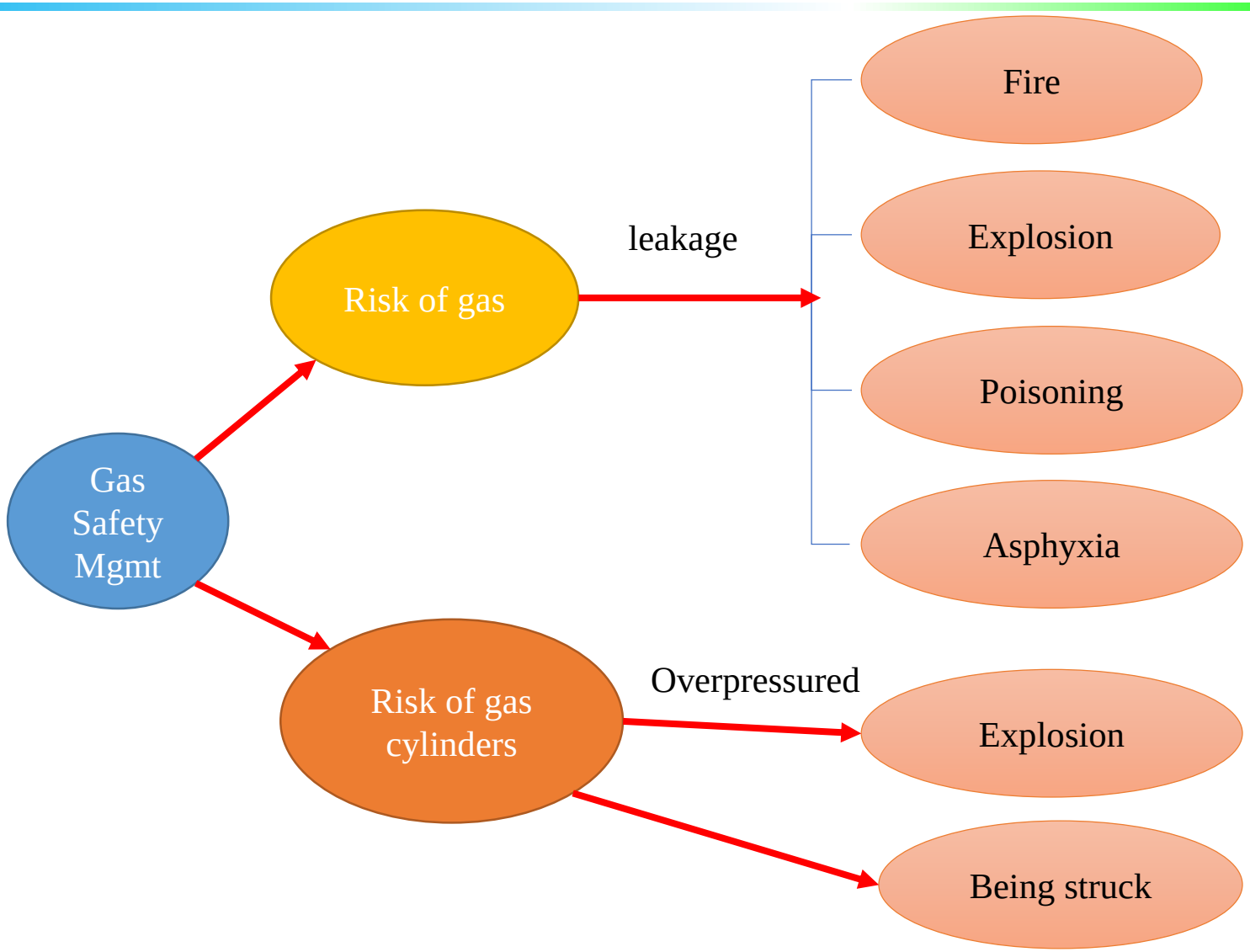
Safety of Gas Supply and Use

Why we are conducting this training?



Unaccepted Scenarios

When new experiment suggests the need for gas supply, new type of gas would be introducted into lab.

Supplier might only provide quick fix in terms of gas cylinder. See below.

Insecure Connection

Temporary fix used as a permanent method

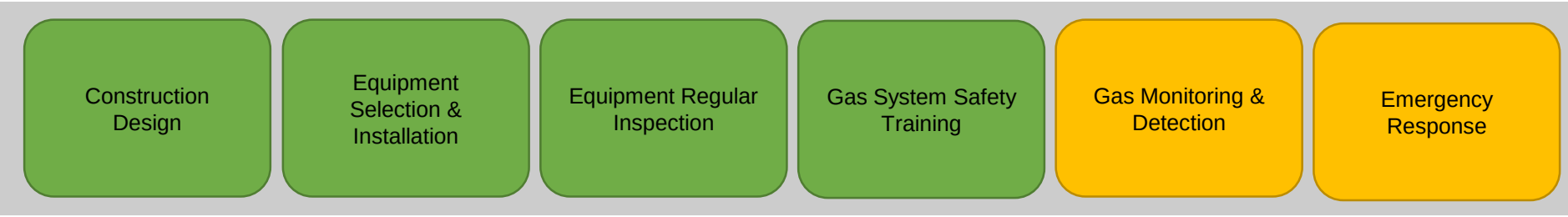
Special request

Potential Risk with current situation:

1. Possible leakage from the plastic hose because of insecure connection or low quality piping, regulator and accessories.
2. Cylinder not properly secured might fall down
3. Frequently operating the regulator could damage the valve, causing leakage and shortening the lifespan of the regulator
4. Not equipped with gas monitor and detector for leakage and pressure of gas supply
5. Not equipped with emergency shut down in case of flammable/ toxic gas leakage
6. No design for ventilating or releasing exhaust gas

Overview of Gas Supply System

Centralized Gas Supply (Cylinders involved)



Independent Gas Supply with Cylinders

Agenda

1. Why we are conducting this training?
2. Gas and cylinder safety requirements
3. Gas supply safety requirements
4. Emergency Response
5. Recap & Case Sharing
6. Issues for Lab attention

2、Gas and cylinder safety requirements

- Classification of common gas

- **Common gas (Classified according to the physical state and critical temperature of the gas in the bottle):**
  - Compressed gas（Tc≤-50℃）——Hydrogen, Nitrogen, Argon, Helium, Oxygen, Air, etc.;
  - High-pressure liquefied gas（-50℃ < Tc≤65℃）——Carbon dioxide, Ethylene, Ethane, etc.;
  - Low pressure liquefied gas（Tc > 65℃）——Ammonia, Chlorine, Propane, Butane, Dimethyl ether, etc.
  - Dissolved gas——Acetylene

- **Common gas (Classified by 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.

