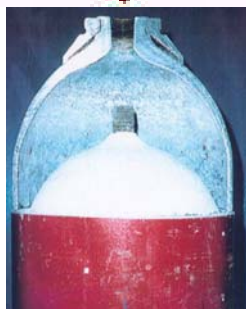
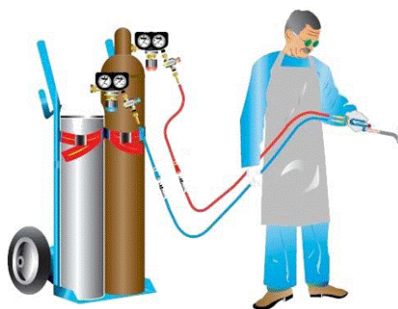


ACETYLENE GAS SAFETY SEMINAR 2010 MALAYSIA

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ON-SITE ACETYLENE CUSTOMER PIPING INSTALLATION

SYSTEM REQUIREMENTS & INDUSTRY BEST PRACTICES

Yong Niam Pyng (MOX-Linde)



DA Gas Supply Units & Storage

**This presentation will focus on the
'DA Gas Supply Units & Storage' design and
installations due to time constraint.**

This refers to the following:

- ✓ Permanent installed manifolds using loose cylinders connected to a manifold (typically 2 cylinders or more)
 - ✓ Acetylene bundles bulk installations
- Supplementary materials are included at the end on other topic areas that are not covered in this presentation

DA Manifold Fire Incident at customer site Jamshedpur, India (May 2007)

Description:

A customer-owned DA manifold installed in 1964 at Jamshedpur in India was involved in a serious fire incident. Two contractor workmen involved in the supply of cylinders, sustained minor burn injuries. The local fire brigade suppressed the fire and the fire was contained within the manifold room. The manifold was damaged and 2 cylinders ruptured.

Immediate Causes:

There was DA leakage from the manifold, followed by uncontrolled release of DA into atmosphere

Basic Causes:

Non standard and old DA manifold

Customer not aware of the risk associated with the non-standard manifold

Actions arising:

- Risk Assessment done for the existing DA customers

Photos of the incident



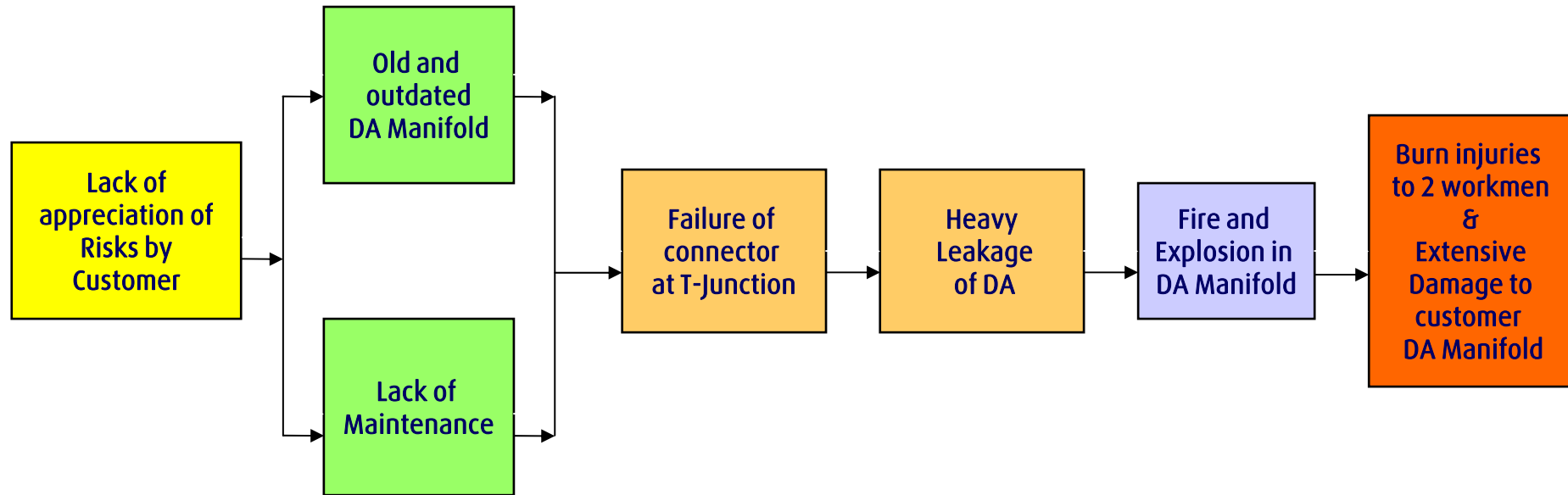
Damaged DA manifold

Photos of the incident



Damaged DA Cylinders

Causal Tree Analysis - DA Manifold Fire at customer site Jamshedpur, India



LACK OF CONTROLS

BASIC CAUSES

IMMEDIATE CAUSES

INCIDENT

LOSS

DA Gas Supply Units & Storage – Types of Manifold

Installation of the gas supply system at customer sites:

- Cylinder Discharge Manifolds
- Bundles Discharge Manifolds

DA Gas Supply Units & Storage

– Safety Distance

For cylinders or bundles, the horizontal separation **Safety Distance** based on BCGA CP6 for the following are given in Table 3:

- Gas oxygen storage and supply
- Non flammable gas storage (liquid or gases)
- Flammable gas cylinder storage
- Naked flame or any source of ignition
- Public roads/ site boundaries
- Electrical equipment which is non explosion-proof
- Car parks

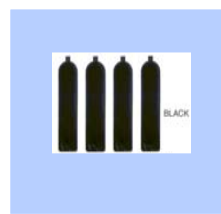


Table 3
Separation Safety Distance depending upon
Number of acetylene cylinders in use
(plus an equal number of connected standby cylinders)

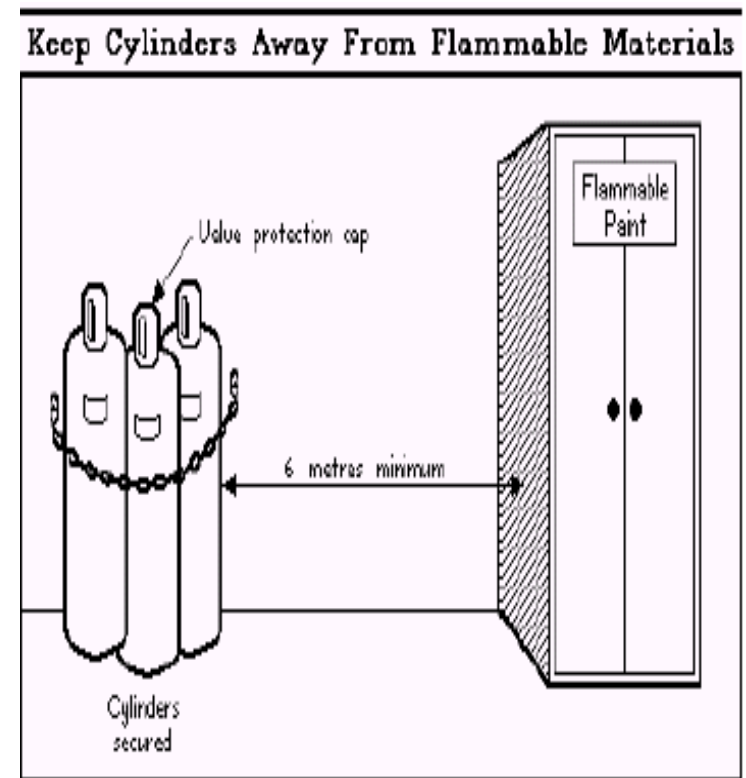
<i>Cylinders</i>	<i>Safety Distance</i>
1 - 2	2 m
3 - 12	3 m
13 - 60	5 m
61 and over	Seek advice from gas supplier

