Global Specialty Gas Solutions
WHY INDUSTRY LEADERS CHOOSE PRAXAIR


These are among the many reasons businesses like you choose Praxair as their Specialty Gases supplier.

More than just an established leader in the manufacture and distribution of atmospheric, process, and specialty gases and equipment – Praxair helps customers maximize their economic performance while minimizing their environmental impact.

That has been our focus and track record for over 100 years.

In fact, in the recent past more than 20% of Praxair’s annual revenue was generated by applications technologies that help customers reduce operating costs, increase process efficiencies and improve their environmental performance.

It’s how Praxair, Inc. has become a Fortune 250 company, the largest industrial gas company in North and South America, and one of the largest worldwide.

This handbook provides information about Praxair’s Specialty Gases, equipment, and capabilities – including descriptions of how our pure and mixture gases have helped customers work more productively and sustainably.

We invite you to have a look.
ProSpec by Praxair is not simply a line of the highest quality specialty gases, equipment and services – it is a way of supporting your business and helping to ensure your success. Backed by the global infrastructure of Praxair, and the industry-leading experience and technical expertise of our teams, ProSpec by Praxair is all about meeting the most demanding requirements of customers like you.

Quality
With ProSpec by Praxair you can expect the highest quality pure gases and mixtures produced to the most ambitious environmental standards – complemented by an extensive line of gas handling and delivery equipment as well as a broad range of services. The result: a complete product supply solution for your business.

Innovation
ProSpec by Praxair are new technologies, products and offerings, designed to meet your specific technical and regulatory requirements. This helps enhance your opportunity to increase productivity while decreasing environmental impact.

Reliability
This is about breadth and depth. Our wide-ranging global locations offer responsive customer service coverage while our deep product offerings and distribution capability ensure fast, cost-effective delivery. We provide product via common carriers, express carriers, and our own exclusive delivery systems. In short, we do whatever it takes.

Support
Our regional centers – staffed with highly trained product chemists, technical service personnel, and field sales representatives – provide answers to your questions and can assist you in meeting any regulatory, technical, and safety requirements. We not only stand behind our products, we help you.

Coverage
ProSpec by Praxair is offered everywhere we are. For us, that means in 50 countries. For you it means world-class products, services, and peace-of-mind.
<table>
<thead>
<tr>
<th>Laboratory analysis</th>
<th>Storage and Supply</th>
<th>Cylinder Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control panel</td>
<td>6. Oxygen deficiency sensor</td>
<td>15. CO₂ Heaters</td>
</tr>
<tr>
<td></td>
<td>11. Portable cryogenic tanks</td>
<td>20. Gas supply systems</td>
</tr>
<tr>
<td></td>
<td>13. Dry ice containers</td>
<td>22. Portable gas detection monitors</td>
</tr>
<tr>
<td></td>
<td>14. Refrigerators for samples control</td>
<td>23. Cylinder trolley</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24. Air Compressor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25. Membrane nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26. Fixed gas detection monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27. Gas purifiers and filters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28. EPA protocol gas station</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29. Gas piping and connections</td>
</tr>
</tbody>
</table>

www.praxair.com
Pure Gases

With over 50 Pure Gases in more than 170 grades, whether in liquid, cryogenic, or compressed gas form, Specialty Gases cover a wide range of products and applications. Whether you need sulfur hexafluoride (SF₆) for electric transmission power insulation, hydrogen sulfide (H₂S) for sour gas testing, hydrogen chloride (HCl) for cotton seed delinting, or hydrocarbon mixtures for stove testing, Praxair can supply you with any of your Specialty Gases product needs.

**Readily Available Gas List**

<table>
<thead>
<tr>
<th>Acetylene</th>
<th>Deuterium</th>
<th>134A</th>
<th>Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Diborane</td>
<td>218</td>
<td>Nitrogen Dioxide</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Dichlorosilane</td>
<td>C318</td>
<td>Nitrogen Trifluoride</td>
</tr>
<tr>
<td>Argon</td>
<td>Dimethyl Ether</td>
<td></td>
<td>Nitrous Oxide</td>
</tr>
<tr>
<td>Arsinic</td>
<td>Disilane</td>
<td></td>
<td>Oxygen</td>
</tr>
<tr>
<td>Boron Trichloride</td>
<td>Ethane</td>
<td></td>
<td>Hydrogen</td>
</tr>
<tr>
<td>Boron Trifluoride</td>
<td>Ethylene</td>
<td></td>
<td>Hydrogen Bromide</td>
</tr>
<tr>
<td>1,3 Butadiene</td>
<td>Ethylene Oxide</td>
<td></td>
<td>Hydrogen Chloride</td>
</tr>
<tr>
<td>n-Butane</td>
<td>Germane</td>
<td></td>
<td>Hydrogen Sulfide</td>
</tr>
<tr>
<td>1-Butene</td>
<td>Halocarbon</td>
<td></td>
<td>Isobutane</td>
</tr>
<tr>
<td>cis-2-Butene</td>
<td>14</td>
<td></td>
<td>Isobutylene</td>
</tr>
<tr>
<td>trans-2-Butene</td>
<td>22</td>
<td></td>
<td>Krypton</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>23</td>
<td></td>
<td>Methane</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>41</td>
<td></td>
<td>Methyl Chloride</td>
</tr>
<tr>
<td>Chlorine</td>
<td>116</td>
<td></td>
<td>Neon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nitric Oxide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nitrogen Oxide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen Bromide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen Chloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen Sulfide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Isobutane</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Isobutylene</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Krypton</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Methane</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Methyl Chloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nitric Oxide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nitrogen Oxide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen Bromide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen Chloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen Sulfide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Isobutane</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Isobutylene</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Krypton</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Methane</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Methyl Chloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nitric Oxide</td>
</tr>
</tbody>
</table>

