AIGA 2007 MEETING

PACKAGED GASES SAFETY

Asia Industrial Gases Association

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PATTAYA, THAILAND

Filling of Carbon Dioxide Cylinders

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Scope

Provide specific guidelines for the safe filling of Carbon Dioxide (CO_2) into cylinders

Cylinder Inspection Before Filling

- Pressure Rating, Test Date
- External Condition
- Cylinder Service
- Cylinder Valve
- Check for Contamination & Corrosion
  - i.e. Hammer test, CO_2 residual
- Tare Weight & Fill Volume

Contamination

- **Sources of Contamination**
  - **Hydraulic test process**
  - **Product**
  - **Vacuum pumps (water-ring pumps)**
  - **Feedback during use (at customers)**

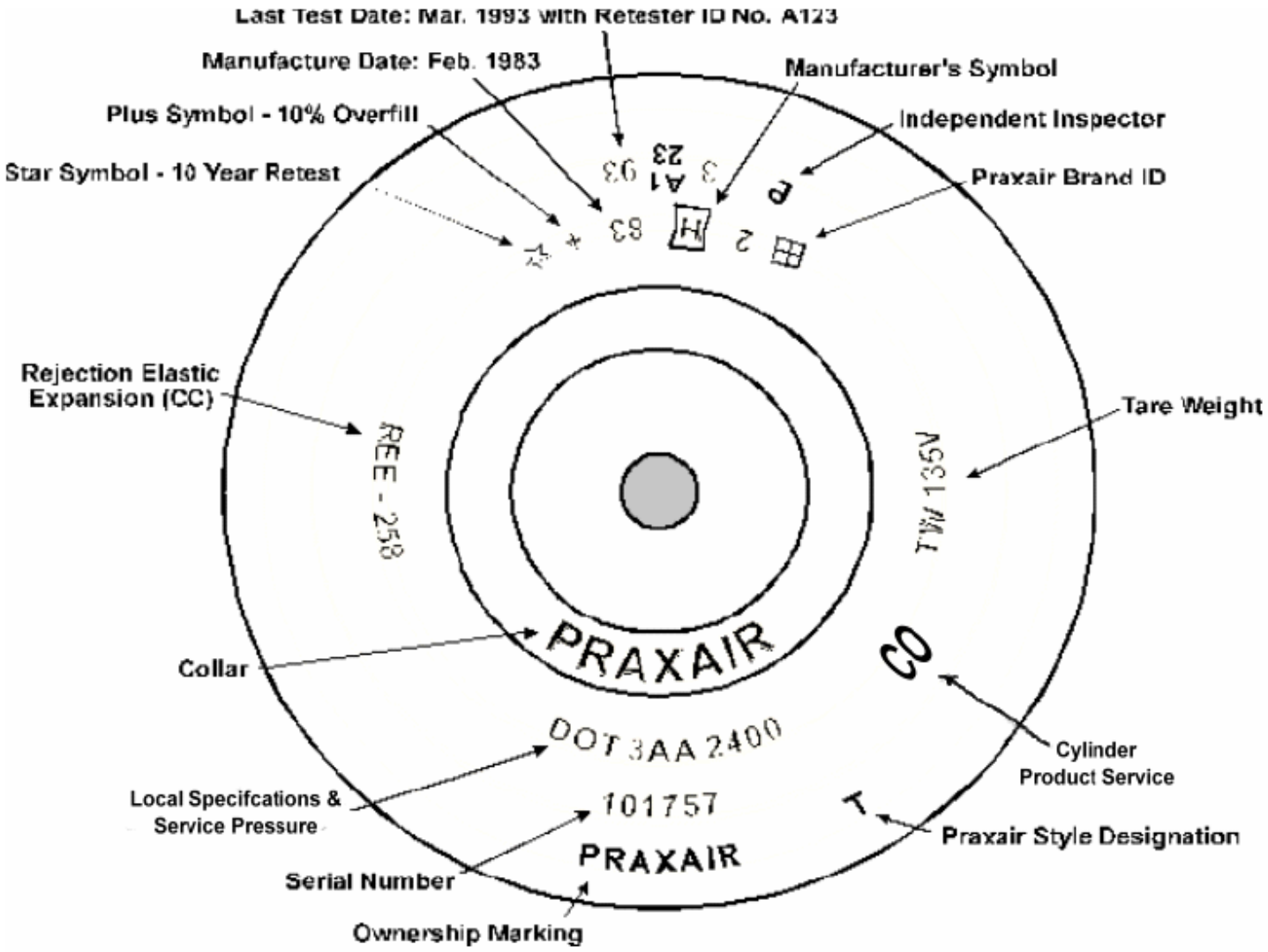
Contamination

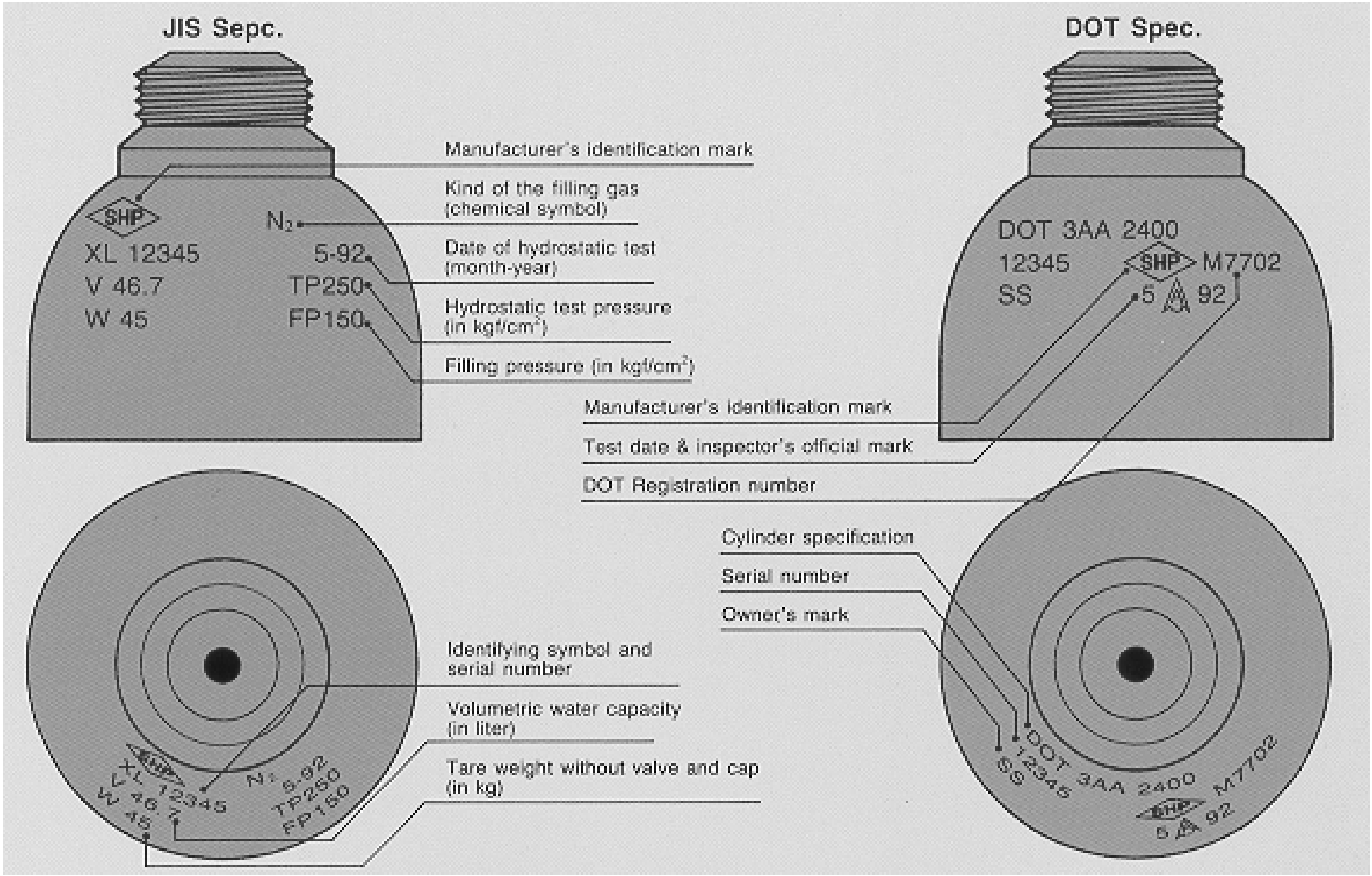
- **Methods to reduce the risk of cylinder corrosion due to contamination:**
  - **Material selection**
  - **Use of RPV / NRV Valves**
  - **Fill equipment design**

