



The Inspection and Refurbishing of Cryogenic Vessels

National Board of Boiler and Pressure Vessel Inspectors

May 11, 2026 - Jacques Sénéchal, Project Owner, Major Investments, North America



Agenda

- **Air Liquide in brief**
- **Defining “Cryogenics”**
- **Product temperature density**
- **Storage sample**
 - API
 - ASME
 - Cold stretch
- **System**
 - Protection SRV
 - Thermal relief
- **Question**



About Air Liquide...

A world leader in gases, technologies, and services for...



Industry

Sustainable solutions for a wide range of industrial sectors (energy, metals, food, chemicals, automotive, pharmaceuticals, semiconductors, etc.) **and for transportation.**

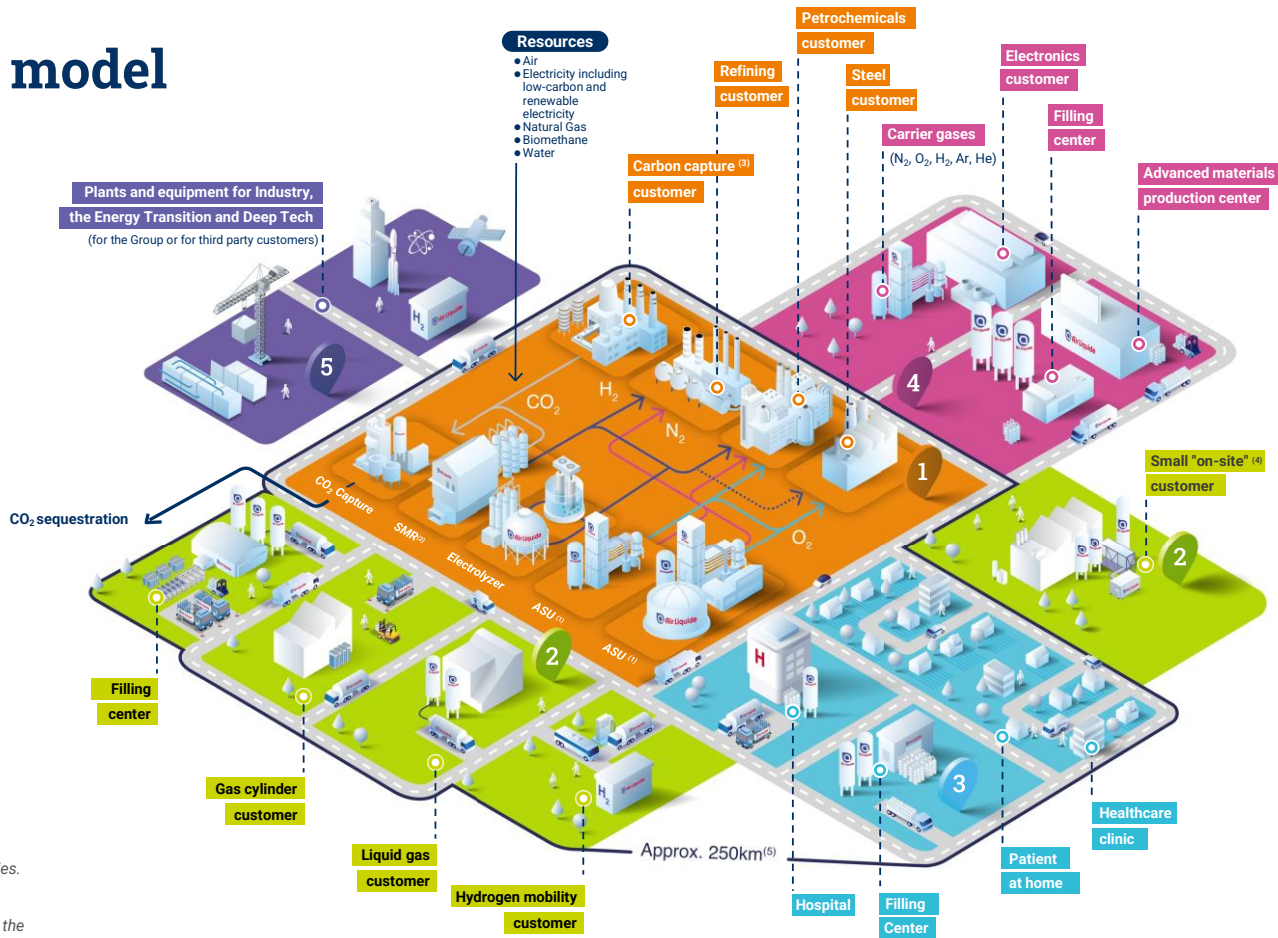


Healthcare

- Patients at home
- Hospitals
- Specialty ingredients

Our industrial model

A unique model that combines resilience, innovation and synergies to create sustainable value at the heart of major industrial basins.



⁽¹⁾ ASU: air gases production unit (air separation unit).