*More gases available upon request.*

**Nomenclature and Purity**

Actual nomenclature will vary with difference in trade and grade names. One of the most important factors is the gas purity. While some products are defined by specific monikers such as UHP (Ultra High Purity) or Research grades, actual purity level can be represented in two ways and usually represents the minimum purity level in the product:

- As a quality code, e.g. 4.5 – where the number before the dot represents the number of nines and the last number indicates the last decimal:
  
  - 4.5 = 99.995%
  - 5.7 = 99.9997%
  - 6.0 = 99.9999%

- As purity in percent, e.g. > 99.9995%

This typically represents the minimum concentration of the actual gas. In the case of liquefied gases the purity always represents concentration in the liquid phase.

As, or sometimes even more, important than the purity grade are the impurities in the gas. Impurities usually result from the gas manufacturing process and, as such, vary by gas and gas products. In the product specifications, the maximum concentrations of the different known impurities are listed in percentage, parts per million (ppm), or parts per billion (ppb) either in function of relative moles, weight, or volume.
# Common Atmospheric Pure Gases

<table>
<thead>
<tr>
<th>Gases</th>
<th>Uses</th>
</tr>
</thead>
</table>
| Air            | - Zero Gas
|                |  - Oxidizer in flame detectors (FID, FDP, AA)
|                |  - Purge Gas
|                |  - Pneumatic Operation                                               |
| Argon          | - ICP, AA, GC
|                |  - Ar/CH₄ mixtures
|                |   - Nuclear Counters / ECD
|                |   - P-5 / P-10                                                       |
|                | - Purge Gas
|                |  - Inerting
|                |  - Gas Discharge Lamps
|                |   - Fluorescent                                                      |
| Carbon Dioxide | - Incubation Gas
|                |  - Biological Atmosphere                                             |
|                |  - Laser Gas                                                         |
|                |  - Detector Cooling                                                  |
| Helium         | - GC Carrier Gas                                                     |
|                |  - Inert atmosphere                                                  |
|                |  - Leak detection                                                    |
|                |  - Liquid Helium
|                |   - NMR, MRI, Superconductors                                        |
|                |   - Operate at Abs. Zero (-452 °Deg. F)                              |
| Hydrogen       | - Carbon free elemental gas                                          |
|                |  - Fuel gas in flame detectors
|                |   - FID, FPD, THC analyzers                                          |
|                |  - Carrier gas                                                       |
| Nitrogen       | - Purging and inerting                                               |
|                |  - Zero Gas                                                          |
|                |  - Carrier gas
|                |   - GC Mass Spec                                                      |
|                |  - Biological storage freezers                                        |
|                |  - Pre-cooling
|                |   - NMR                                                               |
|                |   - MRI                                                               |
|                |   - Superconductor                                                    |
A unique resource for unique applications.

Praxair is one of the industry leaders in Helium with a global presence. With over 25 helium specific patents and a comprehensive logistics system, Praxair can offer you a solution for all your helium needs.

- Pioneered Helium production
- Reliability of supplies is a priority
- Diversity of secured sources
- Re-investment in helium infrastructure
- Global Supply Chain management

<table>
<thead>
<tr>
<th>Properties</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Mass (“Lighter than Air”)</td>
<td>Lifting – blimps &amp; balloons</td>
</tr>
<tr>
<td>Smallest Atomic Radius</td>
<td>Leak detection</td>
</tr>
<tr>
<td>High Thermal Conductivity and Specific Heat</td>
<td>Chemical analyses, Plasmas, Welding</td>
</tr>
<tr>
<td>Lowest Boiling Point (Coldest Liquid)</td>
<td>Superconductivity (MRI, NMR, Physics)</td>
</tr>
<tr>
<td></td>
<td>Purge/pressurize cryogens</td>
</tr>
<tr>
<td></td>
<td>Low temperature science</td>
</tr>
</tbody>
</table>

**Praxair – A Fully Integrated Helium Supplier from Source to Customer**
Mixture manufacturing requires a careful development process to ensure accurate and stable content. Careful attention to raw materials, cylinders, and mixing techniques is required for every product.

**Raw material assay**
- All source gases are qualified to ensure quality and compliance with specifications.
- Impurities can affect performance or stability of the final mixture.
- Various purification techniques are used to remove impurities.
  - Entrapment (Molecular Sieve)
  - Moisture Absorption (Dryer)
  - Distillation Sparging

**Cylinder preparation**
Cylinder preparation varies based upon product specifications.
- Computer controlled heating, vacuum and purge cycles.
- For reactive gas mixtures, passivation may be used to deactivate surfaces. This helps eliminate unwanted residual moisture or oxygen.

