



Safety of Gas Supply



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1、 Lab gas and cylinder requirements

Common gas (Classified according to the physical state and critical temperature of the gas in the bottle):

- Compressed gas ($T_c \leq -50^\circ\text{C}$) ——Hydrogen, Nitrogen, Argon, Helium, Oxygen, Air, etc.;
- High-pressure liquefied gas ($-50^\circ\text{C} < T_c \leq 65^\circ\text{C}$) ——Carbon dioxide, Ethylene, Ethane, etc.;
- Low pressure liquefied gas ($T_c > 65^\circ\text{C}$) ——Ammonia, Chlorine, Propane, Butane, Dimethyl ether, etc.
- Dissolved gas——Acetylene

Common gas (Classified by gas chemical properties, combustibility, toxicity, and corrosiveness) :

- Nonflammable gas——Nitrogen, Argon, Helium, Carbon Dioxide, etc.;
- Combustion-supporting gas——Oxygen;
- Flammable gas——Acetylene, Ethylene, Ethane, Propane, Butane, etc.;
- Toxic gas——Ammonia, Chlorine, Fluorine, etc.



1、 Lab gas and cylinder requirements

Physical parameters of common low-pressure liquefied gases

No.	Gas name	Chemical formula	Saturated vapor pressure at 60°C (gauge pressure, MPa)	Corresponding nominal working pressure (gauge pressure, MPa)	filling coefficient kg/L	Gas toxicity	Gas corrosive
1	Ammonia	NH ₃	2.52	3.0	0.53	poison	Alkaline corrosion
2	Chlorine	Cl ₂	1.68	2.0	1.25	poison	Acid corrosion
3	Propane	C ₃ H ₈	2.02	2.2	0.41	no	no
4	Isobutane	C ₄ H ₁₀	0.76	1.0	0.49	no	no
5	Acrylic	C ₃ H ₆	2.42	2.5	0.42	no	no



1、 Lab gas and cylinder requirements

Physical parameters of common high-pressure liquefied gases

No.	Gas name	Chemical formula	The filling coefficient (kg/L) of gas cylinders under different nominal working pressures (MPa) is not greater than				Gas toxicity	Gas corrosive
			20.0	15.0	12.5	8.0		
1	carbon dioxide	CO ₂	0.74	0.60	-	-	no	no
2	ethane	C ₂ H ₆	0.37	0.34	0.31	-	no	no
3	ethylene	C ₂ H ₄	0.34	0.28	0.24	-	no	no



1、 Lab gas and cylinder requirements

Physical parameters of common compressed gases

No.	Gas name	Chemical formula	Critical temperature (°C)	Cylinder color	Word color	Gas toxicity	Gas corrosive
1	Air	-	-140.6	black	white	no	no
2	Argon	Ar	-122.4	silver gray	Dark green	no	no
3	Helium	He	-268.0	silver gray	Dark green	no	no
4	Fluorine	F ₂	-129.0	white	black	Highly toxic	Acid corrosion
5	Nitric oxide	NO	-92.9	white	black	Highly toxic	Acid corrosion
6	Nitrogen	N ₂	-146.9	silver gray	Dark green	no	no
7	Oxygen	O ₂	-118.4	Light green	black	no	no
8	Hydrogen	H ₂	-239.9	Light green	Scarlet	no	no
9	Carbon dioxide	CO ₂	31.3	Aluminum white	black	Harmful suffocation	Acid corrosion

1、 Lab gas and cylinder requirements

Classification according to the cylinder structure:

- Seamless cylinder;
- Welding cylinder;
- Welding insulation cylinder;
- Winding cylinder;
- Gas cylinder with filling inside





1、 Lab gas and cylinder requirements

According to nominal working pressure:

- High-pressure gas cylinder ——gas cylinders with a nominal working pressure greater than or equal to 10MPa;
- Low-pressure gas cylinder ——gas cylinders with a nominal working pressure of less than 10MPa.

According to nominal volume:

- Small volume cylinder—— $V \leq 12L$
- Medium volume cylinder—— $12L < V \leq 150L$
- Large volume cylinder—— $150L < V$ 。



1、 Lab gas and cylinder requirements

The specificity of the cylinder:

- The gas cylinder containing a single gas must be dedicated, and only the gas consistent with the manufacturing mark is allowed to be refilled.

The cylinder manufacturing mark and its use shall not be changed, and other gases shall not be mixed or added with additives.

- Cylinders containing mixed gases must be filled with mixed gases of the same characteristics according to the gas characteristics determined by the cylinder mark, and no single gas or mixed gases with different characteristics shall be modified.

1、 Lab gas and cylinder requirements

Manufacturing mark of gas cylinder

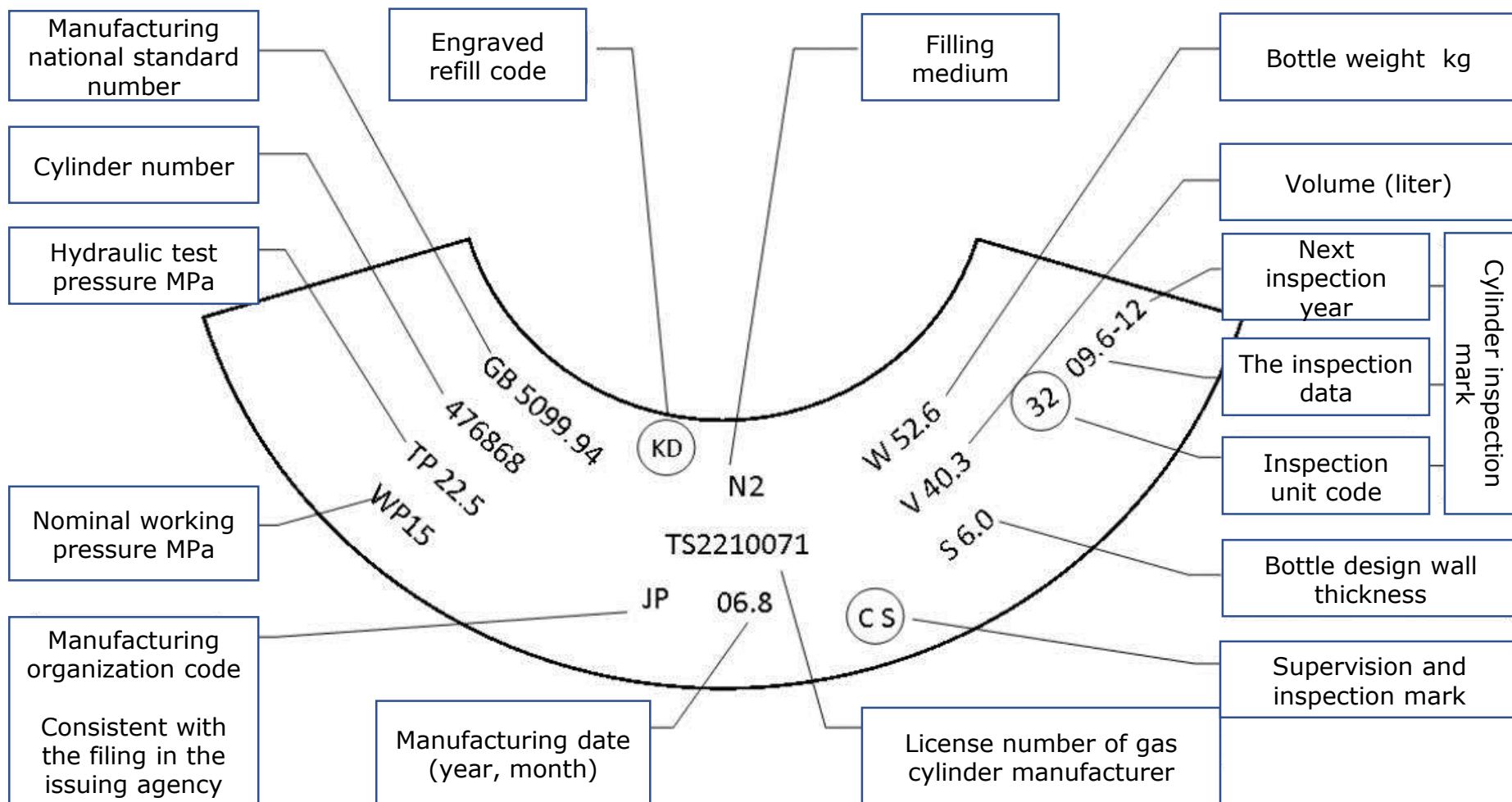
- It is the basis for identifying gas cylinders .
- The arrangement and content of the marks shall comply with the technical regulations and corresponding standards.
- It is a permanent mark.





