

## Notre Dame Safe Handling & Storage of Compressed & Liquefied gases



### Seminar Overview:

- Recognize the different physical and health hazards of compressed gases.
- Obtain information about physical and health hazards of compressed gases.
- Know the general and specific storage requirements.
- Connect and disconnect a pressure regulator.
- Choose appropriate Personal Protective Equipment (PPE)
- Dispose of empty/unused cylinders
- Respond to compressed gas cylinder emergencies appropriately



**Airgas**  
You'll find it with us.

## Airgas Presenters & Contacts

- **Ken Ishman**, VP Sales for Life Science & Healthcare Markets, 35 years of Gas Industry Experience,  
[ken.ishman@airgas.com](mailto:ken.ishman@airgas.com)
- **Austin Terry**, Specialty Gas Specialist, 36 years  
[austin.terry@airgas.com](mailto:austin.terry@airgas.com)
- **Matt Smith**, Account Manager (574) 520-8372  
[matthew.t.smith@airgas.com](mailto:matthew.t.smith@airgas.com)
- Elkhart Branch Support (574) 293-9285  
Jason Blair, Branch Manager



**Airgas**  
You'll find it with us.

## Goals

---

- Keep you safe



- Supplement your current training

**Airgas**  
You'll find it with us.

3

## Incidents Requiring Emergency Attention

---

- Campus Phone      Dial 911
- Cell Phone            574-631-5555
  
- Both reach NDSP Dispatch

**Airgas**  
You'll find it with us.

4

# Responsibilities

## Risk Management & Safety (RMS)

- Provides oversight to ensure conformance of safety procedures.
- Provides assistance, guidance, and training as necessary.
- Reviews and approves procedures for highly hazardous/toxic or special procedures as necessary.

## Principal Investigators/ Supervisors

- Ensure that employees are properly trained in the areas of safe storage, handling, use and transport of compressed gas cylinders.
- Ensures that safety procedures and safe work practices are used.

## Laboratory Workers

- Perform all work with compressed gases in accordance to the safety procedures discussed in this training.

## Departments

- Labeling of common compressed gas cylinder storage areas.
- Follow all safety procedures

## Supplier (Airgas)

- Provides assistance and guidance.
- Provides monthly compressed gas cylinder inventory to RMS & Procurement



5



# University Applications



## Glove Boxes

- Nitrogen (Dewars, Microbulk, Bulk)
- Argon (dewars, Microbulk, bulk)



## Nuclear Magnetic Resonance (NMR) & Magnetic Resonance Imaging (MRI)

- Helium and nitrogen cryogenes
- Cryogen handling equipment



## Other Research

- Electron microscope nitrogen
- Various lecture bottle replacements
- Oxygen for fermentation



## Cryostorage

- Nitrogen (dewars, Microbulk, bulk)
- Cryogen handling equipment
- RDF, inventory systems, supplies



## Various GC

- MS, ICPMS, ICP, ECD, FID
- Various analytical gases – i.e., BIP

## Various LC

- Solvents, Helium purge



## Animal Research

- Nitrous oxide
- CO<sub>2</sub>
- CO<sub>2</sub>/O<sub>2</sub> blends



## Mechanical and Other Storage

- Backup cryogenes (CO<sub>2</sub>, nitrogen)
- Scales, supply mode change equipment
- Dry ice



## Incubators

- Large/Small Scale
- Carbon Dioxide
- Triple Gas Style
- Nitrogen Also



## Manufacture

- Nitrogen
- Process chemicals
- Oxygen, air, and related gases



# Gas Container Examples



•Cylinders Of Various Sizes



•Stationary Tubes  
(aka Hydril Tubes)



•Multi-cylinder Packs



•Lecture Bottles



•Tube Trailers



•Other Small Cylinders



# Airgas Common Cylinder Sizes

Specialty Gas Cylinder Dimensions					
Size	DOT Specification	Nominal Dimensions (Excluding Valve and Cap) in	Average Tare Weight		Average Internal Volume
		in	lb	(kg)	ft <sup>3</sup> (L)
<b>High Pressure</b>					
300	3AA2400	9 x 55 (23 x 140)	137	(62)	1.76 (49.8)
200	3AA2265	9 x 51 (23 x 130)	119	(54)	1.55 (43.9)
80	3A2015	7 x 33 (18 x 84)	57	(26)	0.56 (15.9)
35	3A2015	7 x 19 (18 x 48)	26	(12)	0.26 (7.4)
10	3AA2015	4 x 17 (10 x 43)	9	(4)	0.10 (2.8)
7	3AA2015	4 x 13 (10 x 33)	6.6	(3)	0.075 (2.12)
LBC2	3E1800	2 x 12 (5 x 30)	2	(0.7)	0.015 (0.43)
LB/LBX	3E1800	2 x 12 (5 x 30)	2	(0.9)	0.015 (0.43)
E	3AA2015	4 x 26 (10 x 66)	14	(6)	0.16 (4.5)
3HP	3AA6000	10 x 51 (25 x 130)	300	(136)	1.49 (42.2)
2HP	3AA3500	9 x 51 (23 x 130)	187	(85)	1.53 (43.3)



## Identifying Products

- The only safe means of determining product identity is by consulting the cylinder label.
- **Color codes are meant for general reference only.** Lighting, age, foreign material or coatings, visual acuity and other factors could impact on how a cylinder color appears to an individual.