**Blending techniques**

**Volumetric**
By partial pressure blending

**Gravimetric**
- By weight using precision scales
- Calibration using independent certified weights

**Dynamic**
- Instrument based blending
- High volume / same mixture

**Mixture homogenization**
Most common methods used to ensure gas mixture homogeneity include:
- Mechanical rolling
- Gas turbulence

**Analytical Instrumentation**
Full range of analytical instrumentation for certifying purity and mixture composition
- Gas chromatography with TCD, FID, ECD, FPD, PID, etc. detectors
- Non-Dispersive Infrared (NDIR) for CO, CO₂
- Process analyzers for O₂, H₂O, THC
- Chemiluminescence for NO, NO₂
- Fourier Transform Infrared (FTIR)
- Mass Spectroscopy

**Certification Documentation**

Type of Documents
- Certificate of Batch or Compliance: Batch Raw Materials Analysis
- Certificate of Conformity or Conformance: Batch Cylinder Analysis
- Certificate of Analysis (COA): Individual Cylinder Analysis
Gas Mixtures

**Mixture Grades**

Since most analytical methods are relative and not absolute, it is necessary to calibrate the analyzer with reference calibration mixtures standards of known composition and concentration to determine the quantitative content of the sample accurately. The requirements for a calibration gas are: accuracy, stability, and homogeneity. Several classes of mixtures are provided based on their certification and accuracy levels.

- Calibration mixtures with a traceability to metrological institutes and standards
  
  *Typically the highest level of certification available for any mixture.*
  
  - EPA Protocol Standard
  - NTRM (NIST Traceable Reference Material) standard
  - ISO 17025 accredited standard

- Calibration mixtures certified by gravimetric and laboratory quality controls:
  
  *Highly accurate mixtures analyzed against laboratory and metrological standards*
  
  - Primary Standard
  - Primary Master

- Calibration mixtures certified by laboratory analysis: *These other mixtures are typically mixed and analyzed based on customer or Praxair’s internal specifications*
  
  - Certified Gas Standard
  - Certified Liquid Standard
  - Certified Master
  - Dynamic Blend Master
  - Custom Mixtures

**Blend Tolerance and Uncertainty**

Blend tolerance specifies how close to the ordered concentration the produced mixture will be. The analytical uncertainty identifies the maximum deviation from the certified value that the actual blend mix can have.

Example: 5% minor component mixture. The reported value on the analytical certificate is 5.10% (within the 5% relative blend tolerance) with a certified accuracy between 5.00% and 5.20%.

<table>
<thead>
<tr>
<th>Example: Relative Value</th>
<th>Absolute Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blend Tolerance</td>
<td>± 5% of minor component</td>
</tr>
<tr>
<td>Analytical Uncertainty</td>
<td>± 2% minor component</td>
</tr>
</tbody>
</table>

**ISO 17025 and Guide 34 accredited standards**

Available in some regional offerings, the ISO 17025 international levels of certification are part of a detailed specific audit program to ensure a consistent quality audited by an external agency traceable to chemical reference standards of a metrological level.

Guide 34 sets out the management system requirements for the product reference materials and is intended to be used as part of a reference material producer’s general quality assurance (QA) procedures.
## Key Markets for Specialty Gases

<table>
<thead>
<tr>
<th>Market</th>
<th>Gases</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemical</strong></td>
<td>■ Process gases, environment mixtures, industrial hygiene</td>
<td>■ Production process</td>
</tr>
<tr>
<td></td>
<td>■ High purity 5.0-6.0, zero gases</td>
<td>■ Environmental monitoring</td>
</tr>
<tr>
<td></td>
<td>■ High purity liquids: Ar, N₂</td>
<td>■ Lab QA/QC</td>
</tr>
<tr>
<td><strong>Laboratories</strong></td>
<td>■ Instrument gases</td>
<td>■ Laboratory</td>
</tr>
<tr>
<td></td>
<td>■ High purity 5.0-6.0, zero gases</td>
<td>■ Special applications, ie environmental</td>
</tr>
<tr>
<td></td>
<td>■ High purity liquids: Ar, N₂</td>
<td></td>
</tr>
<tr>
<td><strong>Life Sciences</strong></td>
<td>■ Research mixtures, drug mixtures</td>
<td>■ Pharmaceutical drug / device production</td>
</tr>
<tr>
<td></td>
<td>■ High purity 5.0 – 6.0, zero gases</td>
<td>■ Lab QA / QC</td>
</tr>
<tr>
<td></td>
<td>■ High purity liquids: CO₂, N₂, Ar, O₂, HCL</td>
<td>■ Research</td>
</tr>
<tr>
<td></td>
<td>■ EP, JP, USP and NF grade gases, dry ice</td>
<td>■ Cord blood / stem cell preservation</td>
</tr>
<tr>
<td><strong>Lighting</strong></td>
<td>■ Krypton, Xenon, Neon, Mixtures</td>
<td>■ Fluorescent tubes</td>
</tr>
<tr>
<td></td>
<td>■ Specialty halogen lamps</td>
<td>■ High intensity discharge (HID) lamps</td>
</tr>
<tr>
<td><strong>Refining</strong></td>
<td>■ Protocols, environmental mixtures, VOC mixtures, industrial hygiene</td>
<td>■ Stack emissions</td>
</tr>
<tr>
<td></td>
<td>■ High purity 5.0 / 6.0, zero gases, microbulk</td>
<td>■ Process analysis</td>
</tr>
<tr>
<td></td>
<td>■ Disposables</td>
<td>■ QC / QA, lab gases</td>
</tr>
<tr>
<td><strong>Solar Photovoltaic</strong></td>
<td>■ Silane, Dichlorosilane, Trichlorosilane, Mixtures</td>
<td>■ Solar/Photovoltaic production</td>
</tr>
<tr>
<td></td>
<td>■ Argon, Hydrogen, Nitrogen</td>
<td></td>
</tr>
<tr>
<td><strong>University</strong></td>
<td>■ Research mixtures</td>
<td>■ Research</td>
</tr>
<tr>
<td></td>
<td>■ High purity 5.6 – 6.0, zero gases</td>
<td>■ Labs</td>
</tr>
<tr>
<td></td>
<td>■ High purity liquids: He, Ar, N₂</td>
<td></td>
</tr>
<tr>
<td><strong>Utilities</strong></td>
<td>■ Protocols, Environmental mixtures, mercury (HG) standards, dry ice</td>
<td>■ Stack emissions</td>
</tr>
<tr>
<td></td>
<td>■ SF₆, high purity 5.0, zero gases</td>
<td>■ Breaker insulation</td>
</tr>
<tr>
<td><strong>Window</strong></td>
<td>■ Krypton, Argon, Silane, mixtures</td>
<td>■ Insulation</td>
</tr>
</tbody>
</table>

