Air Liquide
ENGINEERING & CONSTRUCTION

Cryogenics & Lurgi technologies

CUSTOMER SERVICES

YOUR PARTNERSHIP WITH THE WORLD LEADER IN INDUSTRIAL GASES

Air Liquide Group

The world leader in gases, technologies and services for Industry and Health

Air Liquide is present in 80 countries with approximately 65,000 employees and serves more than 3 million customers and patients. Oxygen, nitrogen and hydrogen are essential small molecules for life, matter and energy. They embody Air Liquide's scientific territory and have been at the core of the company's activities since its creation in 1902.

Air Liquide's ambition is to lead its industry, deliver long term performance and contribute to sustainability.

Air Liquide Engineering & Construction

A technology partner of choice

Air Liquide Engineering & Construction builds the Group's production units (mainly air gas separation and hydrogen production units) and provides external customers with efficient, sustainable, customized technology and process solutions.

Our core expertise in industrial gas, energy conversion and gas purification, enables customers to optimize natural resources.

We cover the entire project life-cycle: license engineering services / proprietary equipment, high-end engineering & design capabilities, project management & execution services. In addition we also offer efficient customer services through our worldwide set-up.

As a technology partner, customers benefit from our research and development to achieve energy transition goals.

Our full suite of technologies

- Liquefied Natural Gas
- Cryogenics
- Hydrogen
- Syngas
- Petrochemicals
- Natural Gas Treatment
- Sulfur
- Standard Plants
- Oleochemicals

15 **Engineering centers and front end offices**

3 **Manufacturing centers**

60 **Proprietary technologies**

1,600 **Patents**

Customer Services:

A new perspective for technical partnerships

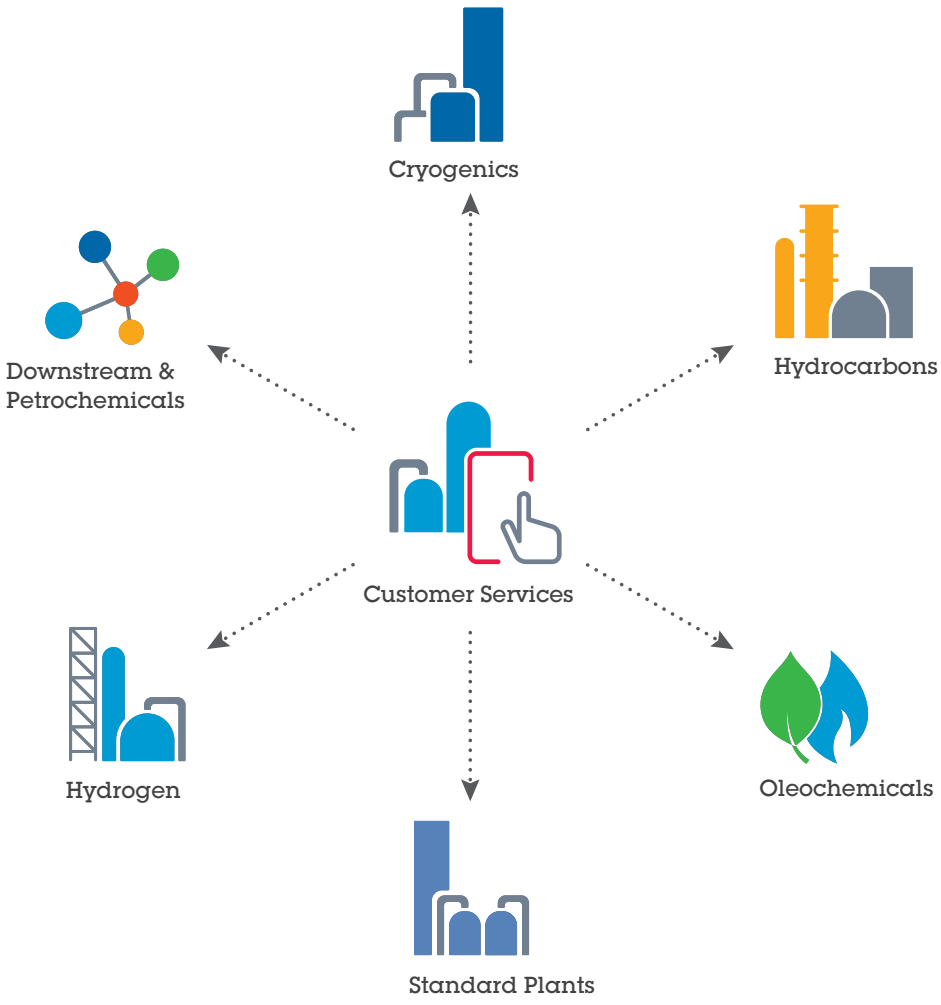
Benefit from the expertise of the world leader in industrial gases

For many years, we have provided long-term support to more than 400 Air Liquide plants worldwide – as an internal service – building deep experience in plant management.