2、Gas and cylinder safety requirements

- Phyiscal paramenters of common compressed gas

No.	Gas name	Chemical formula	Critical temperature (℃)	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	Nitric oxide	NO	-92.9	white	black	toxic	Acid corrosion
5	Nitrogen	N2	-146.9	black	white	no	no
6	Oxygen	O2	-118.4	light blue	black	no	no
7	Hydrogen	H2	-239.9	light green	Scarlet	no	no
8	Carbon dioxide	CO2	31.3	aluminum white	black	Harmful suffocation	Acid corrosion

2、Gas and cylinder safety requirements

- Classification of cylinders

According to cylinder structure：

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

2、Gas and cylinder safety requirements

- Classification of cylinders

According to normal 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.

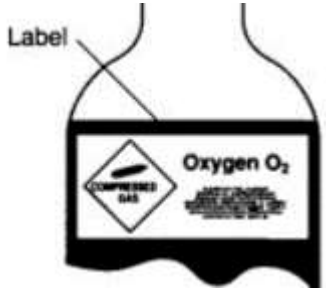
According to normal volume：

- Small volume cylinder——V≤12L
- Medium volume cylinder——12L＜V≤150L
- Large volume cylinder——150L＜V。

2、Gas and cylinder safety requirements

- Precautions for using gas cylinder

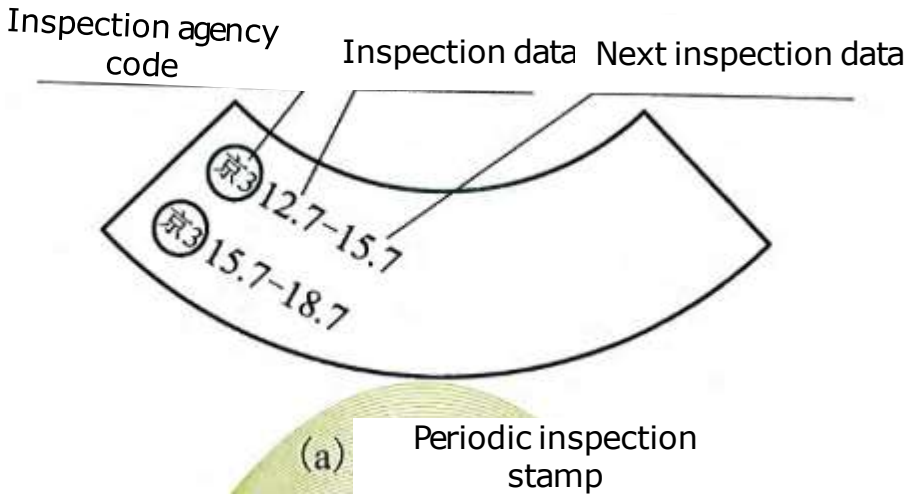
- Select the qualified gas supplier;
- Establish a record of cylinder use;
- Check all compressed gas cylinders before accepting or receiving from the supplier:
  - a) whether the manufacturer's permanent stamped markings on the neck of a cylinder and color coding match the gas contained inside.
  - b) whether the cylinder is fitted with a qualification label.
  - c) whether the safety cap or protective cover of the gas cylinder is in place.

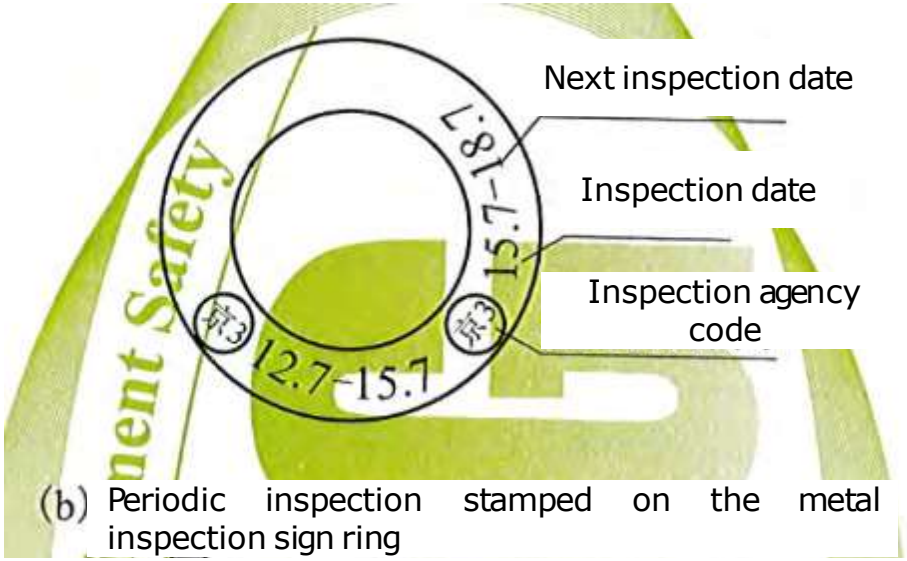


2、Gas and cylinder safety requirements

- Precautions for using gas cylinder

d) Whether the gas cylinder is valid for use. Do not use a cylinder that is out of the certification. The initial and subsequent inspection/certification dates are normally stamped on the the cylinder or on the metal ring.





2、Gas and cylinder safety requirements

- Precautions for using gas cylinder

Cylinders with a single type of gas inside must be dedicated and only refilled with the same type of gas consistent with manufacturer's indication.

- Never mix with any other type of gas or even additives.
- Never modify manufacturer's label or marking stamped on the base or neck of the cylinder.

Cylinders with gas mixture inside must be refilled with same type of gas mixture consistent with manufacturer's indication.

- Never mix with any other type of gas or gas mixture.

CAUTION：

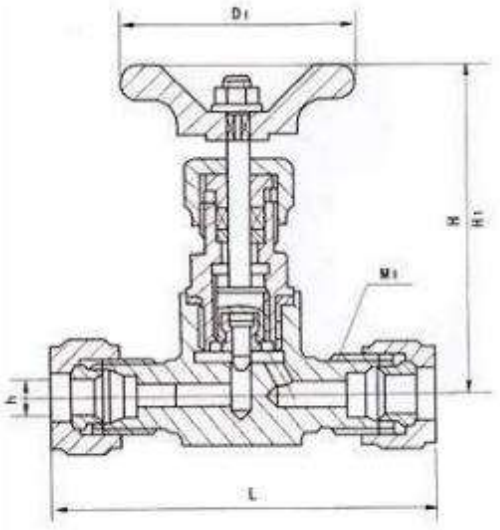
Always maintain the pressure of any gas cylinder at or higher than 170Kpa (1.7 bar).

Never use up the gas in any cylinder !