[www.praxair.com](http://www.praxair.com)
Specialty Gases for Analytical Instrumentation

Analytical instruments are used within virtually every industry. Primary applications include process control, QA/QC, and environmental and safety monitoring. Gas purity is an essential element in the proper operation of instrumentation and plays a vital role in obtaining precise, accurate, and repeatable results.

In addition to high quality carrier gases, fuel gases, instrument support mixtures and calibration gases, Praxair can also provide:

- Cost effective supply modes
- Gases and grade tailored for specific applications
- Safe and compliant gas storage and handling systems
- Compatibility of gases and delivery systems

Analytical Instrumentation

Most common analytical instrumentation applications for specialty gases:

Fuels / Oxidizers – Used to burn
A reference flame is created in the detector head by mixing the fuel and oxidizing gases.

Charged particles generated in the flame (from the sample) migrate to the polarized electrodes.

They are then converted to an electrical current by the electrometer at which point an output signal is generated. The output signal is measured thereby allowing identification of the compound of interest.

Carrier gases – Used to carry
Typically provided at high purity – 5.0 + grades, these gases are used to carry the sample product.

As such, they need to be inert, non-reactive, non-combining, non-interfering with the molecule of interest.

In addition, they also need to be dry so as to prevent damage to the instrument.

Calibration gases – Used to compare
These gases are used to provide a reference standard to compare with the sampling product.

They typically require high purity and low blend tolerance, with a higher certification level, usually offered as reference standards.

COMMON GAS CHROMATOGRAPHY DETECTOR TYPES

<table>
<thead>
<tr>
<th>Detector Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCD   – Thermal Conductivity Detector</td>
<td>Universal</td>
</tr>
<tr>
<td>FID   – Flame Ionization Detector</td>
<td>Organic Compounds</td>
</tr>
<tr>
<td>ECD   – Electron Capture Detector</td>
<td>Halogenated Compounds</td>
</tr>
<tr>
<td>FPD   – Flame Photometric Detector</td>
<td>Sulfur or Phosphorous</td>
</tr>
<tr>
<td>PID   – Photo-Ionization Detector</td>
<td>Selective</td>
</tr>
<tr>
<td>GC/MS – Mass Spectrometer</td>
<td>Universal</td>
</tr>
<tr>
<td>DID   – Discharge Ionization Detector</td>
<td>Universal</td>
</tr>
</tbody>
</table>
Specialty Gases for Environmental Monitoring

Environmental monitoring continues to be an important regulatory mandate affecting almost every industry on the planet. Praxair’s product line addresses the needs of continuous emission monitoring (CEM), mobile emissions monitoring, and ambient monitoring.

We are an acknowledged leader in the supply of high purity specialty pure gases and mixtures for environmental applications. From EPA protocols to a wide variety of globally regulated traceable grades, Praxair products help our customers meet the demanding requirements associated with environmental compliance and control.

Today, industry must carefully monitor its environmental emissions and use reference standards to obtain precise measurements. Praxair produces highly accurate calibration gas standards and ultra pure zero gases for a wide variety of emissions applications. Praxair environmental solutions help ensure regulatory compliance, reduce emissions, increase capacity, improve economics, and help our customers achieve a broad range of environmental benefits.