1、 Lab gas and cylinder requirements

Gas cylinder stamp identification





1、 Lab gas and cylinder requirements

The color markings, words and color rings on the outer surface of the gas cylinder shall comply with the requirements of GB7144 "Colored cylinder mark for gases".

Table 2 List of color signs of gas cylinders

No.	Filling gas	Chemical formula (or symbol)	Body color	Typeface	Word color	color ring
1	Air	Air	Black	Air	White	P=20, White single ring P≥30, White double ring
2	Argon	Ar	silver gray	Argon	Dark green	
3	Fluorine	F ₂	White	Fluorine	Black	
4	Helium	He	silver gray	Helium	Dark green	P=20, White single ring P≥30, White double ring
5	Krypton	Kr	silver gray	Krypton	Dark green	
6	Neon	Ne	silver gray	Neon	Dark green	

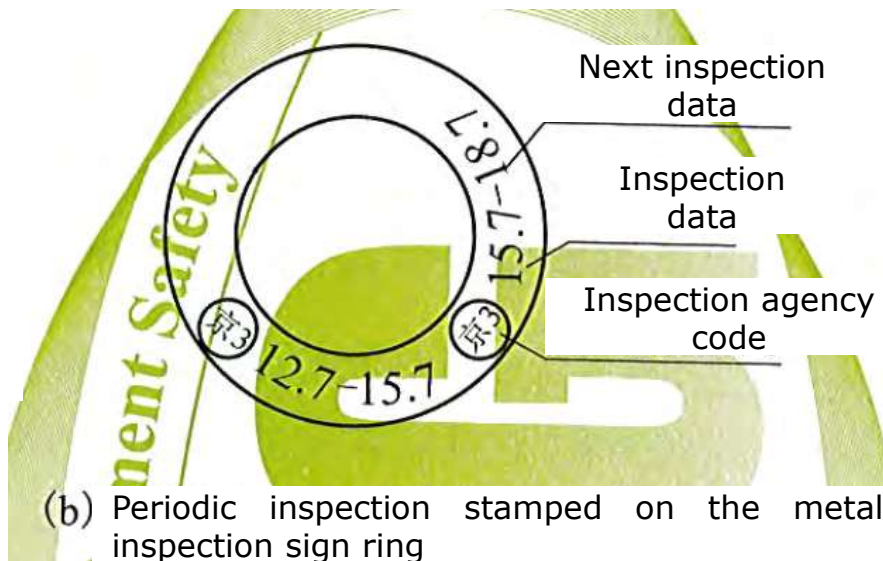
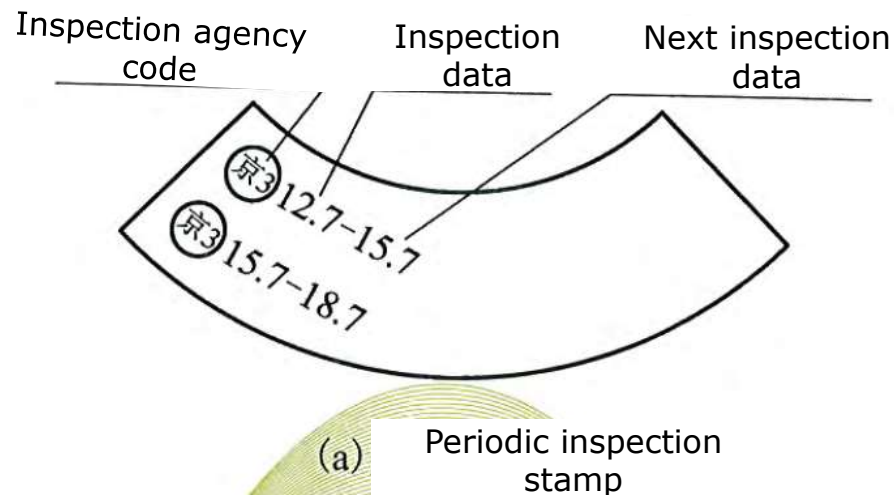


1、 Lab gas and cylinder requirements

No.	Filling gas	Chemical formula (or symbol)	Body color	Typeface	Word color	color ring
7	Nitric oxide	NO	White	Nitric oxide	Black	
8	Nitrogen	N ₂	Black	Nitrogen	White	P=20, White single ring P≥30, White double ring
9	Oxygen	O ₂	Light (phthalein) blue	Oxygen	Black	
10	Oxygen Difluoride	OF ₂	White	Oxygen Difluoride	Scarlet	
11	Carbon monoxide	CO	Silver gray	Carbon monoxide		
12	Deuterium	D ₂	Silver gray	Deuterium		
13	Hydrogen	H ₂	Light green	Hydrogen	Scarlet	P=20, Scarlet single ring P≥30, Scarlet double ring
14	Methane	CH ₄	Brown	Methane	White	P=20, White single ring P≥30, White double ring

1、 Lab gas and cylinder requirements

Regular inspection of gas cylinders, stamp marks, label marks, inspection mark rings and inspection color codes.





1、 Lab gas and cylinder requirements

Regular inspection of gas cylinders, stamp marks, label marks, inspection mark rings and inspection color codes.