Corrosion / Contamination Detection

- **Detection Methods**
  - **Residual Pressure Check**
  - **Weight Check**
  - **Evacuation (delayed time)**
  - **Hammer Test**
  - **Cylinder Inverting**

Cylinder Markings




JIS Sepc.
DOT Spec.
Manufacturer's identification mark
Kind of the filling gas (chemical symbol)
Date of hydrostatic test (month-year)
Hydrostatic test pressure (in kgf/cm²)
Filling pressure (in kgf/cm²)
SHP
XL 12345
V 46.7
W 45
N₂
5-92
TP250
FP150
DOT 3AA 2400
12345
SS
SHP
M7702
5
92
Manufacturer's identification mark
Test date & inspector's official mark
DOT Registration number
Cylinder specification
Serial number
Owner's mark
Identifying symbol and serial number
Volumetric water capacity (in liter)
Tare weight without valve and cap (in kg)

Safe to fill

- Ensure cylinder standard and pressure rating is in accordance with local regulations
- Typically CO_2 content is 68% of cylinder water volume

  Ex. 43 Liter cylinder:

  = 43 x 0.68 = 29.24 kg

  or 29 kg/cylinder

Pressure versus CO_2 Ratio

CO2 % of Water Volume	CO2 Pressure (PSIA) in cylinder @ 100 °F (37.7 °C)
68%	1,465
70%	1,530
75%	1,785
80%	2,185
85%	2,815
90%	3,800
95%	4,920

Fill Termination Weight Calculation

- Determine fill termination weight :
  - cylinder tare weight (including valves & permanent attachments) + fill hose + product weight
- Ensure fill procedure prevents overfilling CO_2 cylinders