This seasoned expertise in Customer Services is now available to all our Customers and business partners, reflecting our standing as a best-in-class, one-stop service provider.

We are ready to adapt our Customer Services to your specific needs, and work in partnership with you to:

- maintain the competitiveness of your assets over their life cycle;
- improve your control over operating costs;
- reduce your total cost of ownership.



Complete suite of value-added Customer Services

We help you maximize the efficiency and reliability of your plants

We provide Customer Services in four categories – Engineering, Remote Support, On-Site and Spare Parts – providing you with convenient solutions that maximize the efficiency and reliability of your assets.

We are equally comfortable working with plants engineered by Air Liquide, or by other organizations in the global market.

We can provide our services on an as-needed basis, or as part of a Customer Service Agreement which gives you simplified ongoing access to our expertise.

We at Air Liquide Engineering & Construction are continuously improving and expanding our Customer Services, to keep pace with the evolution of technology and Customer needs worldwide.

The very fact that we have developed these services with Customers reflects our partnership mindset – and our continuing search for new ideas.

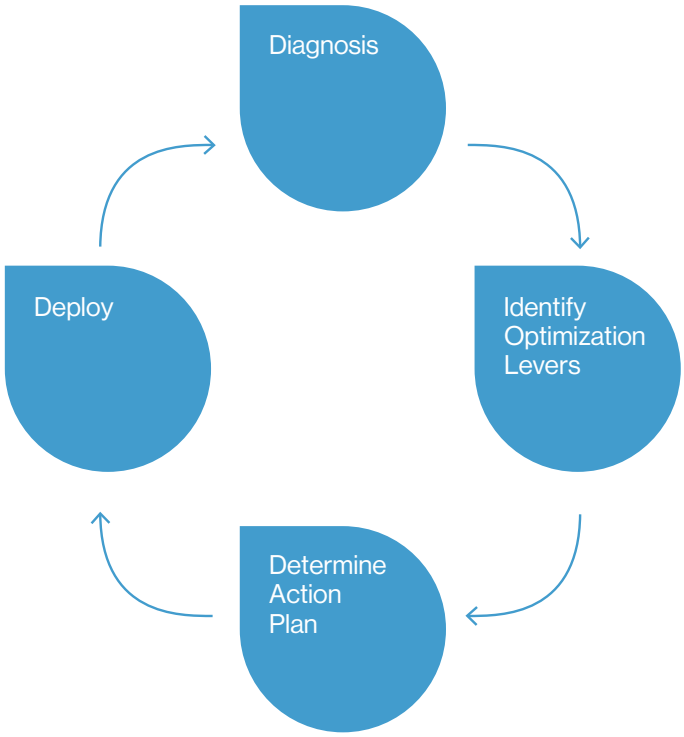
Building stronger partnerships, based on your needs

Experience, resources and a disciplined approach

Our long experience underlies our ability to excel with a wide range of technologies and processes – and the flexibility to adapt to the specifics of your operation – wherever you are located.

We also devote significant resources to meeting Customer expectations. For example, Customer Services draws on Air Liquide Engineering & Construction' research and development work, which benefits from daily operational feedback from installed plants around the world.

Project execution always follows a proven process, from diagnosis to post-deployment feedback. This disciplined approach assures you of the efficient implementation and measurable benefits you deserve.



Engineering Services

Full range of pre- and post-sales solutions, from feasibility studies to plant upgrades

Air Liquide engineers provide a wide selection of pre- and post-sales solutions. These range from feasibility studies for concept validation, all the way to the modification of operating plants to improve performance.

A typical comprehensive project includes detailed design work, procurement, supervision of installation and restart, followed by performance validation tests to verify the effectiveness of the solutions we have implemented.