2、Gas and cylinder safety requirements

- Precautions for using gas cylinder

Needle Valve
Product type: JJY1-1.6 (32) type



Set-up requirements:

- A needle valve or Diaphragm Valve is required to be added to the hydrogen supply line with one end connecting the outlet of the gas cylinder and another end connecting the inlet of the equipment.

2. Material of main parts:

零件名称 Part name	阀杆、阀盖、螺栓 Body、Bonnet、Bolt	阀杆、阀瓣、密封垫 Stem、Disc、Gasket	填料 Packing	垫片Gasket	手轮 Handwheel
JJY1-320-DN5	铬镍不锈钢 Cr、Ni Stainless steel	不锈钢 Stainless steel	聚四氟乙稀，柔性石墨 PTFE，Soft graphite	橡胶石棉板 Latex asbestos	优质碳钢High grade carbon steel

2、Gas and cylinder safety requirements

- Precautions for using gas cylinder

- Hazard notification cards shall be posted for the gas currently being used.
- A cylinder status plate shall be hung on the body of each cylinder, regardless whether it is in use, empty, full or not in service.

2、Gas and cylinder safety requirements

- Precautions for Hose

1910.111(b)(8)(ii)

Hose subject to container pressure shall be designed for a minimum working pressure of *350 p.s.i.g. (24.13Bar)* and a minimum burst pressure of *1,750 p.s.i.g (120.66Bar).*

Hose assemblies, when made up, shall be capable of withstanding a test pressure of *500p.s.i.g(34.50Bar).*

1910.111(b)(8)(iii)

Hose and hose connections located on the low-pressure side of flow control of pressure-reducing valves shall be designed for a bursting pressure of not less than 5 times the pressure setting of the safety relief devices protecting that portion of the system but not less than *125 p.s.i.g (8.62Bar).*

All connections shall be so designed and constructed that there will be no leakage when connected.

2、Gas and cylinder safety requirements

- Precautions for using gas cylinder

When replacing gas cylinders or reconnecting equipment,

- Leak test of connection points must be completed and recorded.

Gas Leak Test Record Form

气体测漏记录表

No. 序号	Location 位置	Type 种类	Pressure 使用压力	Inspector 检查人员	Results 试漏结果	Date 日期
1	Central gas supply room of research building	Nitrogen N2	13.5 kg.f/cm2	XXX	Passed	2021-07-01
2	Central gas supply room of research building	Argon Ar	13.5 kg.f/cm2	XXX	Passed	2021-07-01
3	Central gas supply room of research building	Oxygen O2	13.5 kg.f/cm2	XXX	Passed	2021-07-01
4	Teaching labs building	Nitrogen N2	13.5 kg.f/cm2	XXX	Passed	2021-07-01
5	Teaching labs building	Argon Ar	13.5 kg.f/cm2	XXX	Passed	2021-07-01
6	Teaching labs building	Oxygen O2	13.5 kg.f/cm2	XXX	Passed	2021-07-01

3、Gas supply safety requirements

Normally lab is using a centralized gas supply system through which gas is supplied into lab from the dedicated supply point outside the lab area.

Advantage:

- can simultaneously supply gas to mutiple locations, and provide continous gas supply by installing an automatic switching panel.

Disadvantage:

- Long supply path and high construction cost;
- Strict requirements on the fire rating of structures.

3、Gas supply safety requirements

General requirements：

a) The connections of the high purity gas pipeline must be done via seamless welding. And fittings can only be used when connecting to a valve or a regulating device.

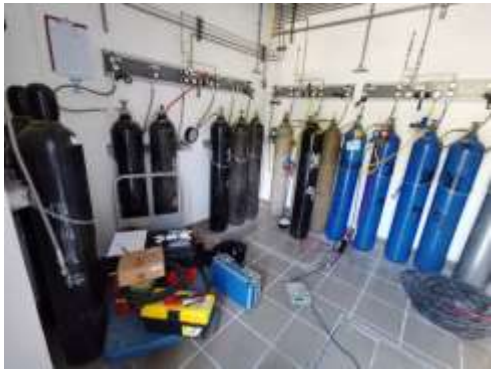
b) Each lab must have a separate control valve, pressure reducing valve and pressure gauge, which shall be properly labelled and color coded.

c) Pressure and leaking test shall be conducted at all connection points under the following circumstances with testing results recorded:

- when the gas supply system is first set up;
- when the gas supply system is resumed after stopping use for a long period of time;
- when changing or replacing cylinders.

d) School shall carry out visual inspections and regular comprehensive inspections for all centralized as well as independent gas supply lines each semester.

e) Caution: Empty cylinders should always be clearly labelled and stored separately from full ones to prevent accidental connection of an empty cylinder to a pressurized system.



3、Gas supply safety requirements

- Standardize the management process of gas supply system

Labs at design or construction phase (C1)	Constructed labs already handed over to Lab PI (C2)
• Design of gas supply system can be handled by CCD. • Piping construction process can be supervised by CCD. • EHS will provide consultation on design and set-up. • The installation cost of piping for C1 lab will be covered under campus construction budget.	• Design of gas supply system can be handled by CCD. • Piping construction process can be supervised by CCD. • EHS will provide consultation on design and set-up. • The installation cost of piping system for C2 lab will be covered under Lab's own budget.

Note: The setting of all gas systems must follow the requirements listed in the next two pages.