Table B-4 Color and shape of inspection color scale (Note B-6)

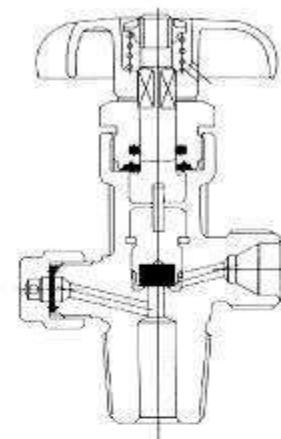
Year of inspection	Color	Shape
2014	Dark green (G05)	Oval
2015	Pink (RP01)	Rectangle
2016	Iron red (R01)	Rectangle
2017	Iron yellow (Y09)	Rectangle
2018	Lavender (P01)	Rectangle
2019	Dark green (G05)	Rectangle
2020	Pink (RP01)	Oval
2021	Iron red (R01)	Oval
2022	Iron yellow (Y09)	Oval
2023	Lavender (P01)	Oval
2024	Dark green (G05)	Oval

The cylinder inspection color code is a cycle every 10 years

1、 Lab gas and cylinder requirements

Cylinder valve

QF-2型 活瓣式氧气瓶阀 (Flapper Type Cylinder valve for Oxygen)



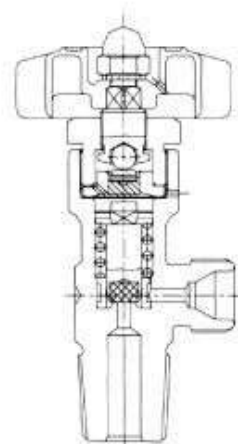
Safety relief device
(Very toxic gas
cylinders are
prohibited from
installing safety
relief devices)

产品型号	QF-2
Product type No.	QF-2
公称工作压力(MPa)	15MPa
PN(MPa)	15MPa
公称通径(mm)	4
DN(mm)	4
出口连接螺纹	G5/8
Outlet Joint Thread	G5/8
与气瓶连接螺纹	PZ27.8
Joint Thread to Cylinder	PZ27.8
安全装置温度或压力	21 ± 1.5Mpa
Temp./Pressure of Safety Device	21 ± 1.5Mpa
适用介质	氧气、氮气、空气
Suitable Medium	O ₂ 、N ₂ 、Air

1、 Lab gas and cylinder requirements

Cylinder valve

QF-90A型 高纯气钢瓶阀 (Steel type valve for high purified gas)

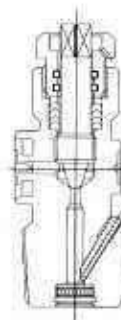


产品型号	QF-90A
Product type No.	QF-90A
公称工作压力(MPa)	15MPa
PN(MPa)	15MPa
公称通径(mm)	4
DN(mm)	4
出口连接螺纹	G5/8
Outlet Joint Thread	G5/8
与气瓶连接螺纹	PZ27.8
Joint Thread to Cylinder	PZ27.8
适用介质	高纯气体

1、 Lab gas and cylinder requirements

Cylinder valve

QF-15A型 乙炔气瓶阀 (Cylinder valve for C₂H₂)



Fusible alloy plug

产品型号	QF-15A
Product type No.	QF-15A
公称工作压力(MPa)	3MPa
PN(MPa)	3MPa
公称通径(mm)	4
DN(mm)	4
出口连接螺纹	∅ 21夹箍
Outlet Joint Thread	∅ 21clip
与气瓶连接螺纹	PZ39
Joint Thread to Cylinder	PZ39
安全装置温度与压力	100°C±5°C
Temp.Pressure of Safety Device	100°C±5°C
适用介质	乙炔
Suitable Medium	C ₂ H ₂

2、 Gas Supply Path design

Lab gas supply method:

1) Direct gas supply from cylinder——Set up a gas cylinder (or in cabinet) near the gas terminal in the laboratory to supply gas directly.

Advantage:

Gas supply path is short;

Disadvantage :

The layout is scattered, the management cost is increased, increase the frequency of cylinder replacement, and introduce the risk of replacing cylinder.



2、 Gas path design

◆ Gas cylinder cabinet

- Adopt fireproof and explosion-proof type
- Combustible gas and toxic gas should be dedicated for special cabinet
- Set the gas leak detector and alarm according to the stored gas
- The gas cabinet is equipped with a mechanical exhaust device, and the exhaust outlet is integrated into the laboratory exhaust system



2、 Gas Supply Path design

Lab gas supply method :

2) Central gas supply——It is introduced by pipeline from the dedicated gas supply area outside the laboratory.

Advantage:

- can supply multiple gas consuming points simultaneously, and can provide the continued gas supply by installing an automatic switching panel.

Disadvantage:

- Supply path is long and the construction cost increases;
- Strict requirements on the fire rating of structures.





2、 Gas Supply Path design

Gas Supply Room:

- The wall of gas cylinder room should adopt the solid wall with 300mm thickness, which is equipped with explosion-proof type door and window;
- Indoor electrical equipment should have explosion-proof type;
- The EX-exhaust fans should always maintain good ventilation;
- Oxidizing gas and combustible gas should be installed in different gas cylinder rooms or fire compartments;
- According to the physical and chemical characteristics of the gas, select the appropriate gas leakage detector and alarm device.

2、 Gas Supply Path design

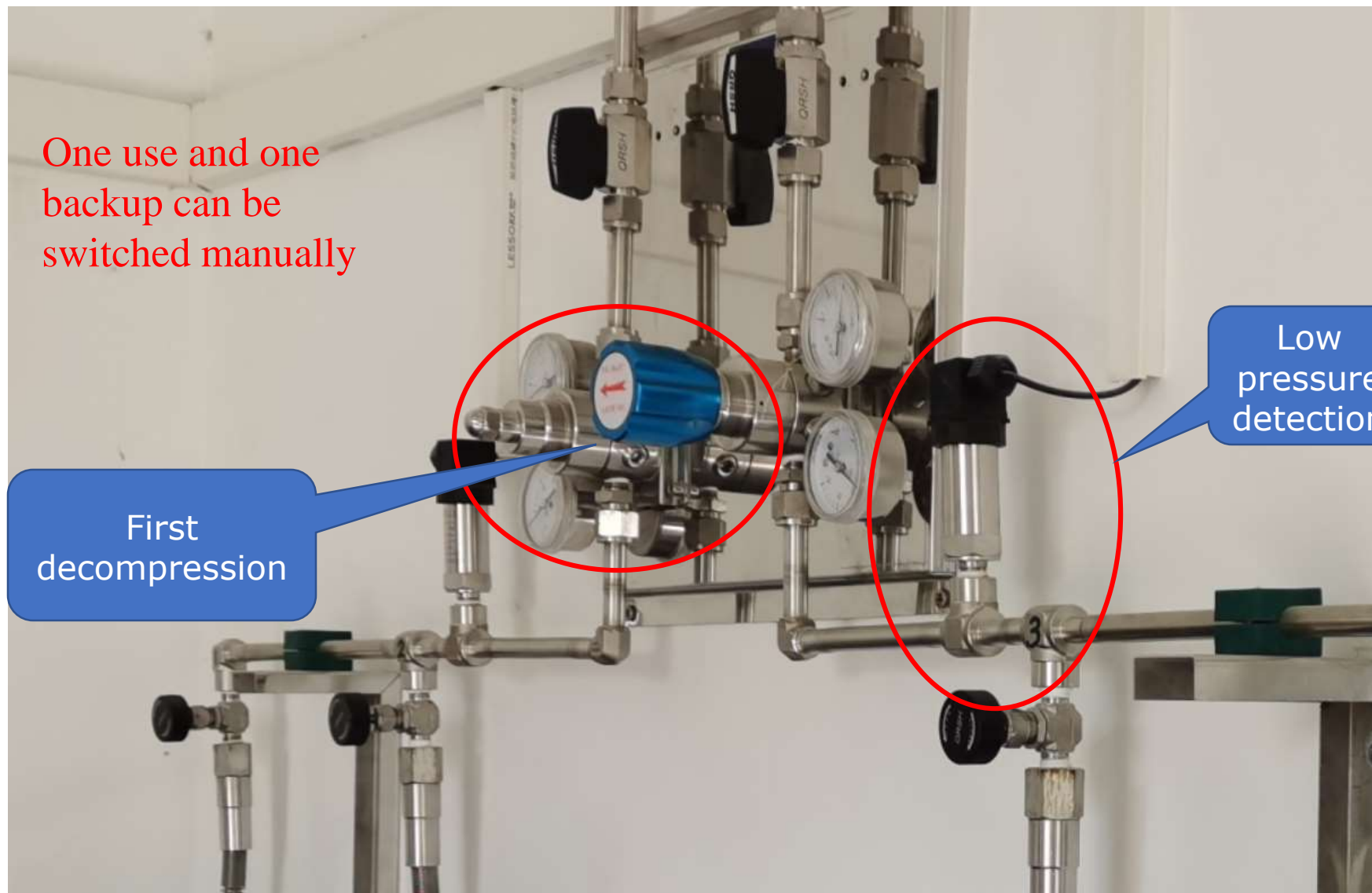
Gas Supply Room:

- 1、 The dedicated gas cylinders are equipped with flushing valves to eliminate impurities introduced each time the gas cylinder is replaced and to ensure the purity of the gas at the end of the pipeline.
- 2、 The gas supply system can switch between gas cylinders manually or automatically to ensure continuous gas supply.
- 3、 When the pressure falls below the alarm limit, the alarm device may be automatically initiated.
- 4、 The system adopts two-stage pressure reduction (the first stage is regulated by the air supply control system, and the second stage is regulated by the control valve at the point of use) to supply air, and a very stable pressure can be obtained.



2、 Gas Supply Path design

One use and one backup can be switched manually



First decompression

Low pressure detection

2、 Gas Supply Path design

Vent Way





2、 Gas Supply Path design

Gas path design general requirements:

- ① The pipe material is stainless steel pipe (BA grade, 316L).
- ② In lab, all pipelines are installed under the ceiling and laid out along the wall.
All pipelines are marked with connected gas. Every 1.5 meters or so, the gas pipeline needs support.
In addition, according to the bending radius of the gas pipeline, set a suitable bracket position.
All bends must be supported.
All brackets of the gas pipeline must be treated with corrosion protection.
- ③ The gas pipeline must be clearly marked at intervals of 1.5 meters and indicate the direction of gas flow.
- ④ Gas pipelines shall not be laid on the same trough as cables and conductive lines.
- ⑤ Flammable gases such as acetylene need to be introduced separately from other gases.

2、 Gas Supply Path design





2、 Gas Supply Path design

Gas path design general requirements:

- ⑥ If hydrogen pipelines are laid in parallel with other combustible gas pipelines, the spacing should not be less than 0.5M; the cross laying time should not be less than 0.25M. When laying in layers, the hydrogen pipeline should be located above.
- ⑦ Compressed air has a purification device for filtering impurities and moisture in the pipeline. This purification device needs to be connected in parallel and isolated by a separate valve to facilitate the maintenance of the filter device.
- ⑧ The connection of the high purity gas pipeline is seamless welding. Fittings can only be used when connecting to a valve or regulating device.
- ⑨ Each laboratory must have a separate control valve, pressure reducing valve and pressure gauge.

2、 Gas Supply Path design

General Requirements:

- A separate control valve should be installed in the gas pipeline leading to the workbench. The workbench shall have control valves for uniformly discharging various gases, with different color codes and clear text marks.
- It is recommended to install a gas purification device in front of the helium pipeline.
- After the installation of the gas supply system is completed, relevant strength tests, sealing tests and stability tests are carried out as required.