Before filling

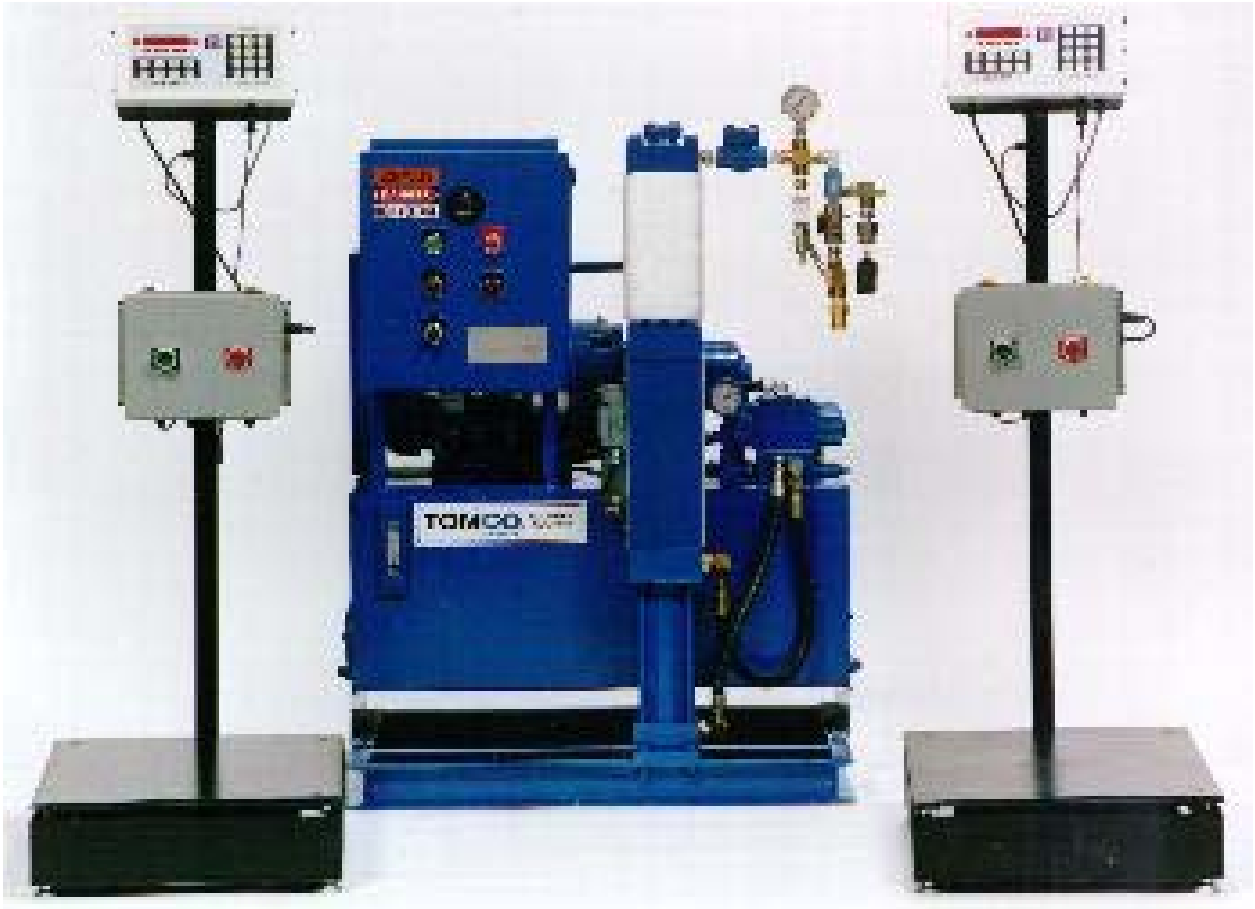
- Fillers have to wear PPE
  - Safety shoes
  - Face shield
  - Gloves
  - Optional (ear plugs, hard hat)
- Calibrate Scale with Standard Weight
  - Define frequency