Engineering Services are central to Customer Service Agreements, where regular product or process improvement options are evaluated as plant upgrades.

Engineering Services

- Revamping
- Debottlenecking
- Process optimization studies
- Performance improvement programs
- Modifications / Conversions / Upgrades
- Plant life cycle assessments and extensions
- Feasibility studies
- Design validation
- Design for third party organizations
- Project development and cost estimates

Case Study: Engineering of an oxygen piping extension, requiring design and safety expertise

EPC (Engineering, Procurement and Construction), Europe 2015

The challenge

A Customer needed to install additional oxygen piping at a refinery, and also ensure safe operations.

This Customer asked us to provide technical validation of the piping extension and mitigate risks linked to oxygen management.

Engineering Services

Our solution

We supported the complete process, providing safety and technical advice, as well as the required procedures and validations. Specific tasks included:

- ISO review and approval of the oxygen network
- Procedures for oxygen commissioning, network blowing, and materials cleanliness management
- Selection of equipment (e.g. filters and valves)
- Provision of documents to perform an oxygen hazard analysis of manual valves
- Review and approval of HAZOP actions

Customer benefits

Safety:
Air Liquide Cryogenics expertise and up-to-date knowledge enabled safe oxygen management.

Operational excellence:
We executed the project flawlessly with zero reworks, completing our assignment ahead of schedule. Consequently, our Customer restarted production activities promptly.

Remote Support Services

Remote monitoring and analysis for quick solutions and support

Our specialists are available to address your needs remotely, through on-line connectivity-based services. We analyze plant data in our product and process centers of excellence, then provide you with reliable solutions quickly.

And there are multiple benefits to conducting predictive analyses remotely:

- preventing potential incidents or problems;
- avoiding costly unplanned downtime;
- supporting life extension programs through plant obsolescence management.

To further support your operations, members of our Remote Support Services team are available to hold customized training courses for your personnel on safety, equipment, processes, and operations and maintenance (O&M).

Remote Support Services

- Flash diagnoses
- Vulnerability studies
- Accident risk analyses
- Energy efficiency assessments
- Health, Safety and Environment (HSE)
- Remote monitoring and diagnostics
- Customer training (e.g. O&M, HSE)
- Operations and maintenance optimization
- Troubleshooting, issue resolution and prevention

Case Study: Deep troubleshooting exercise and a root cause analysis (RCA) after an incident, followed by a total solution

ASU (Air Separation Unit), Europe 2015

The challenge

A major incident after a shutdown for routine maintenance activities might have damaged the internal piping of a Customer's ASU, taking the unit out of operation for months, with a significant impact on production. And it was critical for our Customer to avoid a recurrence.

This Customer asked us to provide expert analysis, address root causes, complete repairs as required, then restart the unit.

Remote Support Services

Our solution

We immediately dispatched engineering department specialists to assess the damage, then completed the final report just one week after the incident. We also supplied logistics support for the procurement and installation of new parts in the ASU.

A comprehensive RCA examined materials, welding, piping construction, assembly and support details, as well as dynamic behaviors in steady state and transient operations.

Finally, we implemented preventive solutions to avoid recurrences, leading to a prompt and efficient restart of the ASU.

Customer benefits

Quick remedial actions:
Troubleshooting and the RCA led to quick remediation and an early restart, avoiding significant downtime and production losses.

Safe ongoing production:
Implementation of a reliable solution, with a planned maintenance schedule in place, enabled smooth ongoing operations.

On-Site Services

On demand expertise in operations, maintenance and supervision

Our experienced field service engineers, trained at Air Liquide Group facilities, are at your disposal to supervise on-site operations and maintenance. This includes restarting your plant after any type of shutdown:

- planned shutdowns for maintenance and refurbishment purposes; or
- unplanned shutdowns in cases of equipment or plant failure.

On-site repair plans and operations, executed by our qualified team, will ensure reliable plant operations for the long term. And our cost optimization services, based on plant operational data, can also make your site more competitive.

On-Site Services

- Repair operations
- Troubleshooting and fixes
- Plant relocation operations
- Emergency call support
- Performance / Efficiency checks
- Supervision of:
  - Plant operations
  - Supplier interventions
  - Installation, commissioning and start-up
  - Planned / Unplanned maintenance

Case Study: ASU relocation and uprating project to meet higher production demands

ASU (Air Separation Unit), Asia 2010

The challenge

A Customer needed to relocate four ASUs then, in-mid project, new business needs called for an uprating to increase production.