3、Gas supply safety requirements

- Set-up for gas supply

For Non-flammable gas cylinders：

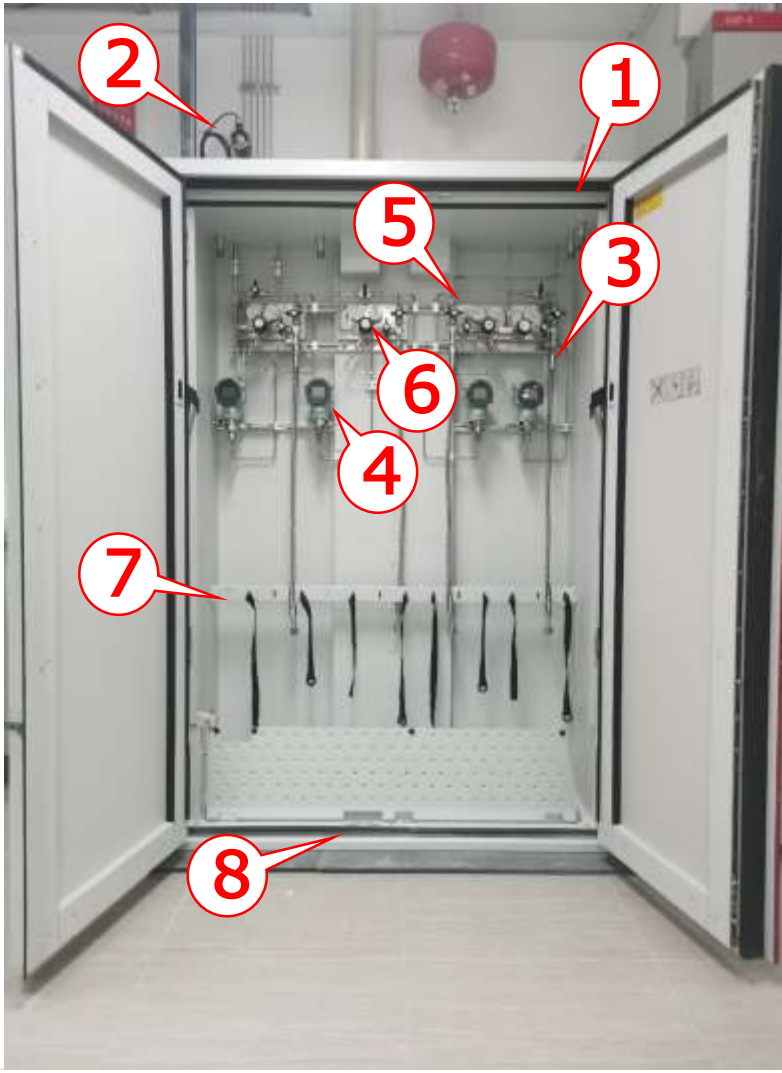
1. Regulator panel
2. Gas regulator suited for the gas type
3. Oxygen concentration detector for the cylinder storage area as well as the using point (optional)
4. Safety straps or chains
5. The names of the gases being stored clearly posted at the storage area

3、Gas supply safety requirements

- Set-up for gas supply

For Flammable / Toxic gas cylinders :

1. 90-minute fire-proof cabinet (EN14470-2)
2. Emergency shut down valve for main piping
3. Gas detector for the cylinder cabinet and the gas using point
4. Leak detection alarm connected to control center
5. Regulator panel
6. Gas regulator suited for the gas type
7. Safety straps or chains
8. Cabinet support (steel plate and rubber pad)
9. Check valve for preventing backflow of gas
10. Venting system with vent exhausts connected to areas outside lab
11. The names of the gases being stored clearly posted at the storage area



3、Gas supply safety requirements

- Centralized gas supply system

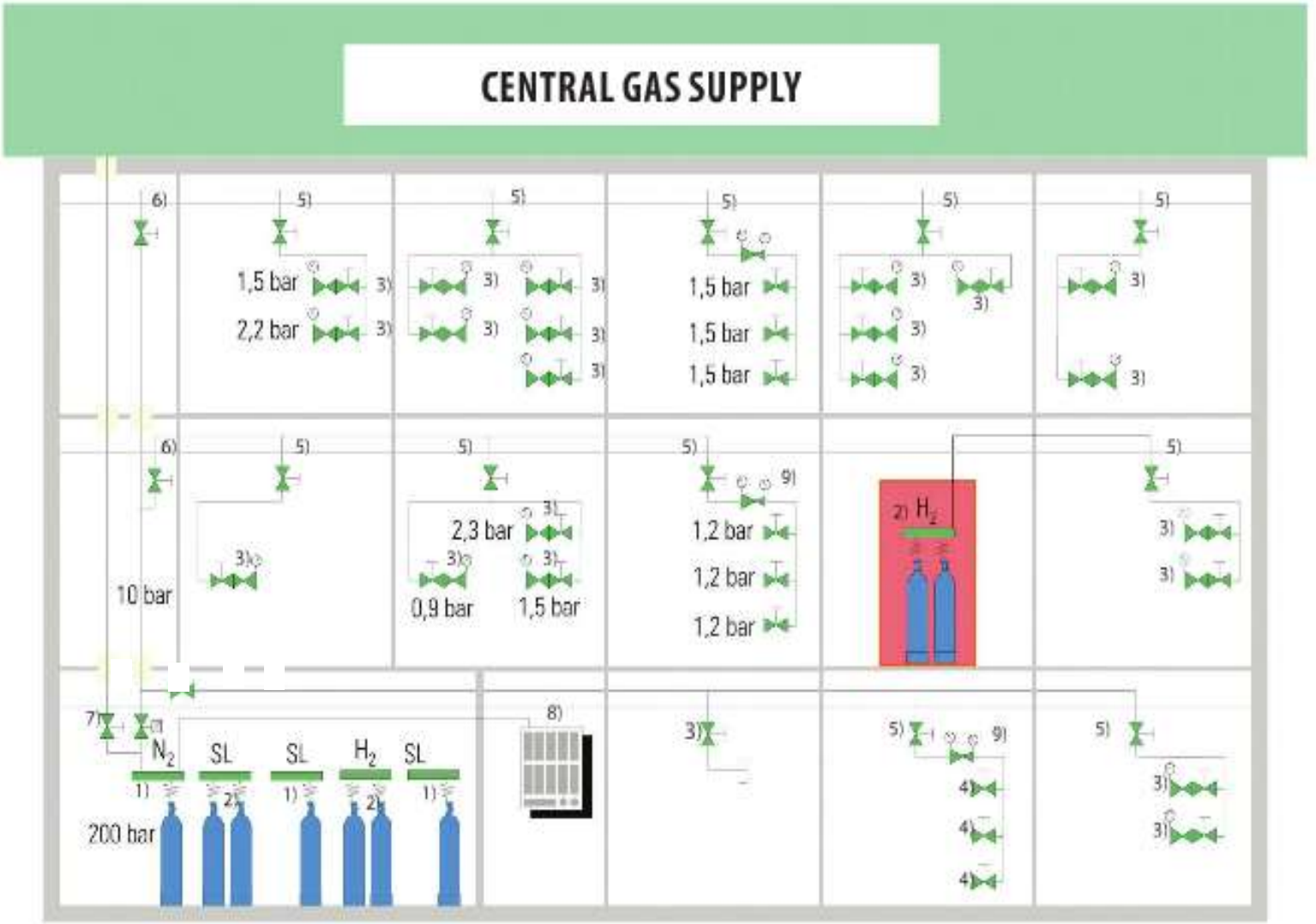
Specification of centralized gas supply						
No.	Gas supply location 供气点	Gas Type 气体种类	Cylinder size 规格/L	Purity 纯度	1st level pressure value 一级减压值Kg.f/cm2	2nd level pressure value 二级减压值
1	T & R	Nitrogen 氮气	40	99.990%	14	Based on Lab request and setting
2	T & R	Carbon Dioxide 二氧化碳	40	99.300%	12.5	
3	T & R	Helium 氦气	40	99.999%	14	
4	T & R	Oxygen 氧气	40	99.600%	9	
5	R	Neon 氖气	40	99.990%	14	
6	T & R	Argon 氩气	40	99.990%	10	
7	T & R	Compressed Air 压缩空气	-	-	6	
8	T & R	Vacuum 真空	-	-	-	