Among the key Environmental segments we serve:
- Stationary Source Emissions Monitoring
  - Utilities / Petrochemical
  - Pulp and Paper Plants
  - Natural Gas Turbine Pumping Stations
  - Incinerators
  - Boilers and Industrial Furnaces
  - Cement Kilns
  - Steel Mills

Mobile Sources
- Motor Vehicle Manufacturers
- State Vehicle Inspection and Maintenance Testing
- Aircraft Engine Testing
- Environmental Laboratories
- Air Quality

Specialty Gases for Electronics

Praxair is a world leader in the supply of semiconductor process gases for the electronics industry. We offer a full product line including silicon source materials, dopants, etchants, and bulk products. The continuous drive to increase device performance means that specialty gases and chemicals must achieve higher purity levels, containers must be free of contamination, and analyses must be precise.

www.praxair.com
Specialty Gases for Hydrocarbon Processing Industry

Oil and gas exploration, refineries, petrochemical / chemical plants, gas processing units, distribution networks…

Performance expectations for these hydrocarbon processing industry (HPI) operations have never been greater. Key to achieving and maintaining this performance level are the many gases critical to this multipurpose industry.

Full Spectrum Product Line

From bulk quantities to small portables, Praxair offers a large selection of gases, containers, and delivery systems:

- Liquid mixtures (Propane, Butane, Pentane…)
- Refinery gas standards
- Trace impurity mixtures (fuel standards, industrial hygiene, environmental…)
- Ultra low sulfur and gasoline standards (stable high quality standards for fuel calibration)
- Custom multicomponent gas blends with over 100 individual components
- Highly reactive volatile organic compounds (HRVOC) standards (vents, flares, cooling towers and fugitive emissions testing)

Support all applications

Praxair has a long history and strong expertise in hydrocarbon processing and has developed solutions to improve productivity, increase capacity, reduce emissions, and enable performance monitoring and tracking.

- Refinery laboratory, Quality control laboratory, and Pilot plant: carrier gases, certified gas mixtures, hydrocarbon blends for complex analytical work. Air quality monitoring, R&D, chemical analysis, gas samples…
- Health and Safety department: calibration gas mixtures, measurement of toxics and environmental compliance.
- Cracker unit: monitors carbon monoxide emissions at different levels
- Sulfur recovery unit: measures sulphur dioxide at different concentrations
- Fuel gas and combustion control: gas residue and hydrocarbon emissions in combustion gas and feed streams.
Keeping Food Fresher, Longer

Our gases provide the product characteristics that our customers need. Frozen, chilled, crisp, fresh, fizzy – it is all possible with Praxair gases and application expertise. We work with a wide range of customers to increase their productivity and improve yield, all while helping enhance food product quality and maintain their focus on food safety. And we do it by developing new and innovative applications and technologies, as well as continuously improving our existing systems to help make their processes even more efficient.

Products: available in Bulk & Cylinder deliveries

Carbon dioxide is a key cryogenic agent in cooling, chilling, and freezing applications, protecting the taste and texture of food products by maintaining proper temperature control. Carbon dioxide also reduces the need for preservatives in packaged products, and is the essential ingredient for fizz in carbonated beverages.

Nitrogen is a key cryogenic agent in cooling, chilling and food freezing. Because of its extremely cold temperatures, immersion freezing in liquid nitrogen is the fastest freezing method known for producing individually quick frozen (IQF) foods. Nitrogen also plays a key role in reducing spoilage, discoloration and off-flavors, while giving strength to retail packaging.

Oxygen is used in aquaculture to deliver the dissolved oxygen levels that are needed for high production and fish health. Praxair oxygen is also key to providing increased dissolved oxygen levels for enhanced aeration and aerobic digestion in food wastewater streams.

Modified Atmosphere Packaging (MAP) gases are used by food processors and packagers to extend the shelf life of their products. The gases include a mixture of pure nitrogen, carbon dioxide, and oxygen and function to displace unwanted atmospheric gases.
Life Sciences
For biotech and pharmaceutical companies, Praxair’s products and services support critical drug development and manufacturing requirements including:
- Research
- Clinical trials
- Cell culture
- Cryopreservation and repositories
- Fermentation
- Manufacturing
- Regulatory compliance

Whether the requirement is for specialized equipment or full turn-key systems, Praxair has the products and services to meet this sector’s specialized needs.

Application specific products for this sector include:
- Biological equipment-freezers, dewars, shippers
- Cryogenic gases and delivery systems
- Controlled rate freezers
- USP, EP and JP grade gases (grade availability varies by country and region)
- Instrumentation gases
- Dry Ice

Laboratories/Research/Healthcare
Praxair’s extensive product line, wide selection of containers, and excellent distribution network meet the needs of busy research scientists and lab technicians. Specialized offerings include:
- Carrier gases
- Laboratory audit
- Calibration gases
- Technical support
- Specialty equipment
- Cylinder management
- Therapy gases (medical drug gases)
- Diagnostic gases (medical device gases)
- Pulmonary functions mixtures (lung diffusion)
- Anaerobic and aerobic mixtures
- CT scanning mixtures
- Sterilant gases
- Instrument gases
## Cylinder sizes

### Compressed Gas Cylinders

The most common means to store compressed gases is to use high pressure cylinders. Some of the most common sizes available are listed below, additional containers from low pressure cylinders as well as liquid containers are available.