This Customer asked us to plan and complete the ASU relocation, and propose a solution to increase significantly gaseous nitrogen production.

Our solution

To address the uprating, we provided our Customer with two detailed proposals for increasing production:
1) adding a new ASU; or
2) upgrading an existing unit.

Our Customer opted for the upgrade, leveraging our deep knowledge and impartial advice.

Customer benefits

Flexible approach to evolving needs:
Our well-structured proposals and sound technical support enabled our Customer to make a well-informed decision with confidence.

Cost-effective major production increase:
Upgrading was the best solution, in CAPEX terms, while our efficient execution made for reliability and a doubling of N_2 production.

On-Site Services

Spare Parts Services

The support you need to manage and supply your spares

Our specialists will support you with comprehensive spare parts lists, specifying everything you need in terms of fit, form and function. They will also assist you with the certification required to comply with the latest regulations in the industry segments and jurisdictions where you operate.

We also complete the consultative studies on safety and capital stocks needed to guarantee the reliability of your plant.

Engineering support will ensure the interchangeability of parts, as well as any potential issues related to changes of suppliers, obsolescence, and the installation of upgraded parts from product development.

Spare Parts Services

- Standard supply
- Emergency supply
- Site inventory audits
- Spare parts installation
- Safety and capital stocks
- Inspection and expediting
- Interchangeability studies
- Storage recommendations
- Obsolescence management
- Compliance with regulations
- Spare parts lists for planned and unplanned maintenance events

Case Study: Upgrade of existing core equipment to improve reliability, and comply with new regulations

Chemical plant, Africa 2015

The challenge

A Customer needed to upgrade three tailor-made bundles for a chemical plant, in operation for 30-plus years, to improve reliability and also certify compliance with updated local regulations.

This Customer asked us to plan and execute the upgrade while resolving a major problem: no original documentation was available for the existing bundles.

Our solution

The original bundle vendor was no longer in business, so our technical support team leveraged its relationships with highly specialized manufacturers, capable of producing bundle components in keeping with our technical specifications.

In partnership with our team, the selected new vendor upgraded the required components and equipment, providing on-time delivery of ready-to-install solutions that complied with the new regulations.

Customer benefits

On-time, ready-to-install solutions: The new bundles were made to fit the plant's design, requiring minimal on-site work at change-out.

Guaranteed performance: The new equipment had a 12-month performance guarantee, effective following the official testing and handover to production.

Spare Parts Services








Customer Service Agreements

Easy ongoing access to our broad range of services and expertise

Customer Service Agreements (CSA) are the most comprehensive way to benefit from our four Customer Services – Engineering, Remote Support, On-Site and Spare Parts.

By simplifying your access to the expertise of Air Liquide, a CSA makes for a close partnership between your team and ours. This includes regular on-site meetings.

A single CSA provides you with the ongoing support of as many of our Customer Services as you require, enabling you to optimize plant performance and maximize cost control over time.

The CSA can be customized to fit your specific needs and circumstances, with options to renew or modify the subscribed services as required. And the duration of the agreement is variable, in keeping with your requirements.

Customer Service Agreements (CSA)

- Easy and effective access to Air Liquide specialists and expertise:
  - Single renewable contract
  - Single contact person
  - First reply guaranteed timing
  - Practical answers with clear and easy operating instructions
  - Regular on-site meetings
- Maintenance programs
- Continuous technical support
- Extended performance guarantees
- Customer-tailored terms on any selected Service

Case Study: Customized CSA underlies a long-term partnership, ensuring flawless operations and maintenance

Refinery CSA (Customer Service Agreement), Asia 2015

The challenge

A Customer refinery in Asia required a trusted and experienced partner to support its Air Separation Unit (ASU), to keep the facility running safely at maximum efficiency.

This Customer asked us to deliver practical and effective solutions, from a one-hour study to an on-site visit, in keeping with their needs.