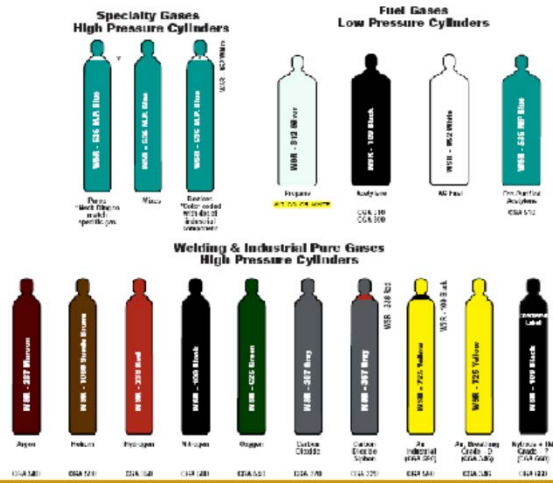


9

**Airgas**  
You'll find it with us.

## Color Coding

- Gas companies use cylinder color coding to help sort cylinders
- These color codes are not universal – different companies have different color code schemes
- Never use color to identify contents. Always read the label!



41

**Airgas**

## Cylinder Labels

- Each cylinder must bear a label that is in compliance with current DOT regulations.



11

**Airgas**  
You'll find it with us.

## What Are Hazardous Materials?

- Substances that pose an unreasonable threat to health, safety, property and the environment
- DOT lists 9 Classes of Hazardous Materials:
  - Class 1 – Explosives
  - Class 2 – Gases
  - Class 3 – Flammable Liquids
  - Class 4 – Flammable Solids
  - Class 5 – Oxidizers / Organic Peroxides
  - Class 6 – Poisons
  - Class 7 – Radioactive
  - Class 8 – Corrosives
  - Class 9 - Miscellaneous



12

**Airgas**  
You'll find it with us.

# Information found on a SDS



## 16 Sections:

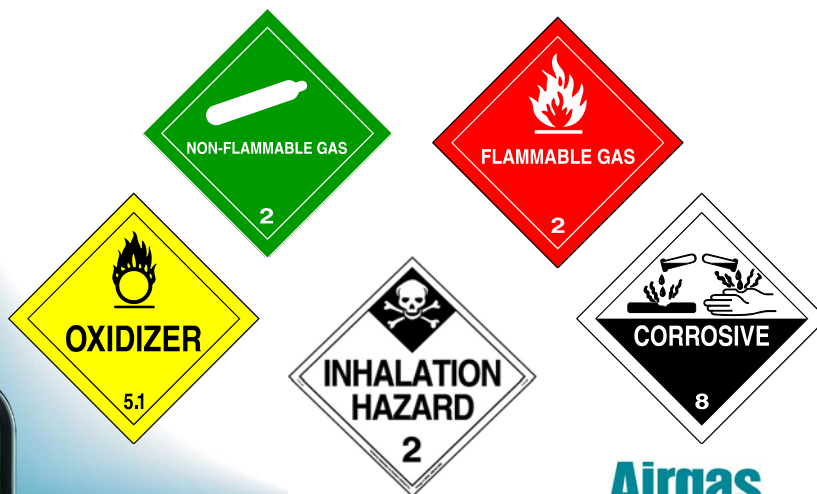
- Product and Company Identification
- Composition, Information on Ingredients
- Hazards Identification
- First Aid Measures
- Fire Fighting Measures
- Accidental Release Measures
- Handling and Storage
- Exposure Controls, Personal Protection
- Physical and Chemical Properties
- Stability and Reactivity
- Toxicological Information
- Ecological Information
- Disposal Considerations
- Transport Information
- Regulatory Information
- Other Information

Airgas.com

**Airgas**  
You'll find it with us.

13

# D. O. T. Hazard Classes



**Airgas**  
You'll find it with us.

14

## Nonflammable Gas



15

- Most hazardous class of products
- Colorless, odorless, tasteless, non-irritating
- NO WARNING PROPERTIES
- Hazards
  - Pressure 6000 psig
  - Asphyxiation >19.5% O<sub>2</sub>
  - Temperature Cryogenic
- Examples
  - Argon, Helium, Nitrogen, Carbon Dioxide

**Airgas**  
You'll find it with us.

## Hazards of Inert Gases



16

- All inert, flammable, and toxic gases have potential to cause an oxygen deficient atmosphere.
- Most gases are colorless, odorless and tasteless, there is no warning.
- Less than 19% oxygen may produce dizziness, fatigue, nausea, vomiting and diminished mental alertness.
- NEVER enter a oxygen deficient area believing you can hold your breath until you re-emerge.

**Airgas**  
You'll find it with us.



## Oxygen Deficiency

### Displacement of oxygen with another gas:

---

- 19.5% Legal minimum concentration for humans (OSHA)
- 15-19.5% Decreased ability to do work, induce early symptoms in persons with coronary, pulmonary, circulation problems
- 12-14% Increased pulse rate and respiration, impaired perception and judgment
- 10-12% Further increase in pulse and respiration, giddiness, poor judgment, blue lips
- 8-10% Mental failure, nausea, fainting, vomiting, unconsciousness
- 6-8% 8 min **100% Fatal**, 6 min 50% fatal, 4-5 min recovery
- 4% Coma in 40 sec, convulsions, breathing stops, **Death**



17

**Airgas.**  
You'll find it with us.

## Hazards of Oxygen

---

- Pressure
- Oxygen should never stored with any hydrocarbons.
- Supports Combustion
  - No Smoking, No Open Flames, and No Flammables are permitted within 20 feet of oxygen storage.



