposed to typical levels. These guaranteed specifications are based on a statistical analysis of analytical data. They represent the maximum impurity concentrations at a 99.7% confidence level (mean + 3 sigma).

The guaranteed specifications reflect a conservative purity level since the statistical analysis includes the analytical detection limit for impurities which fall below the range of detection. This skews the distribution curve, making statistical analysis difficult. Analytical development is a major focus. Our goal is to characterize specialty gas products by reducing analytical detection limits.

Another goal of Air Products is to provide representative analysis of all gases. Analysis of impurities is done in the phase where they exist at the greatest concentration. Inerts are measured in the vapor phase; metals are measured in the liquid phase. Molar ppm is used unless otherwise indicated. A Certificate of Conformance can be provided which guarantees that Air Products meets the published purity. Likewise, but with an additional charge, a Certificate of Analysis can also be provided which shows the actual cylinder analysis obtained for each impurity that is specified.

Air Products will, upon request, supply a Certificate of Analysis for certain impurities not specified in this catalog.

Worldwide Delivery

Air Products provides the highest purity gases to customers located across all continents, including 30 countries around the world. The Consolidated Customer Service System enables our representatives to schedule deliveries specific to your needs. Over 200 worldwide local stocking locations help enable us to provide timely delivery, which reduces your cost of inventory. Current inventory and alternate sourcing data, cylinder tracking capabilities, and on-

Electronic Specialty Gas Cylinder Valve Matrix

Product	Valve Outlet CGA	Valve Outlet DISS	Recommended RFO
Ammonia	660	720	0.04"
Argon	580	718	NA (Std)
Arsine	350	632	0.01" (Std)
Boron Trichloride	660	634	0.16"
Boron Trifluoride	330	642	0.04"
Chlorine	660	634 or 728	0.04"
Chlorine Trifluoride	670	728	
Diborane	350	632	0.01" (Std)
Dichlorosilane	678	636	0.16"
Disilane	350	632	0.01" (Std)
Halocarbon-23	660	716	NA
Halocarbon-116	660	716	NA
Helium	580	718	NA (Std)
Hydrogen	350	724	0.01"
Hydrogen Bromide	330	634	0.04"
Hydrogen Chloride	330	634	0.04"
Hydrogen Fluoride	670	638	0.16"
Nitrogen	580	718	NA (Std)
Nitrogen Trifluoride	330	640	0.01"
Nitrous Oxide	326	712	0.01"
Octafluoropropane	660	716	NA
Phosphine	350	632	0.01" (Std)
Silane	350	632	0.01"
Silicon Tetrafluoride	330	642	0.04"
Sulfur Hexafluoride	590	716	NA
Tetrafluoromethane	580 or 320	716	NA
Tungsten Hexafluoride*	670	638	0.16"

The above restrictive flow orifice (RFO) sizes are the recommended minimum sizes for each product where the RFO is required. For the inert gases it is our standard policy that an RFO is not needed. Some products have a standard RFO size that is offered, and for other products an RFO is not applicable. The correct size should be based on the following: quantity and nature of the product, vapor pressure, local ordinances, ventilation of the area, and scrubber capacity.

*Halocarbon-14

Available Standard RFO Sizes		
0.006 in. (0.15 mm)	0.01 in. (0.25 mm)	0.02 in. (0.5 mm)
0.03 in. (0.75 mm)	0.04 in. (1.0 mm)	0.16 in. (4.0 mm)

line customer profile information are available to meet your requirements. Our computerized scheduling system, fully trained operators of our own distribution fleet, and our network of production and stocking locations have enabled Air Products to offer state-of-the-art delivery through a worldwide distribution network.