Before filling

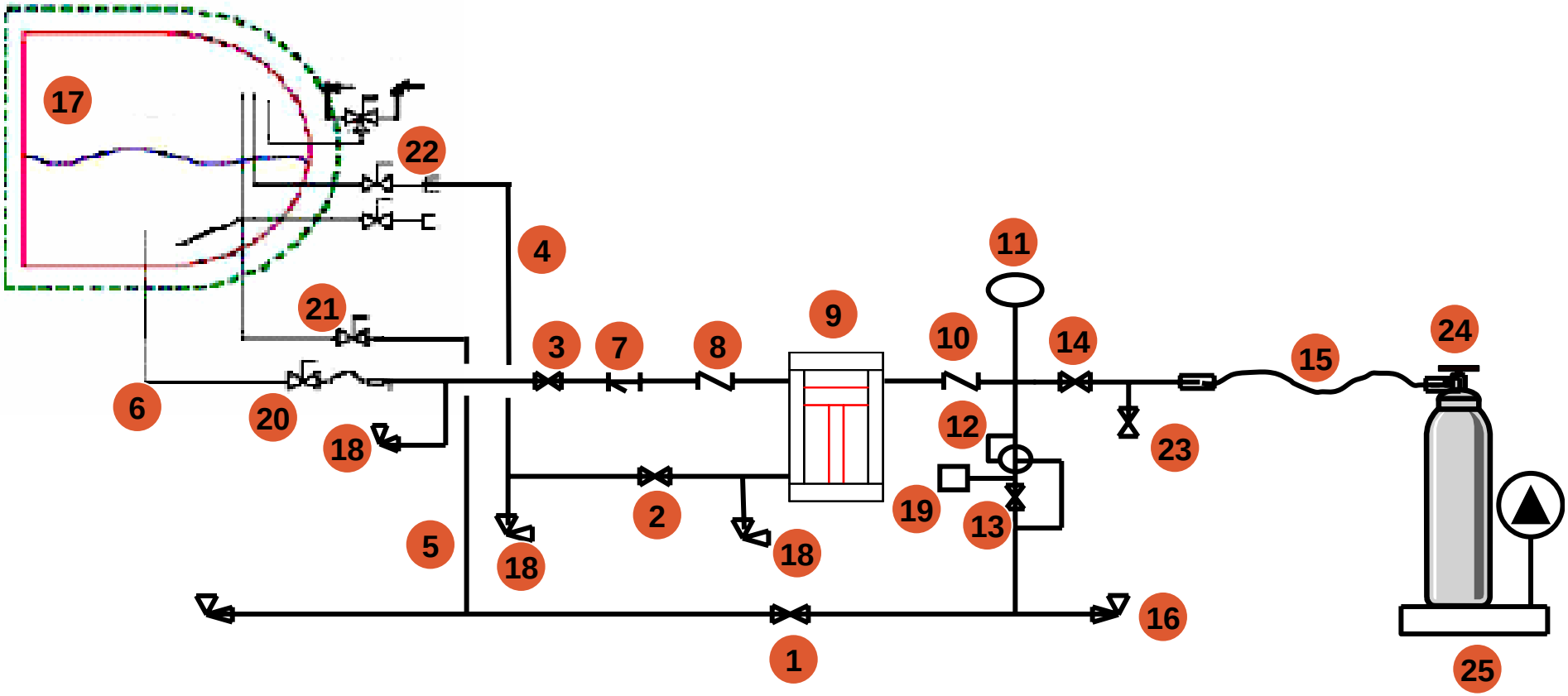
CO_2 Pump

Fill System

CO_2 Pump with Electronic Scales



P&ID Of Cylinder Filling System



P&I Diagram Details

1. Return Line Valve
2. Vapour Purge Valve
3. Liquid Supply Valve
4. Vapour Purge Line
5. Return Line
6. Liquid Supply Line
7. Inlet Y Strainer
8. Inlet Check Valve
9. CO_2 Pump Cylinder
10. Discharge Check Valve
11. CO_2 Pump Pressure Gauge
12. Back Pressure Regulator
13. Manual Bypass Valve
14. Filling Valve
15. Filling Hose

P&I Diagram Details

16. Relief Valve Set @ 450 psi
17. CO_2 Storage Tank
18. Relief Valve Set @ 450 psi
19. Rupture Disk
20. Liquid Isolate Valve
21. Vapour Isolate Valve
22. Vapour Isolate Valve
23. Drain Valve
24. Cylinder Valve
25. Weight Scale

Start Filling Procedure

1. Open the valves at CO_2 tank
2. Place the empty cylinders on the scales
3. Connect fill hose to the cylinder valve. Valve still closed
4. Open the cylinder valve
5. Tare the scales = 0

Filling Procedure

6. Start the CO_2 Pump
7. Close the bypass valve
8. Open Fill Valve
9. Transfer LCO_2 to cylinder until final weight is reached
10. Close fill valve
11. Open the bypass valve

Filling Procedure

12. Close cylinder valve
13. Open the drain valve to release the CO_2 in the fill hose
14. Disconnect the fill hose
15. Recheck the full cylinder weight again, ensure it is within the fill weight tolerance
16. Leak check

Filling Procedure

17. Seal the cylinder valve and close the cap
18. Remove cylinder from the scale
19. Go to step 2 to restart filling process for the next cylinder (skip over step 6)

Finish Filling Procedure

- Switch off the CO_2 Pump
- Close the liquid valve at tank
- Wait until the ice that covers the CO_2 pump melts. (Notice pressure in CO_2 Pump is the same as pressure in CO_2 Tank)
- Close the gas valve at tank