18

**Airgas.**  
You'll find it with us.

## Oxidizer Hazards

- Examples of oxidizing gases are:
  - Oxygen
  - Fluorine
  - Chlorine
  - Chlorine tri-fluoride
  - Nitrous oxide
- Oxidizer Enrichment-Increases reactivity



**Airgas**  
You'll find it with us.



19



20

## Other Safety Item

- Toxic Gas List
  - Requires Preapproval
  - Restricted Products Site Survey w/Airgas

The screenshot shows a spreadsheet with columns for 'Toxic Gas', 'MSLI GAS', 'MSLI GAS', 'MSLI GAS', and 'MSLI GAS'. The rows list various gases and their corresponding MSLI GAS identifiers.

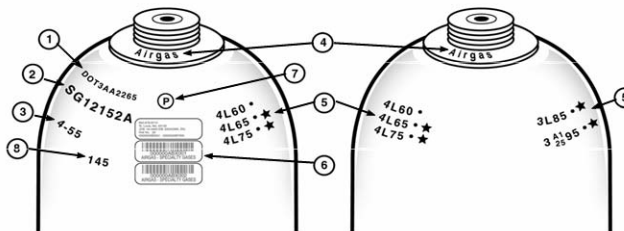


21

**Airgas**  
You'll find it with us.

## Cylinder Markings

1. **Cylinder Specification**
  - DOT - Department of Transportation, which is the regulatory body that governs the use of cylinders
  - Specification of the cylinder type or material of construction (e.g., -3AA)
  - Service or working pressure in pounds per square inch (e.g., -2,265 psi)
2. **Cylinder Serial Number**
  - The letters SG precede the serial numbers for Specialty Gas cylinders
3. **Date of Manufacture**
  - This date (month-year) also indicates the original hydrostatic test
4. **Neck Ring Identification**
  - The cylinder neck ring displays the current owner of the cylinder
5. **Retest Markings**
  - The format for retest markings is: Month-Facility-Year-Plus
  - Rating-Star Stamp
  - The + symbol (Plus Rating) indicates that the cylinder qualifies for -10% overfill
  - The star symbol (Star Stamp) indicates that the cylinder meets the requirements for 10-year retest (instead of a 5-year retest).
  - UT in the facility stamp area designates ultrasonic testing
6. **Bar Code Labels**
  - Provides a unique cylinder identifier to track cylinders through filling
7. **Cylinder Manufacturer's Inspection Marking**
8. **Cylinder Tare (Empty) Weight**



•16

**Airgas**

## Handling Cylinders

- Move cylinders in an upright position by using a suitable cylinder cart or hand truck when possible.



**Airgas.**  
You'll find it with us.

23

# *LET IT FALL!!*



**Airgas.**  
You'll find it with us.

24

## Basic Cylinder Handling and Storage

---

- **NEVER** : drag, roll or slide cylinders
- **NEVER** : lift cylinders by the cap
- **NEVER** : use cylinders as rollers
- **NEVER** : submit cylinders to temperature extremes
- **NEVER** : strike an arc on a cylinder
- **NEVER** : allow cylinders to contact electrical circuits or apparatus
- **NEVER** permit oil, grease, or other readily combustible substances to come in contact with cylinders or their valves, particularly Oxygen.
- **NEVER** use oxygen as a substitute for compressed air.



25

**Airgas**  
You'll find it with us.

## Storage of Cylinders

---

- Indoor storage of toxic gases shall be equipped with a continuous gas detection system that provides an alarm to warn of the presence of toxic gases in levels that present a hazard to life
- Exhaust ventilation systems shall be installed in all indoor areas used for toxic gases



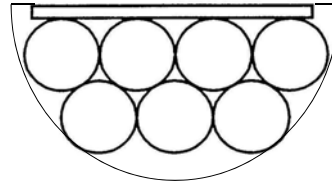
26

**Airgas**  
You'll find it with us.

## Nesting Cylinders

- All free-standing cylinders must be secured by a strap, chain or other means.