T：Teaching Labs building

R: Research building

3、Gas supply safety requirements

- Centralized gas supply system



1) Gas panel SMD,
2) Gas manifold BMD,
3) Point/of/use regulator EMD,
4) Point-of-use shut- off,
5) Room shut-off,
6) Floor shut-off
7) Central shut-off,
8) Gas management,
9) Line regulator

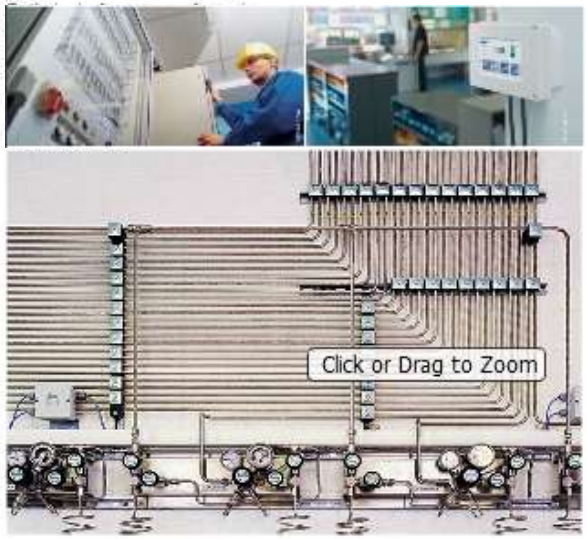
3、Gas supply safety requirements

- Centralized gas supply system

System Control & Monitor Function:

1. *Gas Central Control System*
2. *Gas inventory management*
3. *Gas leak monitoring and alarm*
4. *Visualization of system status (including monitoring)*

beginning with the planning phase.



Point-of-use cabinet with integrated low gas signalling

GAS MONITORING SOFTWARE GASCOM

GasCom, main screen

GasCom, graphic display of cylinder pressure with alarm functions and low supply pressure displays

3、Gas supply safety requirements

- Centralized gas supply system

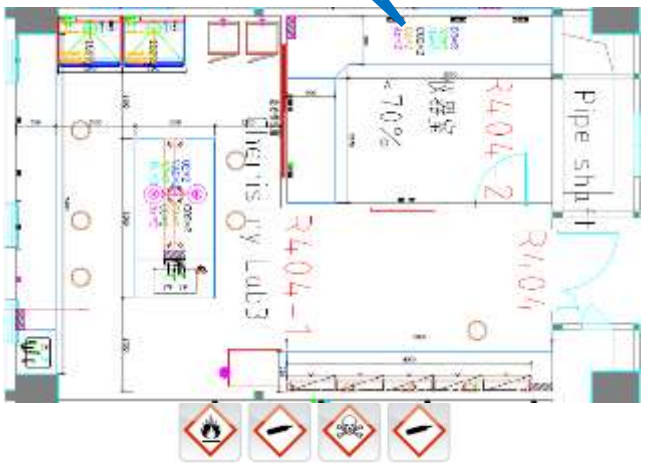
- If lab needs to use the centralized gas supply system and the gas consumption is large (such as 200ml/s 0 ℃, 1atm), Operation and EHS must be notified before starting the experiment.
- When the equipment requires the amount of gas that exceeds the supply capacity of centralized system (300ml/s 0 ℃, 1atm), lab shall choose the independent gas supply.

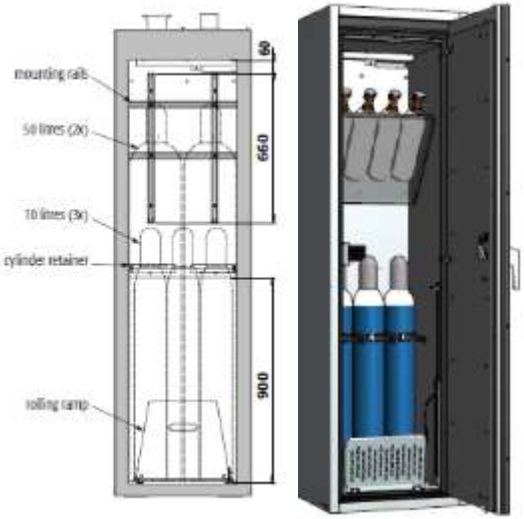
3、Gas supply safety requirements

- Independent 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)