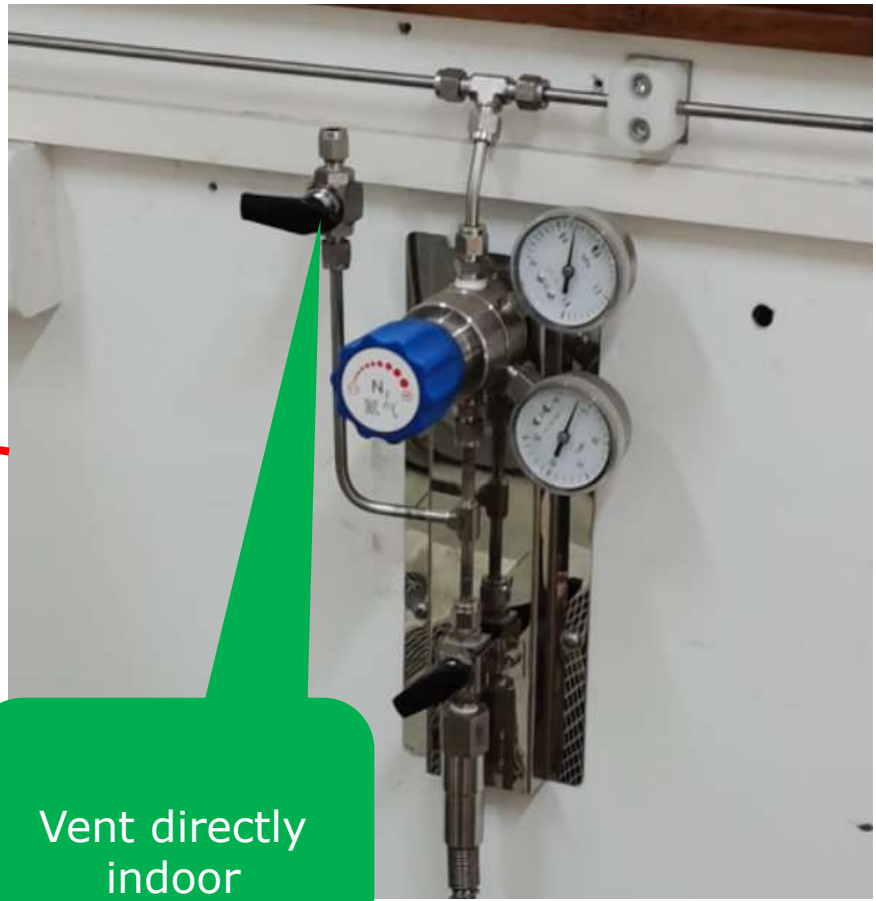
3. Problems for Lab Attention



No status indicator used

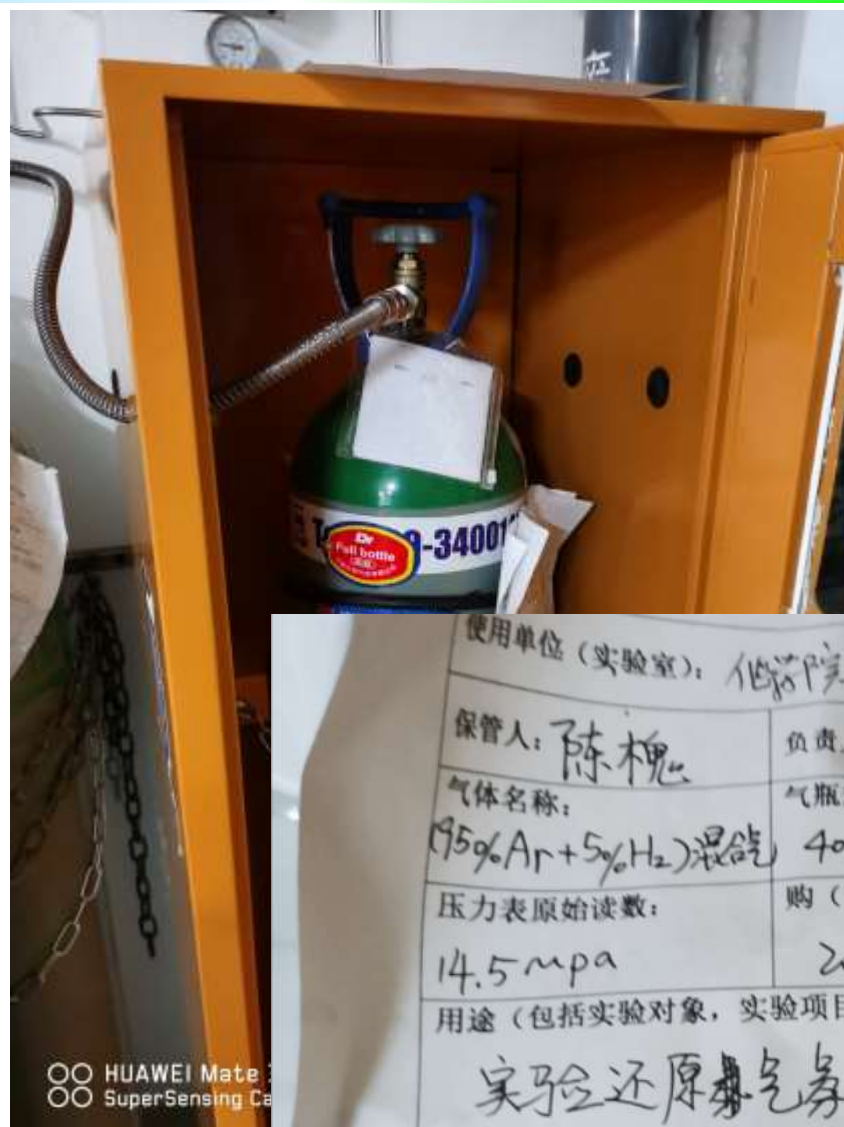
No anti-dumping measures

3. Problems for Lab Attention



Vent directly indoor

3. Problems for Lab Attention



3. Problems for Lab Attention



The label does not match the actual gas used

3. Problems for Lab Attention



A large amount of
Sundries piled
around the cylinder

3. Problems for Lab Attention



The ammonia pipeline uses copper fittings

3. Problems for Lab Attention



Flammable gas is planned to be used in the cylinder room, and the electrical wiring does not meet the explosion-proof requirements.

3. Problems for Lab Attention



The gas leakage alarm setting position does not meet the requirements.

3. Problems for Lab Attention



Valves in the pipeline well

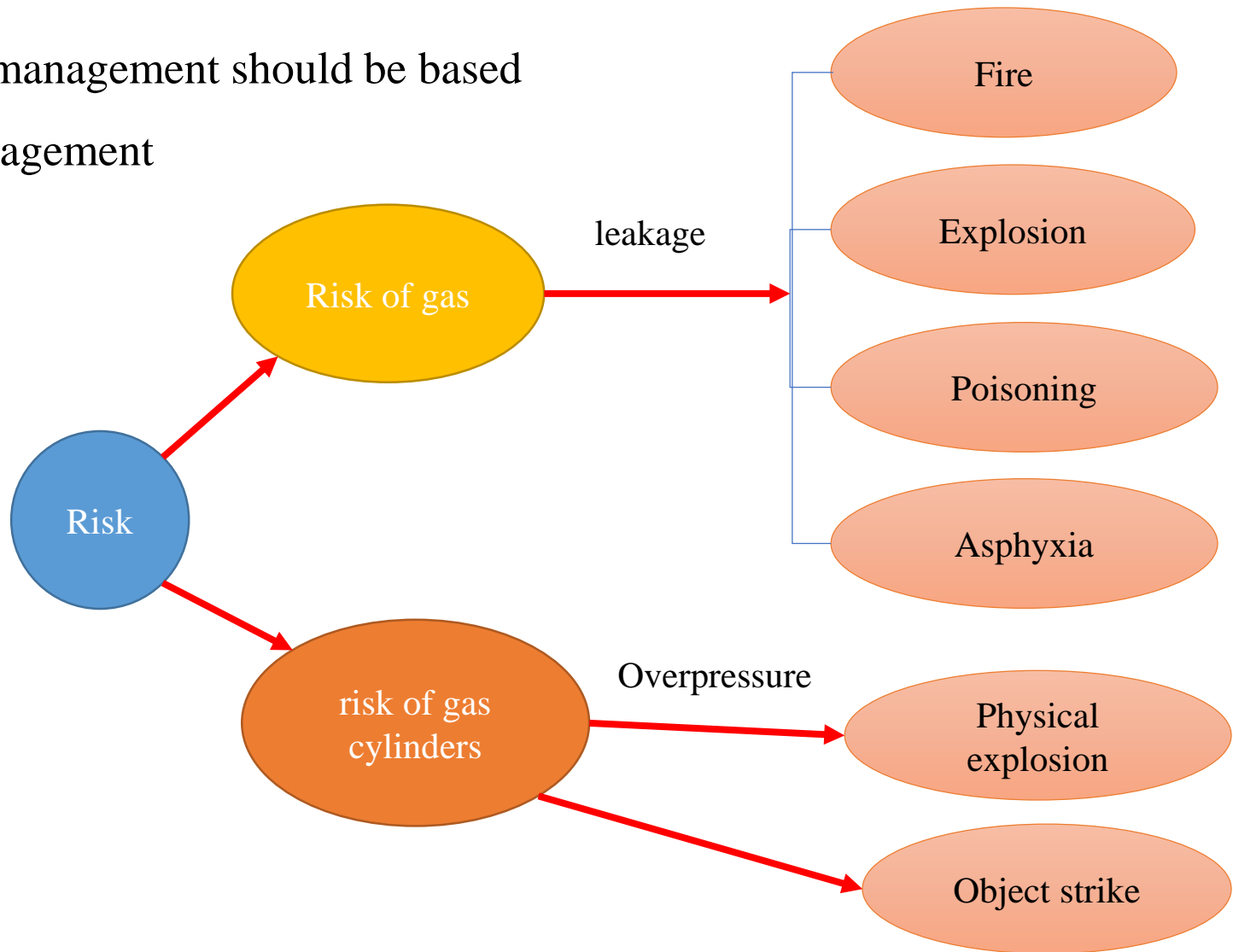
3. Problems for Lab Attention



**There is no
blockage where
the pipeline
crosses the floor.**

4. Safety Requirements for Gas Use

Gas safety management should be based on risk management



4. Safety Requirements for Gas Use

Safety Requirements:

- **Gas detector**——Toxic gas detector, combustible gas detector, oxygen detector
 - **Emergency Shut Down**——Install an emergency shut down valve near the angle valve of the gas cylinder or the first-grade pressure reducing valve, specially for toxic gas and flammable gas, and can be interlocked with gas detection
 - **Mechanical exhaust**——A mechanical exhaust device should be installed in the gas cylinder cabinet or special gas cylinder room, and the mechanical exhaust device should maintain a certain amount of air exchange rate; the exhaust device of toxic gases should have harmless treatment measures
 - **Alarm** —— Low pressure alarm monitoring
 - **Check valve**——Prevent backflow of gas
 - **Fixing device** —— for gas cylinder to prevent tipping
-

4、 Safety requirements for gas use

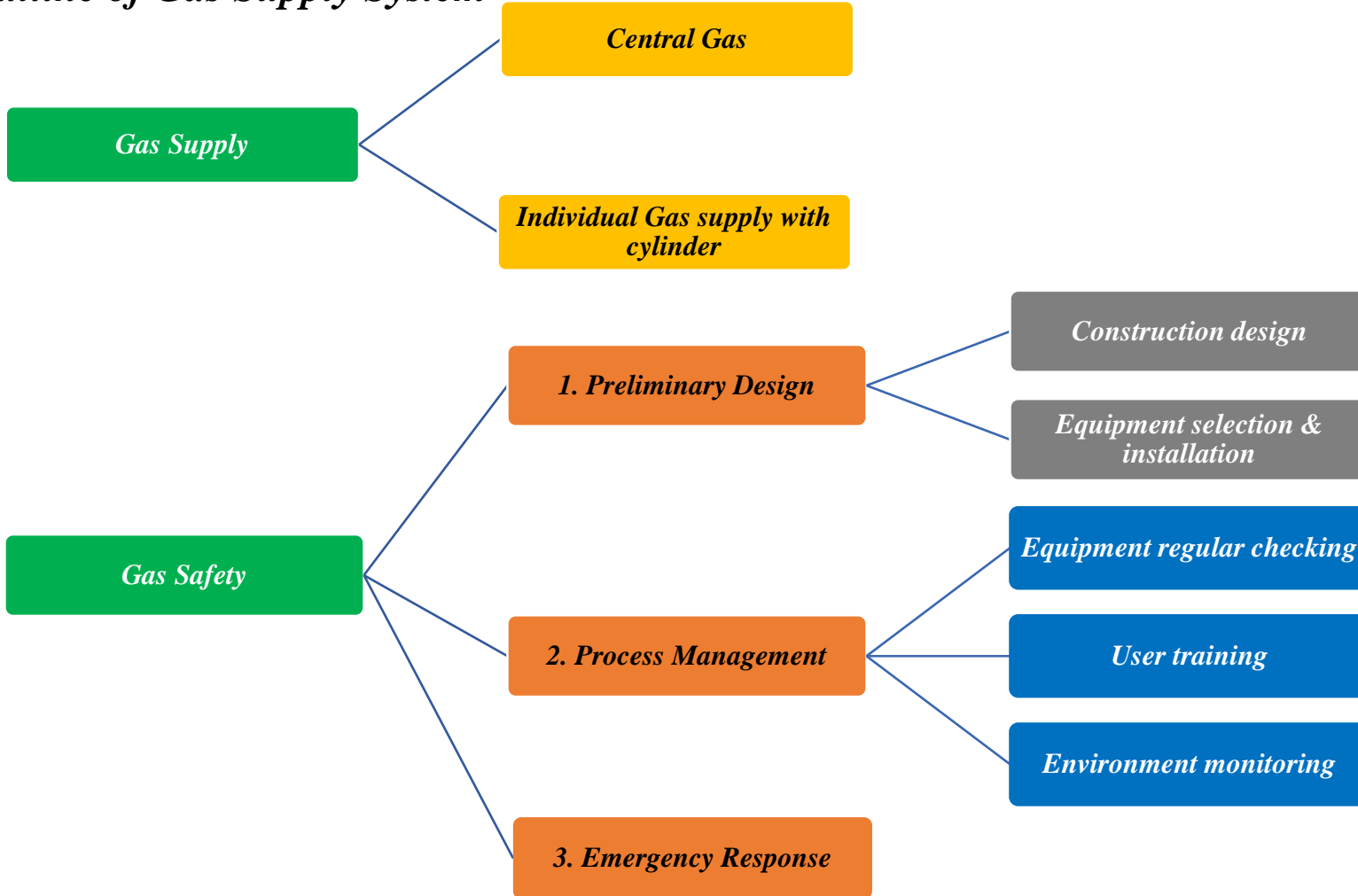
Safety Requirements :

- Select qualified gas supplier
- schools and labs need to establish their own cylinder use record
- Before use, check whether the gas cylinder is within the effective using period, whether the manufacturing mark and color code of the gas cylinder are matched the gas contained, and whether fit with qualified label for the gas cylinder
- Check whether the cap or protective cover of the gas cylinder is in place
- Empty and full bottles should be placed separately and clearly marked
- Equipped with necessary firefighting and emergency equipment according to the gas type
- Propaganda and train about the use of gas cylinder
- Establish Gas Management Procedures, equip with necessary protective equipment, and conduct regular emergency drills
- The gas pipeline should have obvious signs of medium and flow direction



5. Recommendations for gas management

Outline of Gas Supply System



5. Recommendations for school gas management

Central Gas :