Customer Service Agreements

Our solution

Our team provided technical answers to our Customer, who had a wide range of requests such as:

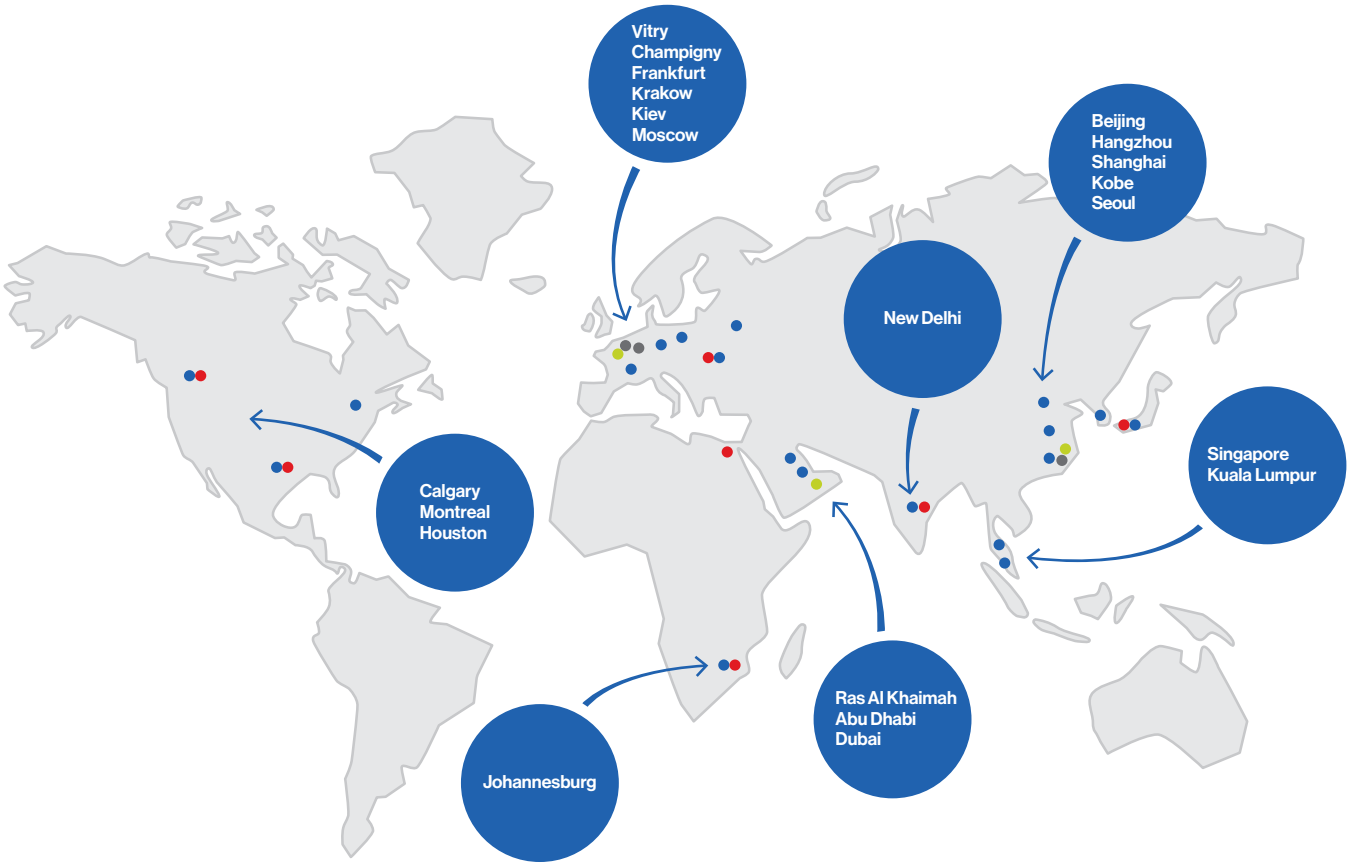
- What is the impact of having CO_2>0.5ppm in a LOX bath?
- Can the adsorber regen be configured to have a shorter adsorbing period?
- Do you have procedures available for replacing valves?
- We have a potential nitrogen system leak, and need a drawing and repair method.

Initial answers were provided within 48 hours, promptly followed up with more complete solutions.

Customer benefits

Quick tailored answers:
Practical high-quality advice, tailored to the specific operation, helped the Customer head-off potential problems in advance.

Easy access to broad expertise:
Access to the full range of Air Liquide knowledge, at any time, through a single point of contact.



- Engineering Centers and front-end offices
- Manufacturing centers
- Service technology centers
- Service front-end offices

Air Liquide Engineering & Construction | 08-2016 | Photos: Air Liquide

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