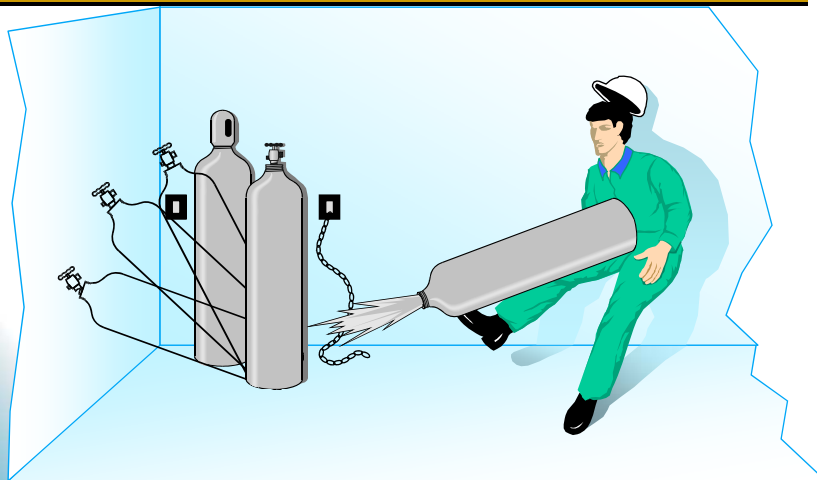
WALL SUPPORTED



27

**Airgas.**  
You'll find it with us.

## Pressure



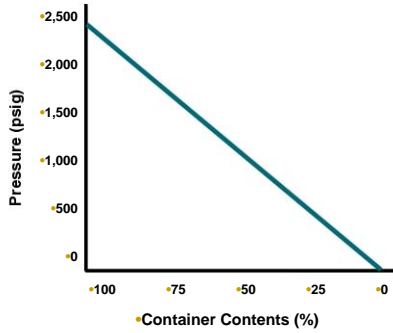
28

**Airgas.**  
You'll find it with us.

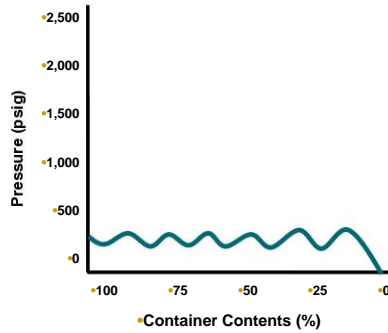
# Pressure During Use



Gas Container



Liquid Container  
Liquified Compressed Gas



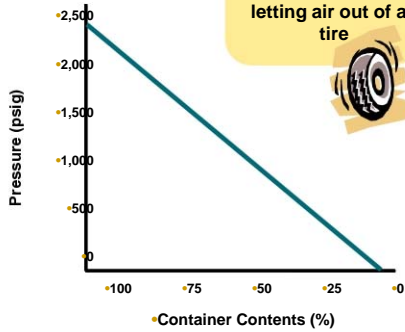
•3



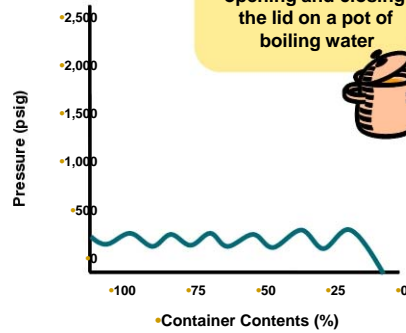
# Pressure During Use



Gas Container



Liquid Container



•4



## What Is This Called?



Gas Container

- Cylinder (most common, correct)
- Bottle
- Tube
- Tank



Liquid Container

- Liquid container (correct)
- Dewar (most common)
- Jug
- Can

**Airgas**

## Regulator Installation

- **Before removing the cylinder cap, move the cylinder to the work site:**
  - Always gloves and eye protection
  - Secure cylinder to floor, wall or bench with appropriate chain or stand to prevent toppling.
  - Remove cylinder cap
  - Be sure cylinder valve is tightly closed
  - Remove cylinder valve plug, if any
  - Inspect the cylinder valve threads for damage or contamination



32

**Airgas**  
You'll find it with us.



## Whenever Connecting or Disconnecting the Regulator

---

- Use a proper wrench
- Do not use pliers



**Airgas.**  
You'll find it with us.

33

## Wrenches

---

Do not use pliers. Use an appropriate cylinder wrench.



**Airgas.**  
You'll find it with us.

34

## Left Hand = Counter-clockwise Has a V-Groove

---

- Right Hand = Clockwise
- Fitting is smooth – No V-Groove



35

**Airgas.**  
You'll find it with us.

## Opening Valves

---

- Never use a gauge above 75% of its maximum face reading.(ANSI B-40.1)
- Immediately replace any gauge whose pointer does not go back to it's zero point when pressure is removed.
- Be certain the CGA connection on the cylinder and the pressure reducing regulator fit together properly without being too loose or too tight. **NEVER USE AN ADAPTER**



36

**Airgas.**  
You'll find it with us.

## CGA Adapters – Don't Use Them!

- Circumvents the system the Compressed Gas Association (CGA) put in place to help prevent accidents
- Each class or individual gas will have a unique connection
- CGA Connections prevent hydrogen from being hooked up to an oxygen line

320 to 580



520 to 510



44

**Airgas**

## Regulator Installation

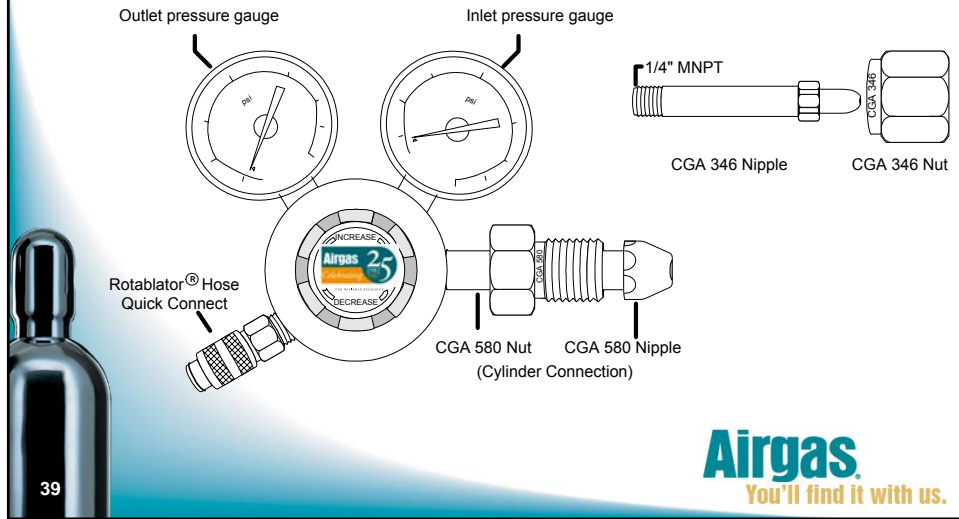
- Position yourself with cylinder between you and the regulator. Keep hand off regulator while opening cylinder valve.
- Slowly open cylinder valve. Observe the high pressure gauge on regulator as it climbs to full cylinder pressure.
- **Observe all connections for leaks.**
  - An approved soap solution may be applied to the connections, if compatible to your usage, to indicate leaks by bubbling
  - To further check for leaks, or if soap solution cannot be used, close the cylinder valve for five minutes and watch for a drop in pressure.