⁽²⁾ SMR: hydrogen production unit (steam methane reformer).

⁽³⁾ Carbon Capture: for hard-to-abate sectors to decarbonize their activities.

⁽⁴⁾ On-site: small gas generator on the customer site.

⁽⁵⁾ Air Liquide's model is designed so that gases are packaged and distributed in a given geographical area, around 250 km maximum from the production site.



Air Liquide Group's Key Figures

2025 figures



~ **65,000**
EMPLOYEES



PRESENT IN
59 COUNTRIES



4.3 MILLION
CUSTOMERS & PATIENTS



REVENUE
~ **€27bn**



NET PROFIT RECURRING⁽¹⁾
(GROUP SHARE)
€3.7bn

(1) Excluding exceptional and significant transactions that have no impact on the operating income recurring



INVESTMENT BACKLOG
€4.9bn⁽²⁾

(2) Including €0.2bn from DIG Airgas

Air Liquide + Airgas



Since 2016, Air Liquide and Airgas have provided a complete supply of gases, technologies and services for Industry and Health across the United States.

Airgas, an Air Liquide company

1M+
customers

90+
business
segments

18,000
associates



68 Large Primary
Production Plants

200+ On-site Units

410+ Cylinder Fill Plants

100+ Specialty Gas Labs



12.1M
cylinders



25,000+
bulk tanks



232K+
hardgoods
products
available



3,500
sales people

6
Distribution centers

900+
branches

500
field-based
application
experts

Airgas[®]

an Air Liquide company

Definition

- **Cryogenics is the field that involves very low temperatures.**
- **Common cryogenic liquids and their approximate boiling points include Liquefied Natural Gas (LNG) at -162 °C (-260 °F), Nitrogen and Oxygen around -170 °C (-274 °F), and Hydrogen at -254 °C (-425 °F).**
- **The application requires specialized equipment such as cryogenic reciprocating pumps, vacuum-insulated vessels or tanks, and cold boxes for process insulation.**