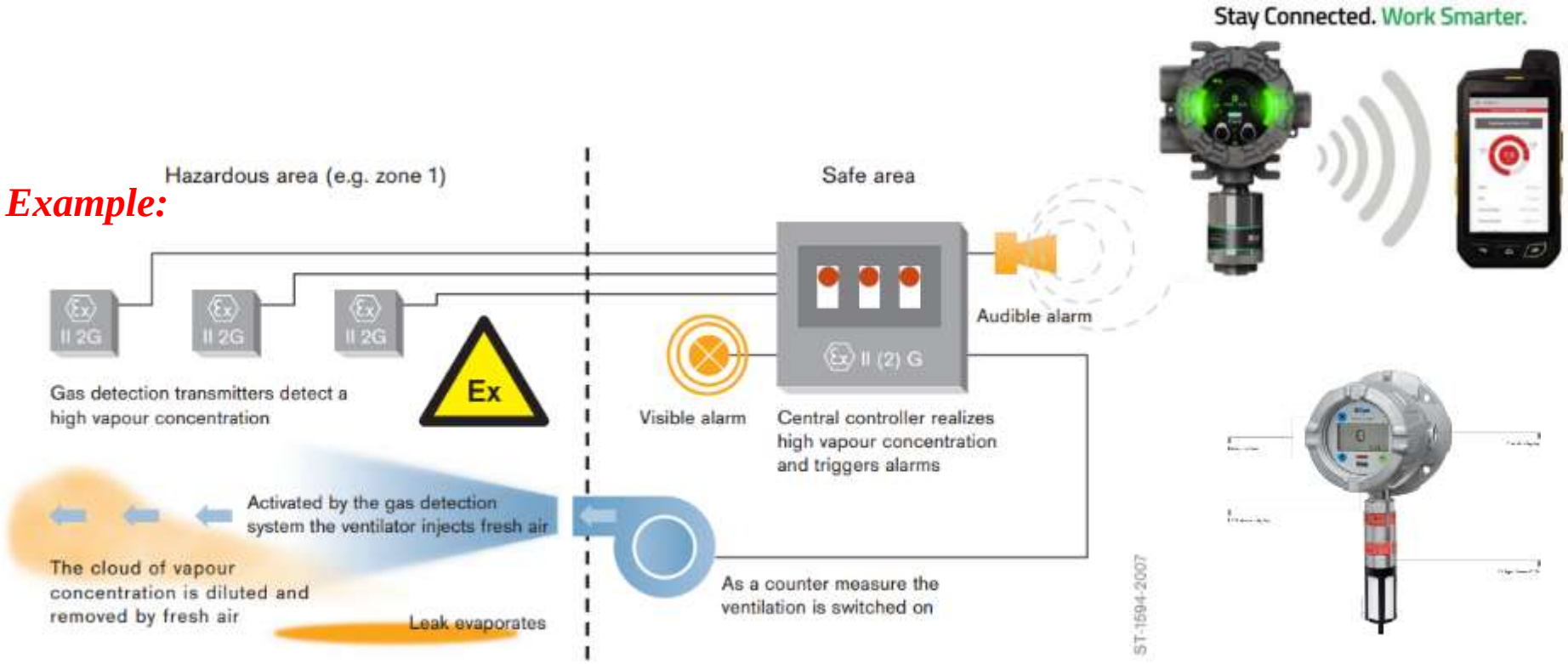
4. Emergency Response

Gas detecting system in gas cylinder cabinet and using area:

1. *Oxygen concentration*
2. *Flammable gas concentration*

Alarm is set at the 25% of the lower explosion limit（LEL） of flammable gas.

Example:



4. Emergency Response

What to do if a gas leak detector alarm sounds,

- *Verify whether the main valve for the gas supply in lab is completely closed.*
- *Immediately notify the local Emergency Response Team.*

5. Recap & Case Sharing

1. Preliminary Design

a) Construction design

b) Cabinet selection

c) Piping design

d) Supporting and monitoring system design

e) Emergency system design

3. Emergency Response

a) Emergency Response Plan

b) ERP Drilling & practice

2. Process Management

a) Gas supply by qualified supplier

b) Regular calibration and testing by authority for piping and accessories

c) Verify special compressed piping certificate and management certificate

d) Management procedure for gas use & the facility using gas

4. Audit & Improving

a. Audit local gas supplier

b. Regularly inspect the labs using gas

c. Verify records of gas use

d. Continuous improvement

Case Sharing： Disruption of N2 Supply

Case Date & Time: 2021-4-23 09:00

Case Description:

R802’s experiment was disrupted and R804 discovered his experimental solvent was extracted due to the nitrogen of central gas supply system running out. They informed EHS by emergency call.

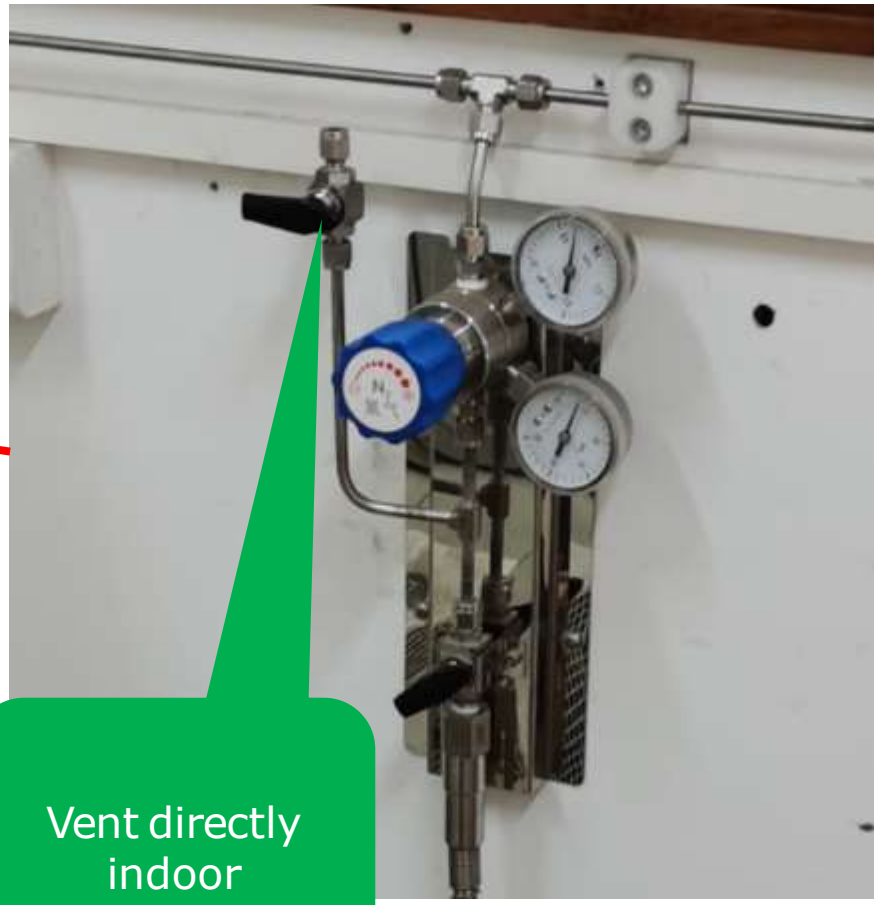
Upon investigation, it is found out that the nitrogen consumption of R203-4 equipment is too high (14L/min*100Psi), which used up all nitrogen in the centralized gas supply system. Therefore, the vaccum status of nitrogen pipeline instead sucks in the experimental solvent from R804.

EHS immediately informed R203-4 to stop consuming nitrogen from central supply system after verifying the experiment can be stopped safely. Operation team then asked the gas supplier to replace the empty nitrogen cylinder and resume the nitrogen supply afterwards.