38

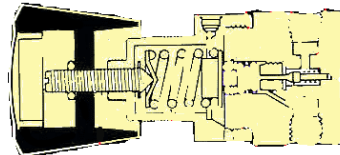
**Airgas**  
You'll find it with us.

## Regulator Components - Pressure



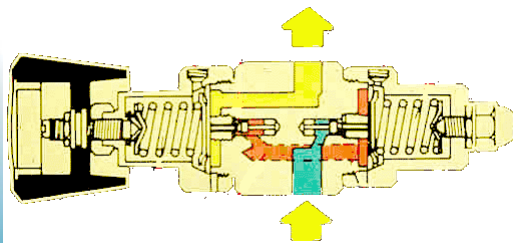
39

## What's The Difference Between Single and 2-Stage Regulators?



### Single Stage

Not Precise Delivery Pressure  
Due to Supply Inlet Effect



### Two Stage

Precise Delivery Pressure

**Airgas**  
You'll find it with us.

---

## ANY QUESTIONS ON CYLINDERS?



**Airgas.**  
You'll find it with us.

## Cryogenic liquids

---

- Cryogenic liquids are kept in their liquid state at very low temperatures ( $-240^{\circ}\text{C}$ )
- Different cryogens become liquids under different conditions of temperature and pressure, but all have two properties in common: they are extremely cold, and small amounts of liquid can expand into very large volumes of gas.
- Without adequate venting or pressure-relief devices on the containers, enormous pressures can build up.



**Airgas.**  
You'll find it with us.

## Cryogenic Gases

Gas	Boiling Temperature °F	Liquid Evaporation Rate Per Day	Expansion Ratio Cu.Ft. Liquid. To Cu.Ft. Gas
Oxygen	-297.33	1.20%	1 to 861
Nitrogen	-320.36	1.85%	1 to 696
Argon	-302.55	1.20%	1 to 841
Helium	-452.1	1.20%	1 to 754



**Cryogenic liquids** will vent (boil off) from their storage containers as part of normal operation. As an example, a 160-liter tank will vent the gas equivalent to 2 liters of **liquid** a day.

**Airgas**  
You'll find it with us.

## Cryogenic Liquid Hazards

- Physical Hazards
  - Over Pressurization
    - Proper Venting of Liquid Systems (Inline PRV between shutoffs)
    - Max. Allowable Working Pressure (MAWP) exceeded on components
  - **Oxygen rich atmospheres (increased fire potential)**
  - Mechanical Failures
    - Material Embrittlement (i.e carbon steel)
  - Material Handling
    - Pinch Points
    - Muscle Strain
    - Back Injuries



**Use Approved  
Carts  
Hands on  
Handle  
Push Dewar**



44

**Airgas**  
You'll find it with us.

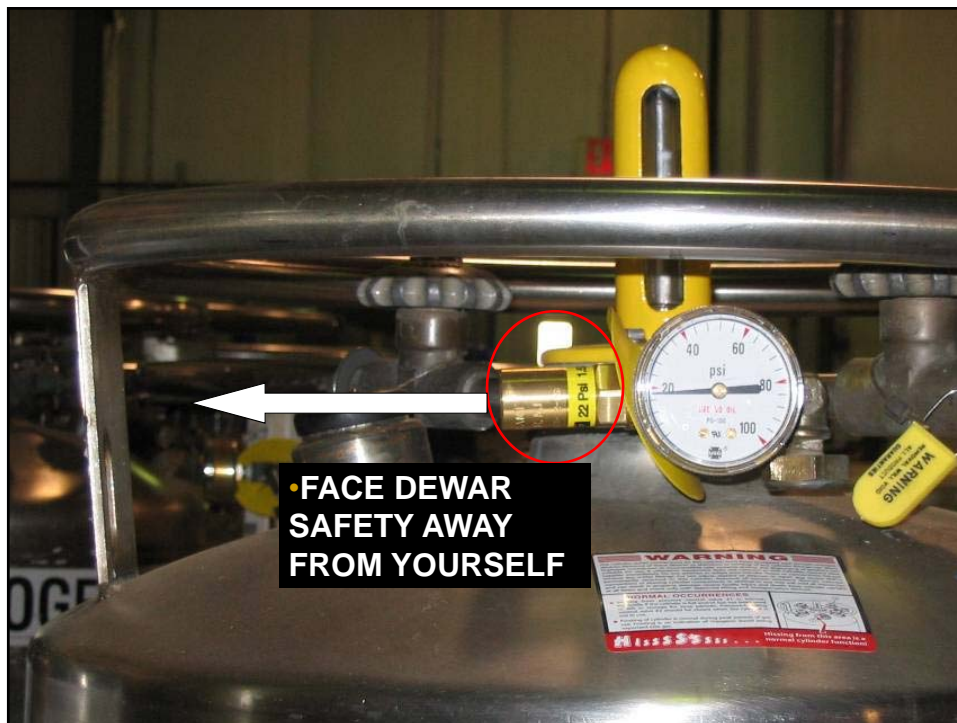
## Cylinder Tipping or Damage

- Keep Liquid containers upright
- If Container Falls - Let it!
  - Allow 15 minutes for container to settle
  - Assess for structural integrity before approaching it. Check if venting, Air monitoring may be required.
  - Minimum 2 person team to lift in upright position
    - PPE Full Face Shields & Gloves
    - Use mechanical lift, hoist, tripod assembly to upright if possible
- Notify Airgas of the Incident



45

**Airgas.**  
You'll find it with us.



## Cryogenic Liquid Hazards

- Health Hazards
  - Frostbite
  - Skin Tearing
    - Touching Super Cooled Metal & Plastics
  - Asphyxiation
    - These gases are colorless, odorless
    - Deadly consequences
    - See a person down, what's your first reaction?