1. *Compressed air*
2. *Nitrogen*
3. *Carbon dioxide*
4. *Liquefied*

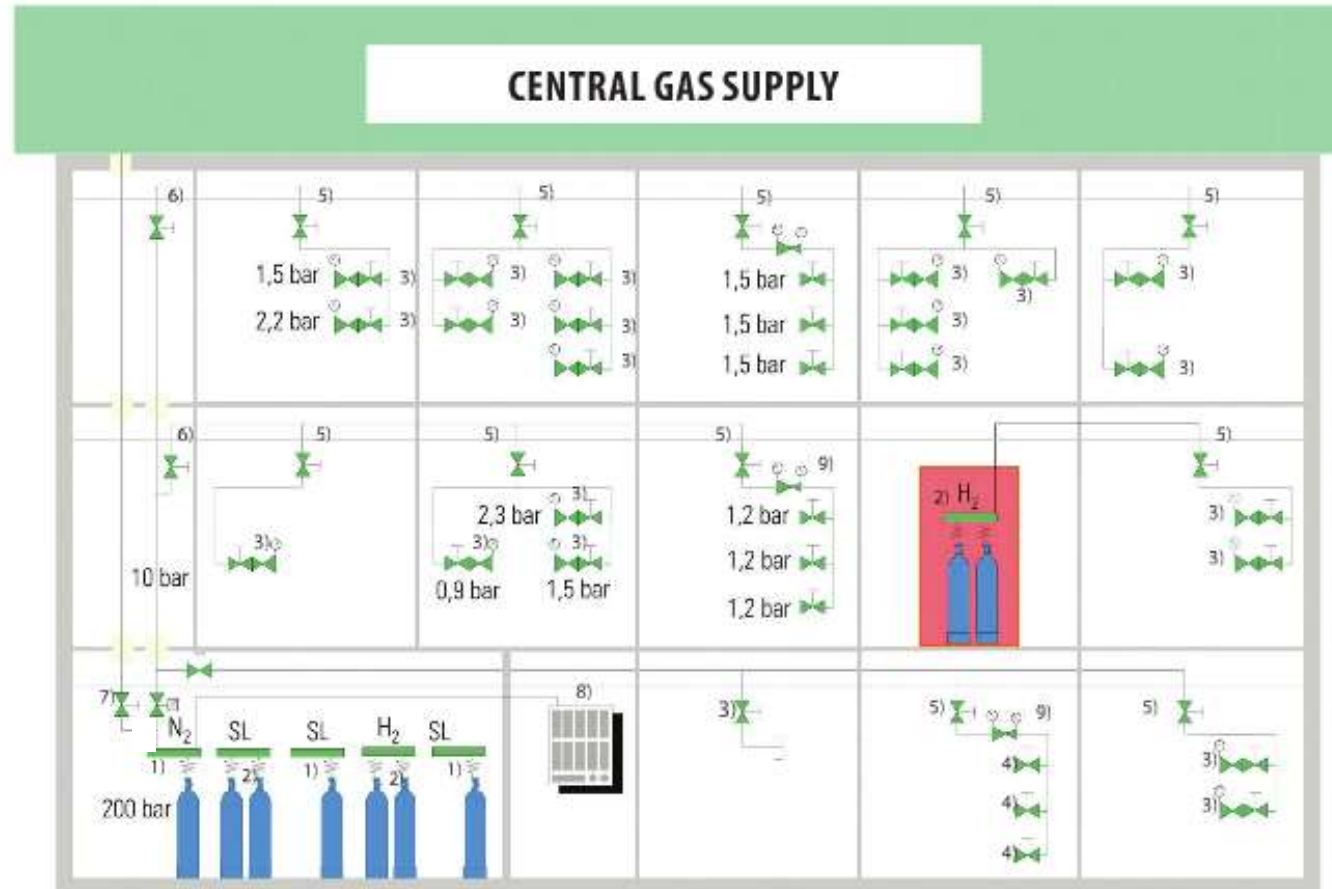
Petrol Gas

5. *He*
6. *Argon*
7. *Oxygen O2*

System Functions of Gas central control panel:

1. *Gas volume monitor*
2. *Gas leakage monitor & alarm*
3. *Point of use & shut off*
4. *Room shut off*
5. *Floor shut off*
6. *Central shut off*

1. Central Gas Supply



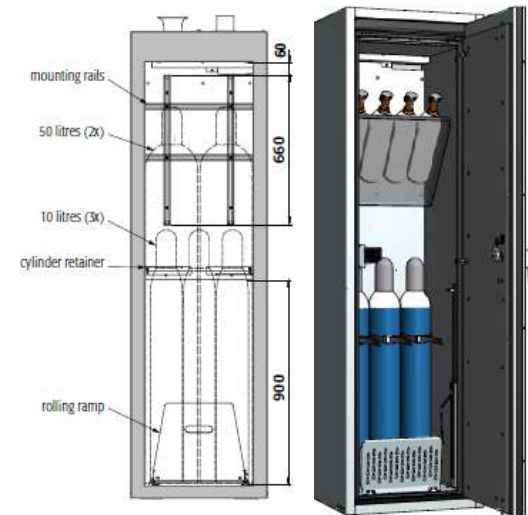
5. Recommendations for school gas management

2. Single Gas Supply



Portable Gas cylinder in labs:

1. NH_3
2. H_2
3. C_2H_2



Combined storage

of 2 and 10-litre cylinders, taking model G90.205.060.R as an example, and 1 inclined shelf with standard interior equipment (Order No. 30782) and 1 inclined shelf (Order No. 30788)

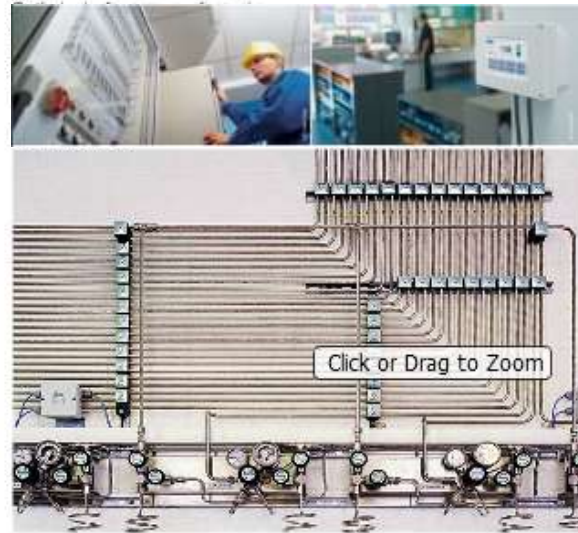
5. Recommendations for school gas management

3. Gas System Function Requirement

System Control & Monitor Function:

1. Gas central control panel
 - Point of use & shut off
 - Room shut off
 - Floor shut off
 - Central shut off
3. Gas stock management
 - Gas volume monitor
4. Gas leakage monitor & alarm
5. Visualizing of system status (include monitoring)
6. Fault & cost reduction
7. Statistic & archive functions

beginning with the planning phase.