<table>
<thead>
<tr>
<th>Material</th>
<th>Main Applications*</th>
<th>Model</th>
<th>Approval zone</th>
<th>Dimensions (in x in) (mm x mm)</th>
<th>Normal Fill Pressure (psig) (bar)</th>
<th>Internal Volume (L)</th>
<th>Tare Weight (lb) (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra HP Steel</td>
<td>H₂, N₂, Ar, He for medical, industrial high volume low purity</td>
<td>6K US</td>
<td>10 x 51</td>
<td>254 x 1295</td>
<td>6,000 413</td>
<td>42.7</td>
<td>303 138</td>
</tr>
<tr>
<td>HP Steel</td>
<td>Purge, inerting, carrier gases, dedicated non-reactive lab standards</td>
<td>T US</td>
<td>9 x 55</td>
<td>235 x 1397</td>
<td>2,400 165</td>
<td>49</td>
<td>138 63</td>
</tr>
<tr>
<td></td>
<td></td>
<td>K US</td>
<td>9 x 51</td>
<td>229 x 1295</td>
<td>2,000 137</td>
<td>43.8</td>
<td>133 60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50H EU</td>
<td>9 x 59</td>
<td>229 x 1498</td>
<td>2,900 200</td>
<td>50</td>
<td>125 57</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Dedicated low concentration reactive gas mixes, high purity pure and mixtures</td>
<td>AT US</td>
<td>10 x 52</td>
<td>249 x 1313</td>
<td>2,200 151</td>
<td>48.1</td>
<td>93 42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50HA EU</td>
<td>10 x 59</td>
<td>250 x 1500</td>
<td>2,900 200</td>
<td>50</td>
<td>123 56</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Dedicated low concentration reactive gas mixes, preferred cylinder for environment monitoring gases</td>
<td>AS US</td>
<td>8 x 48</td>
<td>203 x 1214</td>
<td>2,000 137</td>
<td>29.5</td>
<td>50 23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20HA EU</td>
<td>8 x 38</td>
<td>203 x 955</td>
<td>2,900 200</td>
<td>20</td>
<td>55 25</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Research quantity reactive products, low concentration reactive gas mixtures</td>
<td>AQ US</td>
<td>7 x 33</td>
<td>184 x 836</td>
<td>2,200 151</td>
<td>15.7</td>
<td>33 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10A EU</td>
<td>7 x 27</td>
<td>176 x 695</td>
<td>2,900 200</td>
<td>10</td>
<td>30 13</td>
</tr>
<tr>
<td>HP Steel</td>
<td>Non-reactive mixtures and pure gases</td>
<td>Q US</td>
<td>7 x 33</td>
<td>178 x 836</td>
<td>2,000 137</td>
<td>14.7</td>
<td>63 29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20H EU</td>
<td>8 x 31</td>
<td>203 x 795</td>
<td>2,900 200</td>
<td>20</td>
<td>59 27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10H EU</td>
<td>5.5 x 32</td>
<td>140 x 813</td>
<td>2,900 200</td>
<td>10</td>
<td>25 11</td>
</tr>
<tr>
<td>HP Steel</td>
<td>Research quantity pure gas products</td>
<td>G US</td>
<td>6 x 20</td>
<td>152 x 508</td>
<td>2,000 137</td>
<td>7.3</td>
<td>28 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3H EU</td>
<td>4 x 20</td>
<td>100 x 500</td>
<td>2,900 200</td>
<td>3.0</td>
<td>10 5</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Low volume reactive gas mixtures – shelf life concerns</td>
<td>A3 US</td>
<td>7 x 16</td>
<td>175 x 396</td>
<td>2,200 151</td>
<td>5.9</td>
<td>16 7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5HA EU</td>
<td>6 x 21</td>
<td>150 x 525</td>
<td>2,900 200</td>
<td>5.0</td>
<td>15 7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2HA EU</td>
<td>4 x 15</td>
<td>102 x 385</td>
<td>2,900 200</td>
<td>2.0</td>
<td>7 3</td>
</tr>
<tr>
<td>HP Steel</td>
<td>Small capacity pures (toxic and corrosive)</td>
<td>F US</td>
<td>4 x 17</td>
<td>104 x 432</td>
<td>2,000 137</td>
<td>2.8</td>
<td>10 4</td>
</tr>
</tbody>
</table>

*List is not exhaustive

### Cryogenic Containers

Designed to store gases in a liquid state at cryogenic temperature, these “dewars” can provide either liquid or gas withdrawal at either low (~20 psig) to high (up to 450 psig) pressure. High performance dewars also exist for liquid helium usage with multi-layer insulation to reduce evaporation losses.

In addition, Praxair can help source all necessary equipment in the cryogenic space: from liquid withdrawal to cryopreservation to storage systems.
Portable Cylinders

From calibrating instruments in industrial hygiene applications to bar mixtures in emissions monitoring or for laboratory and university research, portable cylinders offer the best solution.

**Products Applications**
- High blend accuracy
- Product traceability
- Customized blends upon request

**Applications**
- Workspace air / toxic emissions monitoring
- Safety / Emergency response kits
- Laboratory field analysis

**Disposable Cylinders**
Cylinders can be offered in steel for pure gases and non-reactive mixes or aluminum for reactive mixes and can accommodate as little as 4 liters to over 550 liters of gases and mixtures. The cylinders are traditionally disposed of after use.