**Airgas**  
You'll find it with us.

47

## Personal Protective Equipment (PPE)



A picture is worth a thousand words !

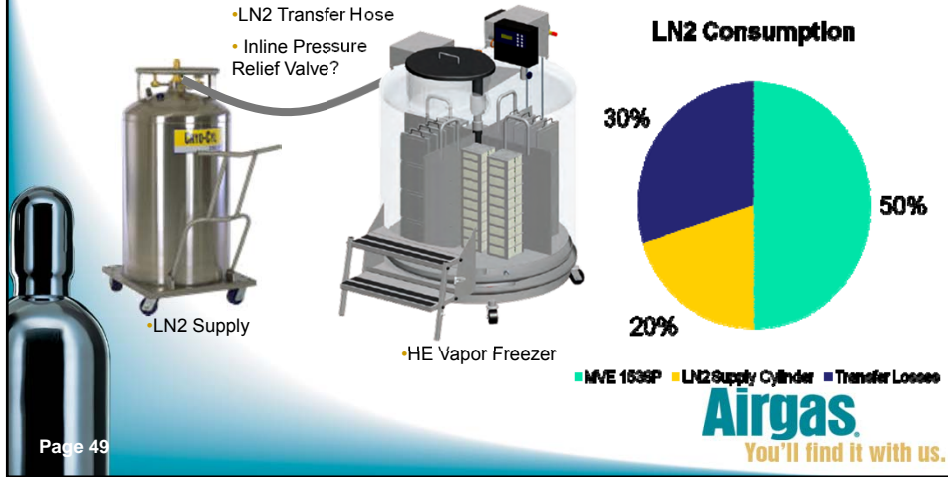


48



## LN2 Consumption Example – CryoStorage

- 1-3% Volume/Day + 30% Transfer Loss/Fill + 7.5 L/Day NER @ 1.4 Fills/Week ≈ 100 L/Week
- (LN2 Supply NER)                      (Transfer Losses)                      (Freezer NER)                      (Total Consumption)



Page 49

## Expansion in a 230 Liter Liquid Nitrogen Dewar

Cylinder Contents	230	Liters
Evaporation Rate	1.85%	Percent
Daily Conversion	4.25	Liters
	104.7	Cubic Feet per day

**Airgas**  
You'll find it with us.

## What is a cryogenic liquid cylinder?

- A pressurized, double-walled, insulated container
- Holds either cryogenic liquefied gas or refrigerated liquefied gas.
- The inner vessel is insulated from the outer vessel by a vacuum space.



**Airgas**  
You'll find it with us.

## Liquid Operation

- Configurations
- Product Withdrawal
  - liquid
  - Gas
- Pressure Control
  - pressure build-up
  - economizer
  - relief



**Airgas**  
You'll find it with us.

## Liquid Operation

---

Part No.	DOT Rating	Relief Valve	Normal Operation Pressure
NI NF230LT22	4L100	22	5-18
NI NF230LT230	4L200	235	120
NI NF350LT350	4L300	350	300



**Airgas.**  
You'll find it with us.

## Theory of Operations

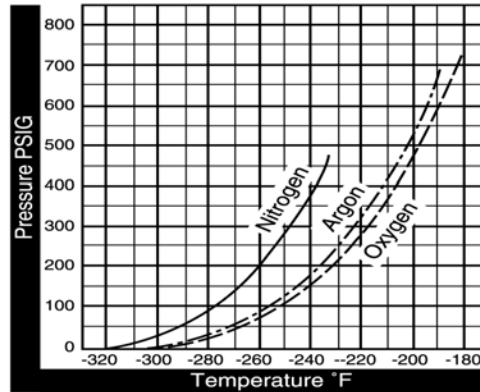
---

- Keep the liquid from reaching the relief valve rating of the dewar
- Liquid converts to gas at or above evaporation rate
- Venting of gas through relief valve is product lost
- The lower the pressure the colder the liquid.
- The lower the safety setting the colder the liquid temperature in the dewar



**Airgas.**  
You'll find it with us.

Pressure over liquid oxygen, nitrogen and argon compared with temperature at which liquids boil



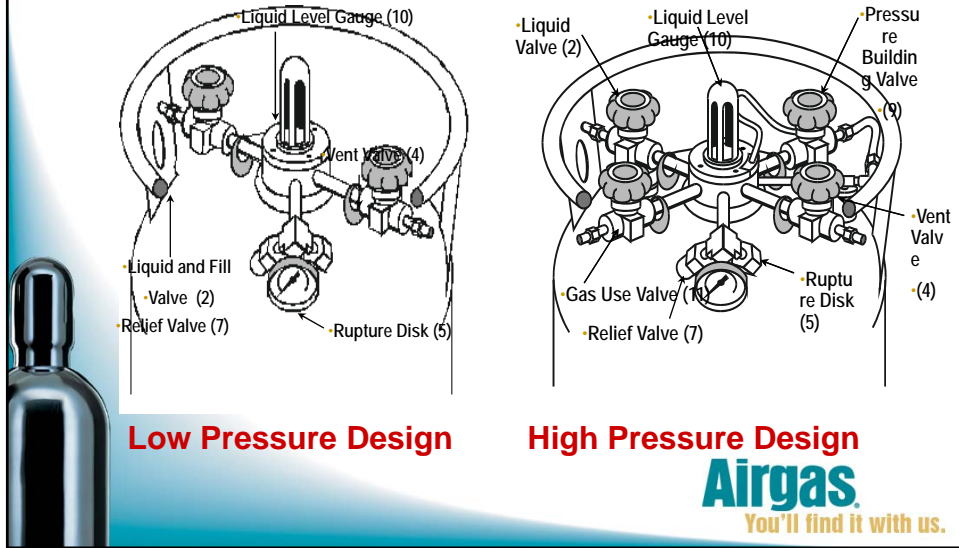
**Airgas**  
You'll find it with us.