Volume Ratio Gas/Liquid

LNG
620

Nitrogen
680

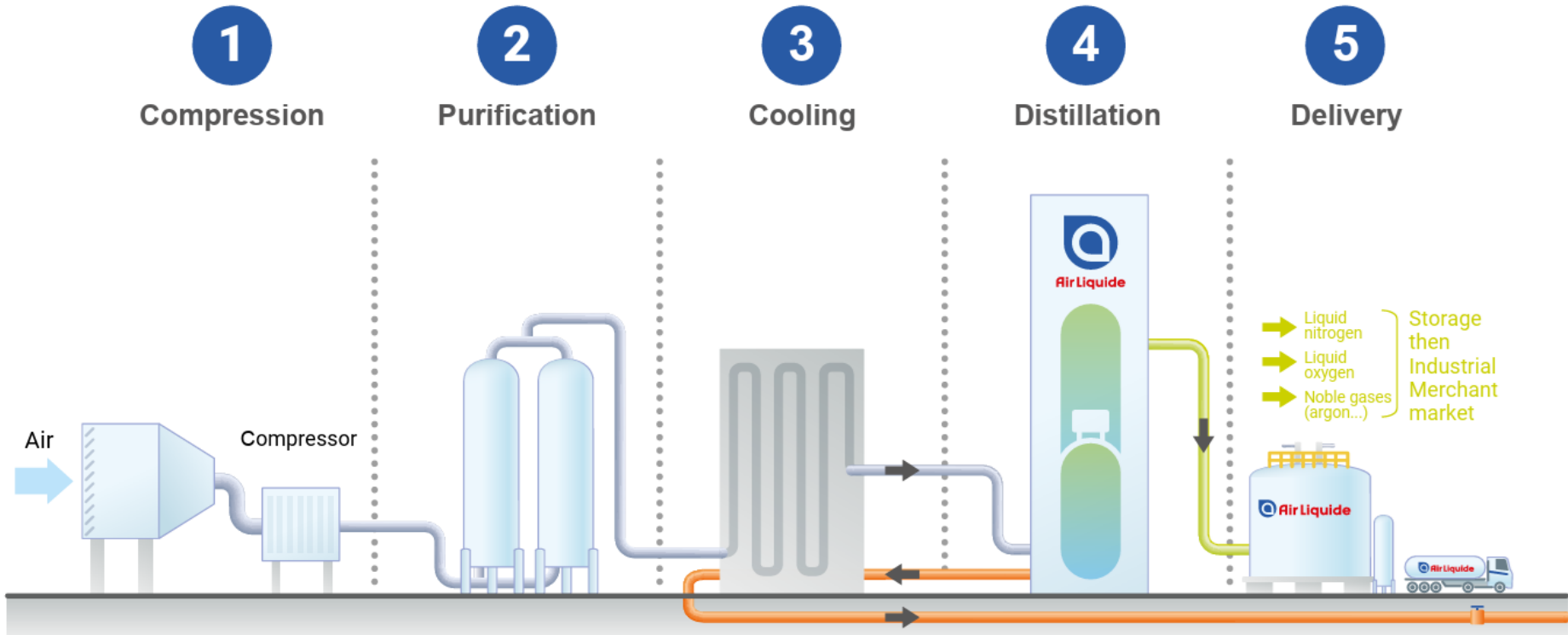
Oxygen
840

Hydrogen
825

Design Codes

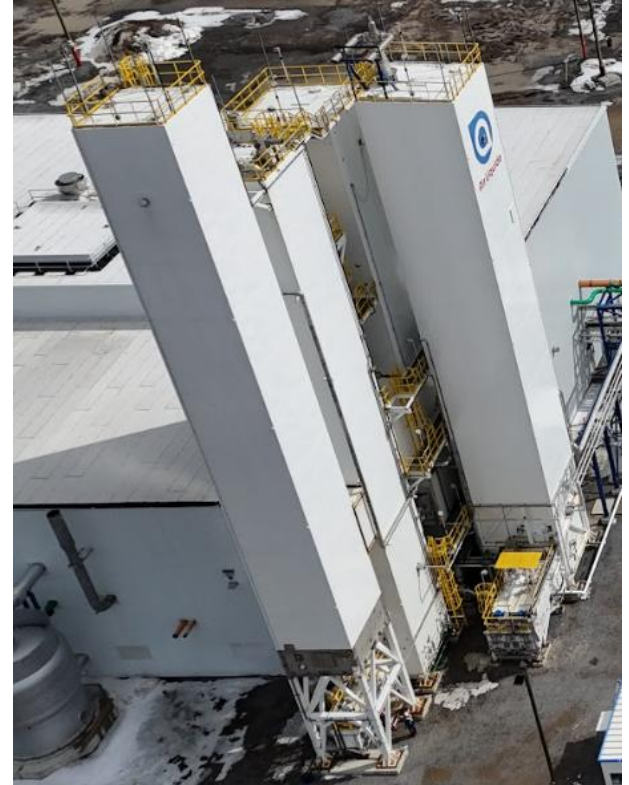
- API 620 for pressure up to 2.5 psig storage tanks
- ASME B31.3 process piping
- ASME Sec VIII division 1 pressure vessels including storage tanks
 - Small tank up to 18 000 USG
 - **Cold stretch design** is a pressure-strengthening technique used on austenitic stainless steel pressure vessels to increase yield strength by plastically deforming them at room temperature. By pressurizing to 1.5–1.6 times the maximum allowable working pressure (MAWP), the vessel strengthens via work hardening, allowing for 20%–50% lighter designs (thinner walls) while increasing volume

Typical cryogenic process



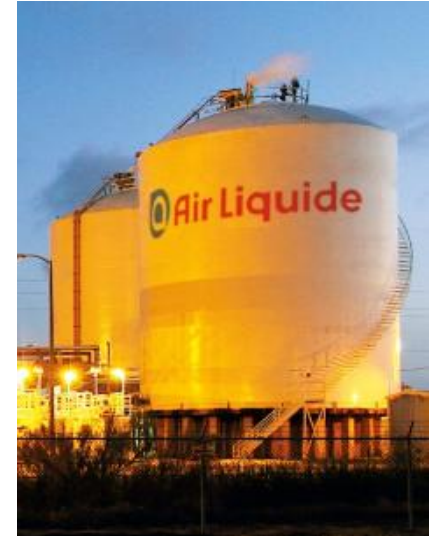
Cold box

- **Pressure vessel ASME sec VIII**
 - Material for low temperature
 - Plate exchanger
 - All pressurized equipment are in the cold box
- **External shell**
 - Low pressure to keep the insulation dry
- **Repair or maintenance**
 - Usually plans in advance and takes weeks or months
 - Similar to any process equipment



Low Pressure Storage tanks

- Design and construction of large, welded, low-pressure aboveground storage tanks
- Annual inspection
- PSV recertification
- Tank repair requires decommissioning
- Inspection on the piles should be the first priority



ASME Storage tanks

■ Insulation system

- Both vessels are divided with a vacuum space to guarantee insulation. Other options are available, including the addition of a combination of insulation materials.

■ Outer Vessel

- Known as the vacuum jacket, this part is made of carbon steel and is in charge of guaranteeing insulation, acting as a protective wall avoiding heat transfers from the outside environment.

■ Internal Vessel ASME Sec VIII div 1

- Repair as per any ASME vessel



■ Inner Vessel

- Generally Cold Stretch Design
- When the vessel is damaged the tank will probably be scrapped



Protection

■ Pressure Safety Valve PSV

- Maintain as per regulation/code
- Very low corrosion extended recertification possible to match the turnaround schedule

■ Thermal Relief

- When the liquid is trap between two mechanical components like valves, the thermal relief will protect the pipe
- Periodic visual inspection and replace when it's required



Question