Point-of-use cabinet with integrated low gas signalling



GasCom: graphic display of cylinder pressure with alarm functions and low supply (no more display)

5. Recommendations for school gas management

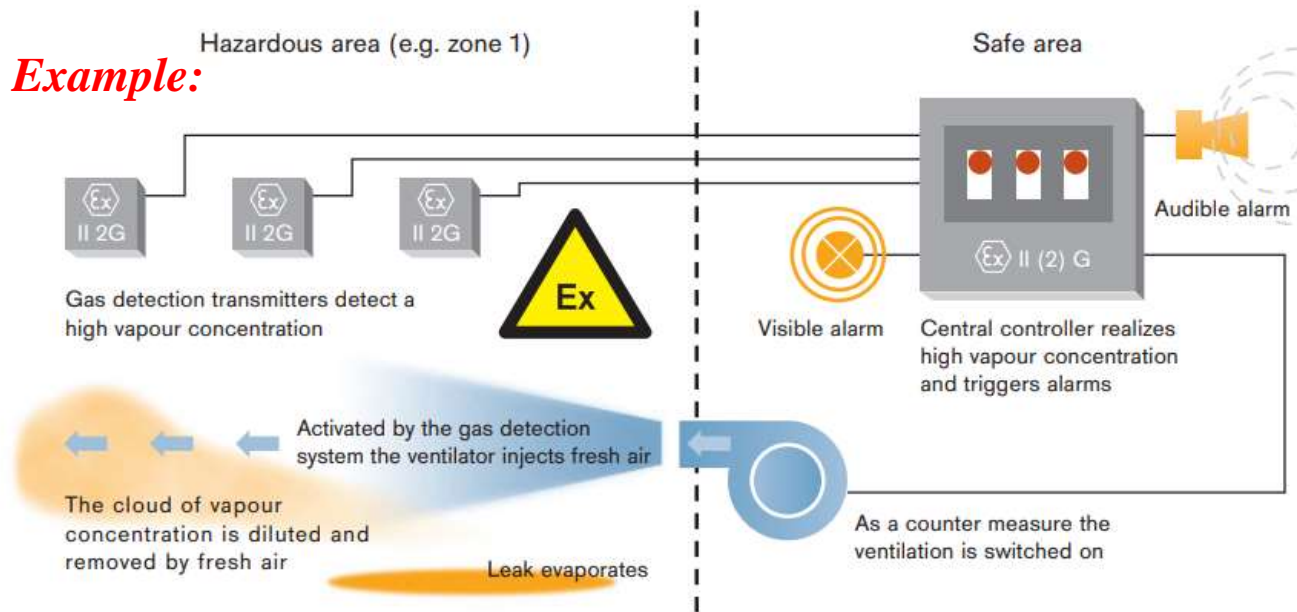
4. Emergency system design (Supporting system)

Gas detecting system in gas cylinder cabinet and using area

Type:

1. Oxygen concentration
2. Flammable gas concentration

Example:



Stay Connected. Work Smarter.



ST-1594-2007

5. Recommendations for school gas management

5. Gas Supply System *(based on central & independent supply)*

1. Preliminary Design

1. Construction design
2. Cabinet selection
3. Piping design
4. Supporting and monitoring system design
5. Emergency system design

3. Emergency Response

1. Emergency Response Plan
2. ERP Drilling & practice



2. Process Management

1. Gas supply by qualified supplier with good quality
2. Regular calibration and testing by authority for piping and accessories
3. Special compressed piping certificate and management person certificate
4. Management procedure for Gas using & facility

4. Audit & Improving

1. Audit local gas supplier
2. Regular inspect the gas using labs
3. Check all gas using record
4. Keep improving with findings

5. Recommendations for school gas management

Design Requirement for Gas Supply System

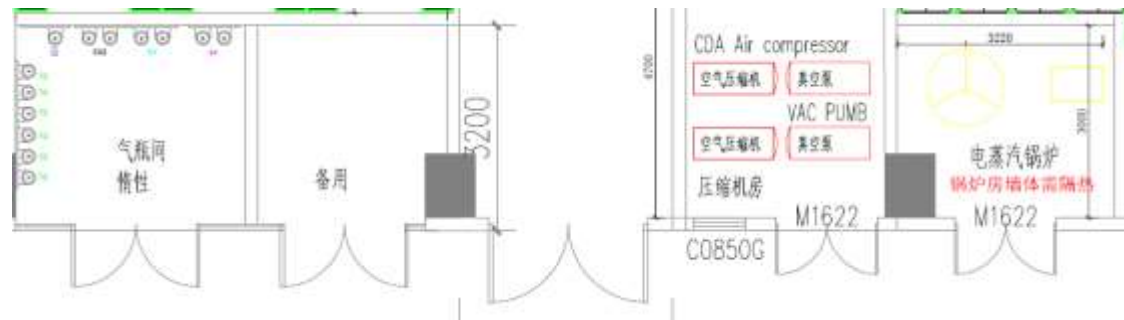
Central Gas :

1. Compressed air
2. Nitrogen
3. Carbon dioxide
4. Liquefied Petrol Gas
5. He
6. Ar
7. Oxygen O₂

Individual Gas cylinder in lab:

1. NH₃
2. H₂
3. C₂H₂
4. C₂H₄
5. CH₄
6. CO
7.

Example for Teaching lab building:



Central supply Gas Cylinders

- Teaching labs building: 21 + 21
- Research building: 24+24

Minimize the risk of **Explosive /Flammable/Toxic** gas using,

Set the portable gas cylinders in the gas cabinet of labs.

1. Maximum Volume control
2. Shorten the length of gas supply piping
3. Design for gas leakage control/monitor/emergency response setting
4. Special equipment regular calibration/testing



5. *Recommendations for school gas management*

Gas monitoring system recommendations (Teaching and Research Buildings)

Design concept:

- Use centralized gas supply throughout the building as much as possible, reduce the storage of various gas cylinders in the laboratory, and reduce hidden danger points through centralized control;
- Inflammable and explosive gases that cannot be placed independently from the central supply must be prevented in the fireproof cabinet;
- The pressure and usage of various gas cylinders can be monitored by the monitoring system. Once a leak occurs, it can not only be found in time, but also the source of the leak can be cut off through remote control, so that emergency operations are intrinsically safe, reducing personnel exposure risks, and ensuring school experiments Safety environment for personnel operation.

Monitoring system function and setting requirements:

- The central gas supply station adds corresponding gas detectors for the gas used, and centrally monitors control signals, such as oxygen, CO, flammable and explosive gases, etc.;
- The independent gas cylinder cabinet and the equipment connected to the gas supply pipeline must be equipped with corresponding gas cylinder detectors;
- Real-time display of the pressure of each cylinder unit;
- The system can set high and low pressure alarms for each monitoring point through the lower limit of gas explosion LEL of different gas supply units;
- The system can set the pressure alarm value of each monitoring point through the pressure resistance and leakage pressure of the gas cylinders of different gas supply units;
- Equipment failure and abnormal alarm.



5. Recommendations for school gas management

Gas monitoring system recommendations (Teaching and Research Buildings)

Control system function and setting requirements:

- The valve of any cylinder controlled by the system can be closed or opened through the remote control solenoid valve;
- Control system alarm and fault handling function;

Gas supply monitoring system and setting requirements:

- Each node can be connected via wireless network such as monitoring system;
- The control system must be able to meet the number of gas cylinder points in the scientific research building and teaching building, and a 20% margin should be reserved;
- Monitoring data is recorded and automatically saved, and the storage time shall not be less than 90 days.



*„Nothing we do is worth getting
hurt for!“*

没什么是值得以牺牲安全作为代价！