## Types of Liquid Cylinders

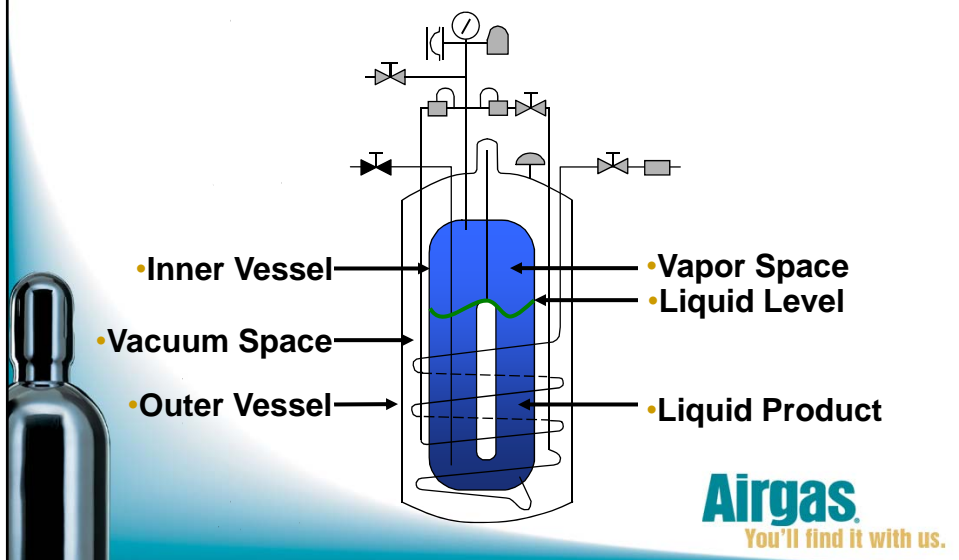
- Liquid cylinders come in many configurations
  - Liquid withdrawal only
  - Liquid withdrawal only with pressure builder
  - Gas and Liquid withdrawal with high and low pressure relief valves
  - Gas and Liquid withdrawal with high pressure reliefs
  - Relief valve settings ranging from 22 to 500 PSIG

**Airgas**  
You'll find it with us.

# Common Configurations

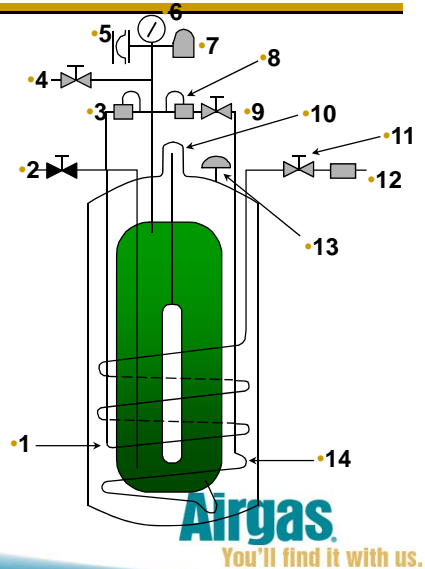


# Container Cross Section



## Flow Diagram

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



## Control Valves

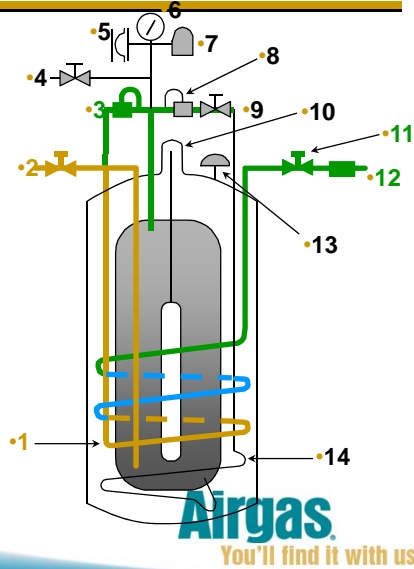
- Most cylinders can be used for either gas or liquid withdrawal.
  - Top of cylinders have the following valves:
    - Liquid Withdrawal Valve
    - Vent Valve
    - Liquid Fill Valve
    - Gas Withdrawal Valve\*
    - Pressure Building Valve\*