**Reusable Cylinders**
Within the Portagas™ family of transportable cylinders, the Portagreen™ line offers a complete reusable sustainable solution along with extended shelf life. With the unique Strip & Ship™ packaging option, cylinders can easily be returned back to Praxair. In addition, cylinders are individually serialized and combined with ISO 17025 and Grade 34 certification offer high quality product. The Portagreen line is available in the most common cylinder sizes and, with global stocking locations, offers expedited shipping solutions wherever it is needed.

**PortaCYL™ Compact Reusable Integrated Package**
Permanently mounted on a refillable high pressure cylinder, the Portacyl package offers the value-added features of an integrated pressure regulator valve. Designed with an ergonomic easy to carry handle, it offers optimal portability and ease of use. It can be used with a wide variety of gases and mixtures applicable in many industries including hydrocarbon and chemical processing, automotive, aerospace, utilities and power plants, or waste management.
Equipment for Specialty Gases

Role of equipment in your gas applications

All the care that has been taken to provide a calibration mixture’s stability or a specified maximum impurity level in your high purity gases should not be jeopardized by using improper equipment. The equipment has to respond to all functional, safety, and quality aspects of the corresponding gas application.

Praxair has decades of experience in the sourcing, equipment selection, assembly and installation of gas handling systems as used in laboratories, universities and research, semiconductor, chemical, pharmaceutical and many other high demanding industries.

Functional aspects

For safety and local regulations, gas cylinders are mostly installed at a central location. The gas or gas mixture should be transferred from the cylinder to the point of use, not only at the specified pressure and flowrate but also with its original specifications.

Safety aspects

Starting from the high pressure in the gas cylinder, the equipment has to provide a constant reduced pressure at the point of use, while assuring leak tightness to avoid contamination of the work environment by the characteristics of the gases in use (flammability, toxicity, corrosivity).

Quality aspects

Intrusion of ambient impurities, for example O₂ and H₂O (retrodiffusion), in a gas handling system will lead to deterioration of the stability of certain calibration mixtures and contamination of high purity gases. Leak tightness of the equipment and the overall installation (piping, connection points, welded joints, etc..) should be verified.
Equipment Program

A comprehensive program covers all basic requirements for the safe and qualitative handling of all your specialty gas applications. It includes a range of pressure regulators (single stage and double stage) panels based on the gas type, switch-over systems, and point-of-use regulators. In addition, Praxair can source all the necessary equipment for your gas uses, including gas filters, flow meters, controllers, and cryogenic apparatus.

Pressure regulators
Available in single stage and double stage design, the latter being used in applications where constant outlet pressure is required independent of decreasing inlet pressure.

Critical purity: These stainless steel and brass regulators are used where purity and contamination requirements are critical. They are typically used with high purity gases and toxic or flammable gases.

High Purity: These nickel-plated brass/stainless steel regulators are used for applications where diffusion resistance is an important factor in ensuring purity.

High Purity Economical: These chrome-plated brass regulators have similar features to the high purity series. They are most often used with high purity gases when higher flow rates are required and cost is the most important issue.

Gas Distribution Panels
Praxair offers standard solutions that cover most of the gas applications: wall mount design, connection with the cylinder by a stainless steel wound (“pigtail”) or flexible tubing.

- Panel to connect one cylinder of an inert non flammable gas of medium quality. Without purging capability.
- Panel to connect one cylinder of an inert or flammable gas of medium to high quality. With purging capability using the connected gas.
- Panel to connect one cylinder of a toxic, corrosive or flammable gas of medium to high quality. With cross purging capability using an inert assist gas (typically N₂ 6.0).

In addition, Praxair can source fully enclosed gas cabinets for hazardous gases in compliance with local safety codes.

Switchover Systems
Gas supply panel for connecting 2 times 1 cylinder, with automatic switch-over for continuous gas supply, extendable to connect more cylinders at each side. For gases and gas mixtures of medium to high purity, equipped with process-gas purging. These switchover stations can be equipped with a power supply/remote alarm to provide both local and remote indication of status.
Leading in Safety
Safety is one of Praxair’s primary concerns. This concern starts with our own suppliers, continues with internal plant security, to structures is the safe application of specialty gases at our customer’s premises. The potentially hazardous properties of Specialty Gases, such as pressure, flammability, toxicity and corrosiveness, require handling with a combination of safety awareness training, know-how, skilled resources and personal commitment at all levels within an organization.

Quality
Cylinder preparation, analytical capabilities and qualitative laboratory practices are key elements in the production of Specialty Gases. Praxair facilities worldwide have obtained various quality certifications such as:
- EN 14001
- ISO 9001-2008
- TS 16949
- ISO17025
GHS (Global Harmonization System) Product Labeling

Under the recently adopted GHS rules, each product label requires the following:

- Product identifier
- Pictogram (see below)
- Signal word (DANGER, WARNING if needed)
- Hazard statement(s)
- Precautionary statement(s)
- Name, address, and telephone number of the responsible party.