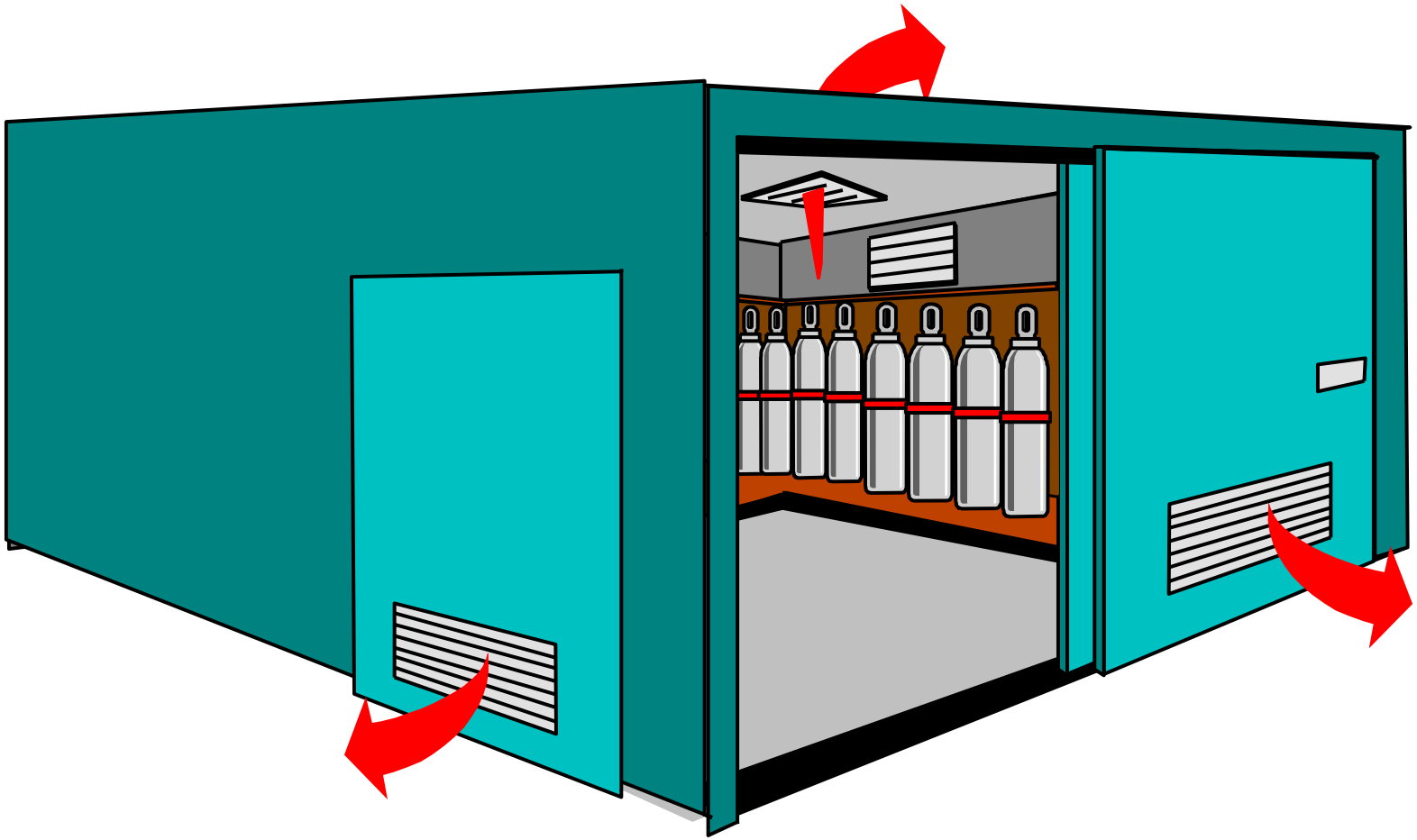
Finish Filling Procedure

- Open the drain valve to release CO_2 pressure in process to 100 – 150 psig.
- Take all full cylinders to storage room

Safe to Storage

- Storage room temperature is not over 125 °F (51.7 °C)
- Good ventilation
- Floor is not slippery and is easy to clean the water from ice on the cylinders

Safe to Storage



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THE END