6、Issues for Lab's attention

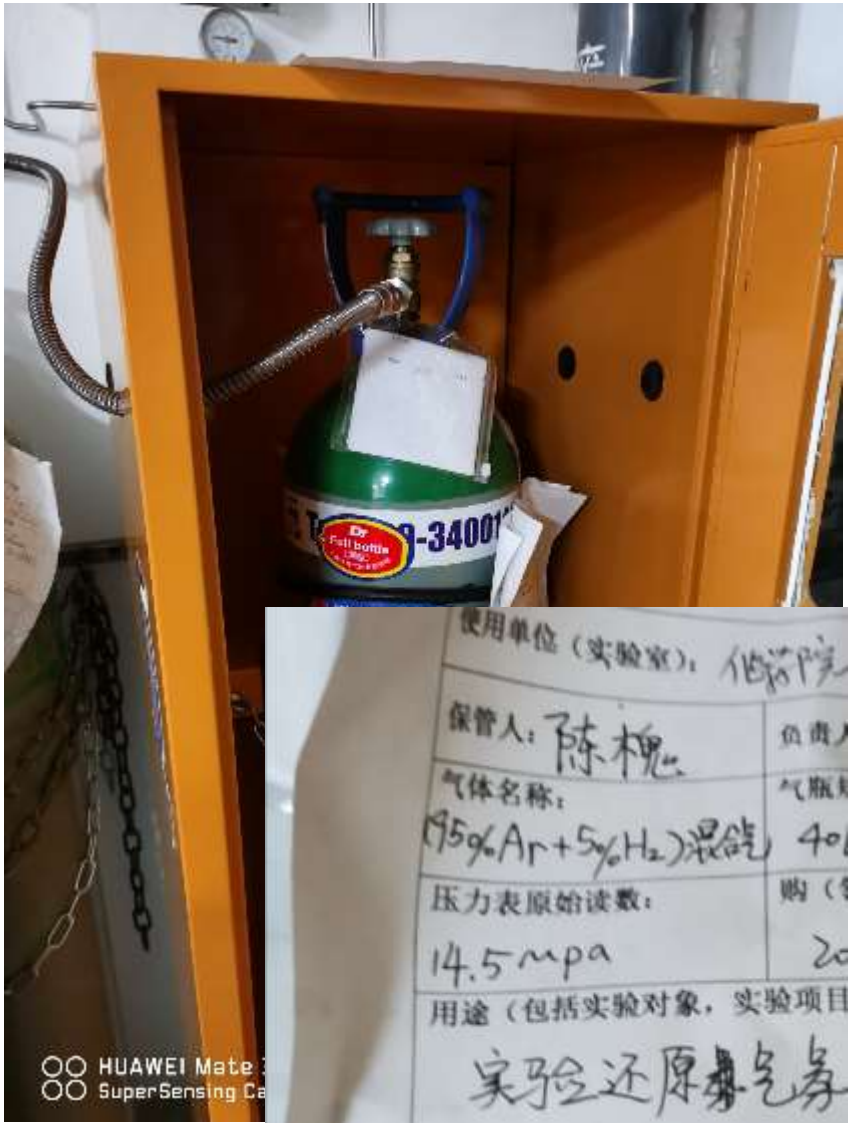
No status indicator

Not secured with chains or straps

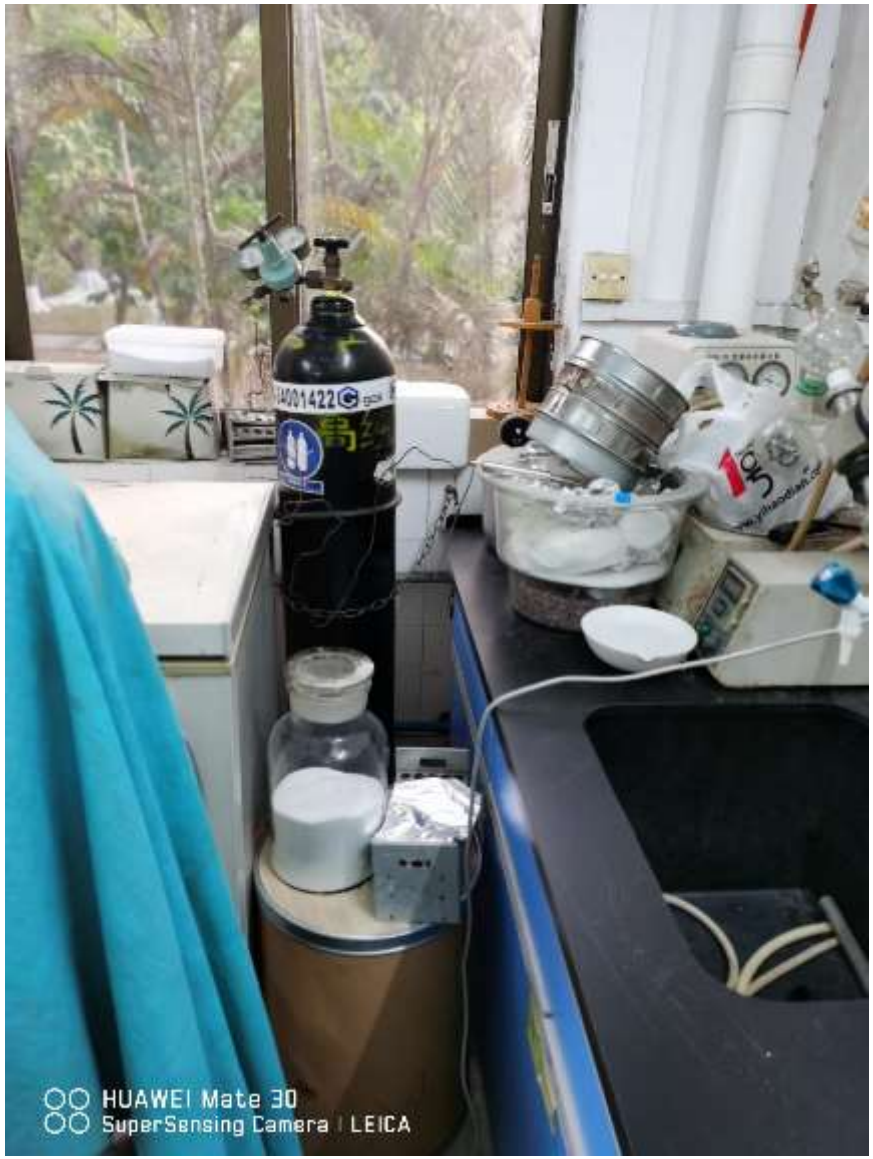


Vent directly indoor

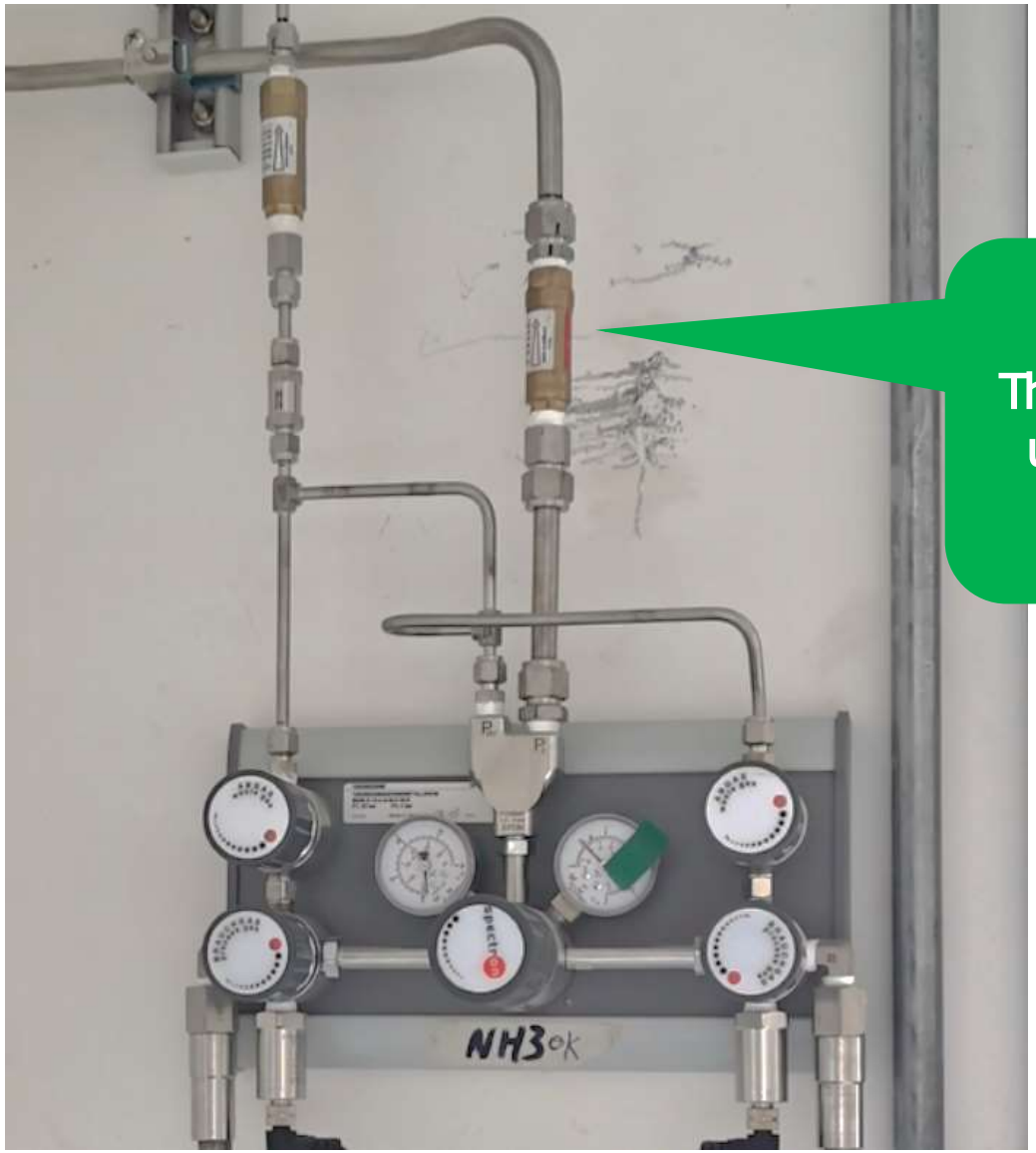

HUAWEI Mate 30
SuperSensing Camera | LEICA


使用单位（实验室）：
保管人：陈槐
气体名称：
(95%Ar+5%H2)混合
压力表原始读数：
14.5mpa
用途（包括实验对象，实验项目
实验还原
HUAWEI Mate
SuperSensing Ca

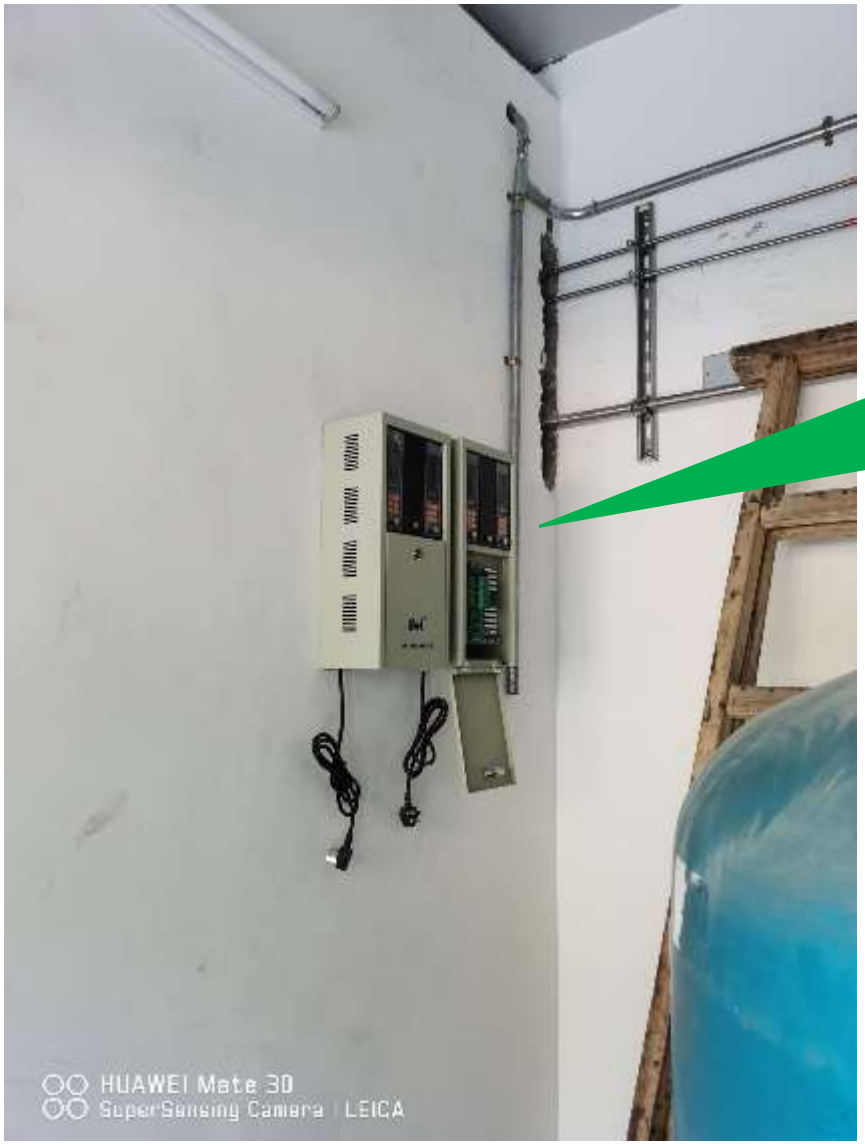

氮气 N_2
不燃气体
2
必须采取固定措施
The label does not match the actual gas used



A large amount of Sundries piled around the cylinder



The ammonia pipeline uses copper fittings



The gas leakage alarm setting does not meet the requirements.


Flammable gas is planned to be used in the cylinder room, and the electrical wiring does not meet the explosion-proof requirements.
HUAWEI Mate 30
SuperSensing Camera | LEICA

Valves installed in the pipeline well

There is no cover where the pipeline crosses the floor.

„Nothing we do is worth getting hurt for !“

没什么是值得以牺牲安全作为代价！