Pictogram Identification

Flammable
(Flammable, self reactive, Pyrophoric, Self-heating, Emits flammable gas, Organic Peroxide)

Acute toxicity (oral, dermal, inhalation)

Oxidizer

Skin corrosion, serious eye damage

Compressed gases
Liquefied gases
Refrigerated liquefied gases.

Respiratory sensitization, Germ cell mutagenicity, Carcinogenicity, Reproductive toxicity, Specific target organ toxicity, Aspiration hazard.

Acute toxicity (oral, dermal, inhalation), Skin irritation, Eye irritation, Skin sensitization, Specific target organ toxicity, Respiratory tract irritation, Narcotic effects

Acute and chronic hazards to the aquatic environment

Pictograms:

- Flammable
- Oxidizer
- Compressed gases
- Respiratory sensitization
- Acute toxicity
- Skin irritation
- Eye irritation
- Skin sensitization
- Specific target organ toxicity
- Aspiration hazard
- Narcotic effects
- Aquatic environment

Image: A truck carrying various chemicals with GHS labels.
Transport labeling

ADR Rules are issued by the United Nations and are valid for the road transport in most countries in Europe while DOT Rules are issued by the U.S. Department of Transportation and applicable mostly in Americas.

Color Code Identification

Cylinders contents are identified by a unique color according to internation regulations like norm EN 1089-3 applicable for industrial and medical gas cylinders, or CGA C-9 for medical cylinders. Color identification varies per regional regulations and are generally based on the following attributes:

- Toxic and / or corrosive
- Flammable
- Oxidizing
- Inert (asphyxiant)

Safety Data Sheets

Safety data sheets are used to communicate and report the hazards of chemical products. Their contents, recently standardized by the GHS rules, include the following 16 sections:

1. Product and company identification
2. Hazard(s) identification
3. Composition / information on ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls / personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal information
14. Transport information
15. Regulatory information
16. Other information
As a Fortune 250 company, and one of the largest industrial gas companies in the world, we operate in more than 50 countries and serve over one million customers representing a wide array of industries including: energy, manufacturing, chemicals, metal production, and healthcare.

To learn more about Praxair’s expertise with specialty gases, call us at **1-800-PRAXAIR** or visit our website at [www.praxair.com](http://www.praxair.com).

**USA**

Praxair, Inc.  
39 Old Ridgebury Road  
Danbury, CT 06810-5113  
Phone: 1-800-PRAXAIR  
www.praxair.com

**Canada**

Praxair Canada, Inc.  
1 City Centre Drive, Suite 1200  
Mississauga, ON L5B 1M2  
Canada  
Phone: 905.803.1600  
www.praxair.ca

**Mexico**

Praxair Mexico, S. de R.L. de C.V.  
Oficinas en el Parque, Torre II, Piso 14  
Bd. Díaz Ordaz # 140  
Colonia Santa María Monterrey, N.L. C.P. 64650  
Tel.: +52 (818) 124-4800  
www.praxair.mx

**Middle East**

Praxair Gulf Industrial Gases  
Al Wahda Commercial Tower – 4th Floor  
Hazza Bin Zayed Street  
Abu Dhabi, United Arab Emirates  
Tel. No.: +971 2 6437210  
www.praxair.com

**South America**

White Martins Gases Industriais Ltda.  
Av. Pastor Martin Luther King Jr. 126  
Bloco 1, Rio de Janeiro, RJ 20760-005  
Phone: +55 (21) 3279.9000  
www.whitemartins.com.br

**Europe**

Praxair Euroholding S.L.  
Calle Orense, 11  
E-28020 Madrid, Spain  
Phone: +34.91.453.30.00  
www.praxair.es

**Scandinavia**

Yara Praxair AS Headquarters  
PB 23 Haugenstua  
0915 Oslo  
Norway  
Phone: +47.21.49.3434  
www.yarapraxair.com

**India**

Praxair India Private Limited  
Mercury 2B  
Prestige Technology Park,  
Outer Ring Road, Marathahalli,  
Bangalore – 560 103  
Phone number: +91 80 30691000-1009  
www.praxair.co.in

**China**

Praxair Asia, Inc.  
26F, Kerry Parkside  
No. 1155 Fangdian Rd.  
Pudong, Shanghai, PRC 201204  
Phone: +86.21.2894.7000  
www.praxair.cn

**Praxair Korea Co. Ltd**  
943-19, Shinan Building 16th Fl.  
Kangnam-Ku, Daechi-Dong  
Seoul, 135-280  
Korea  
Phone: +82.2.569.4100  
www.praxair.co.kr

© Copyright 2014 Praxair Technology, Inc.  
All rights reserved  
Praxair, the Flowing Airstream design, Portagreen, Strip & Ship, Portacyl, ProSpec and Making our planet more productive, are trademarks or registered trademarks of Praxair Technology, Inc. in the United States and/or other countries.  
The information contained herein is offered for use by technically qualified personnel at their discretion and risk without warranty of any kind.  
Printed in the United States of America  
10/14  
P-40-4012

Praxair, Inc.  
39 Old Ridgebury Road  
Danbury, CT 06810-5113  
USA  
www.praxair.com  
info@praxair.com

Telephone:  
1-800-PRAXAIR (1-800-772-9247)  
(716) 879-4077  
Fax:  
1-800-772-9985  
(716) 879-2040