\* not available on all cylinders

**Airgas**  
You'll find it with us.

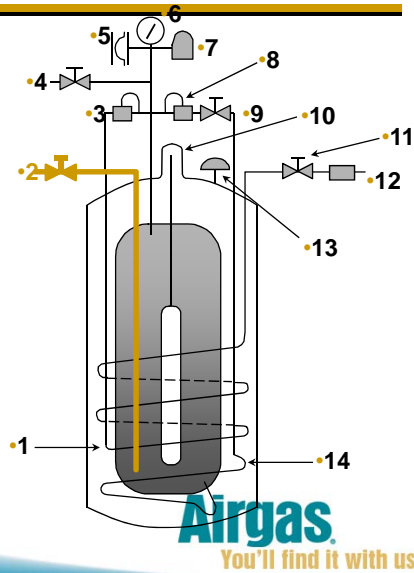
# Product Withdrawal

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



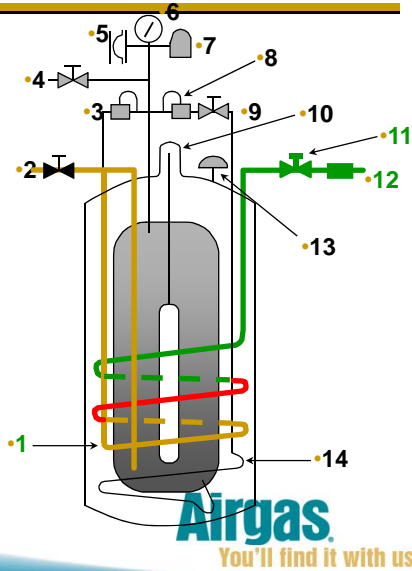
# Liquid Withdrawal

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



## Gas Withdrawal

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



## Pressure Building Circuits

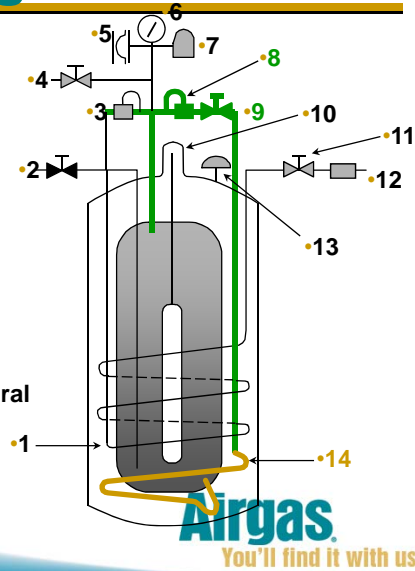
- Designed to maintain constant supply of liquid or gas over prolonged periods of use.
- Dewars without pressure builders are not designed for continuous withdrawal
- Pressure builders are set to operate below safety pressure ratings

**Airgas**  
You'll find it with us.



## Pressure Building

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



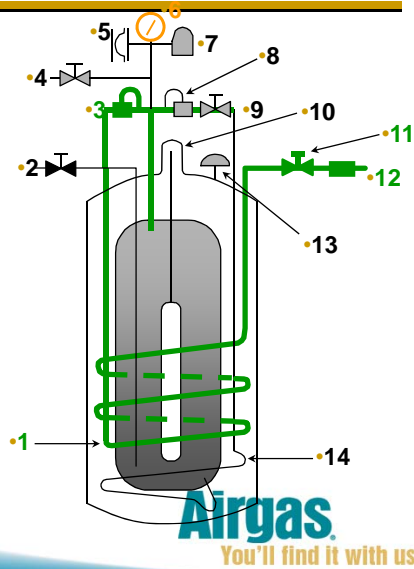
## Economizer Circuit

- Set at 25 PSIG above pressure building builder setting
- Releases excess pressure buildup into gas use valve.
- Attempts to keep pressure from reaching safety setting which would allow release of gas to atmosphere

**Airgas**  
You'll find it with us.

# The Economizer

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



**Airgas**  
You'll find it with us.

# Pressure Relief

- Pressure relief valve to prevent building pressure above desired use and DOT rating of Dewar.
- Rupture disc in case of failure of relief valve



Call 911?

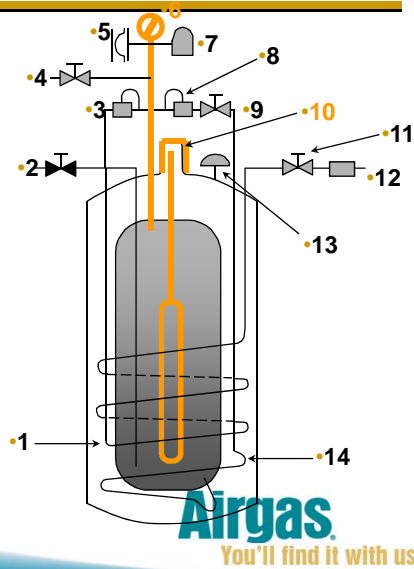
Normal Operation is to vent periodically



**Airgas**  
You'll find it with us.

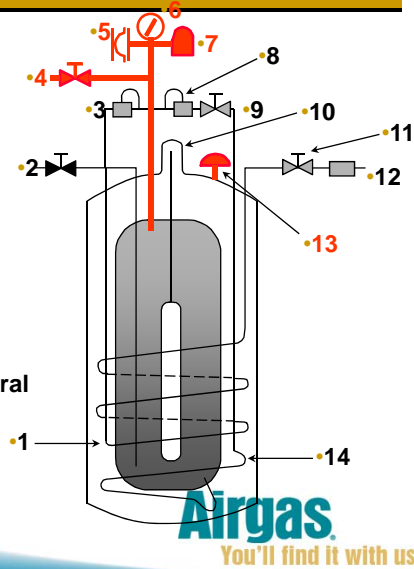
# Monitoring

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



# Pressure Relief

- 1 Gas withdrawal vaporizer
- 2 Liquid withdrawal valve
- 3 Economizer regulator
- 4 Vent valve
- 5 Inner tank rupture disk
- 6 Pressure gauge
- 7 Pressure relief valve
- 8 Pressure building regulator
- 9 Pressure building valve
- 10 Liquid level gauge
- 11 Gas withdrawal valve and integral check valve
- 12 Check valve in house line
- 13 Outer tank rupture disk
- 14 Pressure building vaporizer



# Safety & Cryo Supplies Items Available from Airgas



**THANK YOU!**  
**And be Safe!**



71

• Lab Design & Engineered Solutions

**Airgas**  
You'll find it with us.