DA Gas Supply Units & Storage

– Safety Distance

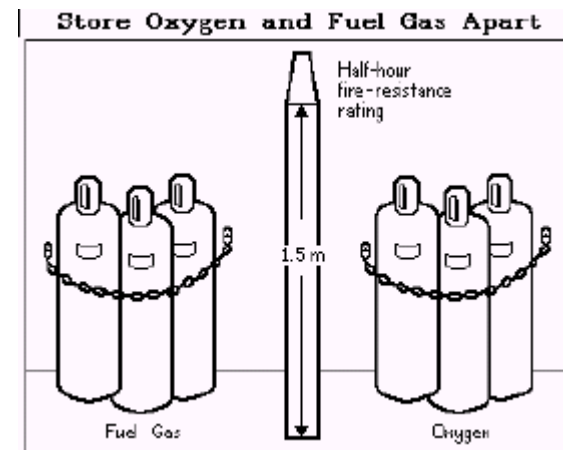
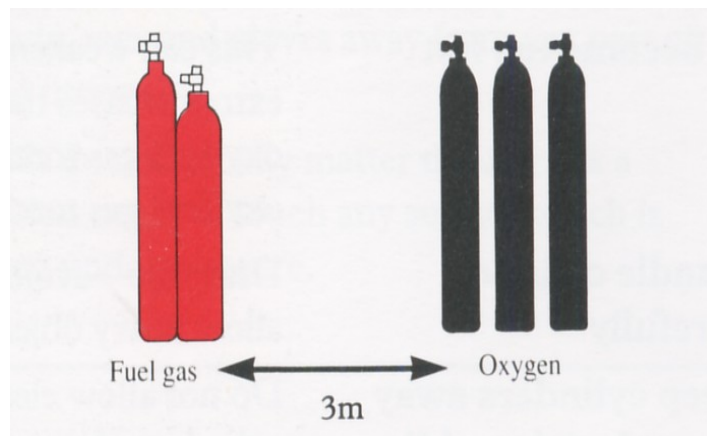
For the following, the separation safety distance shall never be less than **5 meters**:

- Liquid oxygen fixed installations
- Combustible materials
- Bulk flammable liquid and LPG storage
- Buildings of non fire resisting materials
- Air compressor intakes



Cylinder Storage Area Guidelines

- **STORE** cylinders in a dry, well ventilated area, away from heat or ignition sources .
- **STORE** oxidising gas and flammable gas cylinders at least 3 m (10 ft.) apart, or separated by a 1.5 m (5 ft.) high wall with a half-hour fire-resistance rating.



DA Gas Supply Units & Storage

– Siting of Cylinder Discharge Manifolds

- Gas manifold mounted on wall or free standing
 - ✓ Outside the building (preferably)
 - ✓ Inside the building
- Supply piping separation distances

DA Gas Supply Units & Storage

– Siting of Cylinder Discharge Manifolds (Outdoor)

- Manifolds installed:
 - ✓ Outdoors without roof coverage (shall have at least one side open for adequate ventilation)
 - ✓ In Outdoor sheds/canopy (Outdoor sheds definition: Covered with roof and minimum of 75% of sides are open-without wall)
- Adequate cross ventilation to disperse any gas accumulation
- All electrical fixtures and fitting within 15 ft from the manifold shall be classified : Class1 Div 2.
- Fire extinguishing equipment required
- Weather and direct sunlight on cylinders protection recommended
- Vehicle damage protection

DA Gas Supply Units & Storage

– Siting of Cylinder Discharge Manifolds (Indoor)

- Manifolds installed indoor inside a room: Needs proper ventilation at roof level to disperse any gas leakage.
- All electrical fixtures and fitting inside the room shall be classified : Class1 Div 2.
 - ✓ Class 1 Div 1 within 5 ft from the frequently make-n-break connections.
- Threshold limit of gas cylinders capacity **when connected** to the manifold installed indoor:
 - ✓ Non-sprinklered building: Total quantity :28.3 M3
 - ✓ Sprinklered: Total quantity : 85 M3
- If more than 85 M3 is stored indoors, then the room shall be used exclusively for acetylene with explosion proof venting, non-combustible material construction and separated with 2 hr fire wall from other occupancies.

DA Gas Supply Units & Storage

– Piping Separation from Exposures

- Piping should not pass through heated enclosures. The piping must be 600mm (24 in) away from any source of heat including steam/ hot water
- Frequent make and break connections (for outdoor installations) shall be at least 15 feet away from the non-classified electrical connections, switches, panels, equipment and fixtures.
 - Within 15 ft Class 1 div 2; Within 5 ft Class 1 Div 1
- Piping not to cross under bare power grid piping without protection. Unprotected exposed piping shall be 15 ft away from the bare power lines (measured horizontally)
 - Exception: insulated wiring is excluded from this requirement
- Manifolds shall be 6.1 m (20 ft) from property line. A minimum of 1m (3 feet) from the buildings. No separation is required if mounted on a wall with ½ hour fire rating.

DA Gas Supply Units & Storage

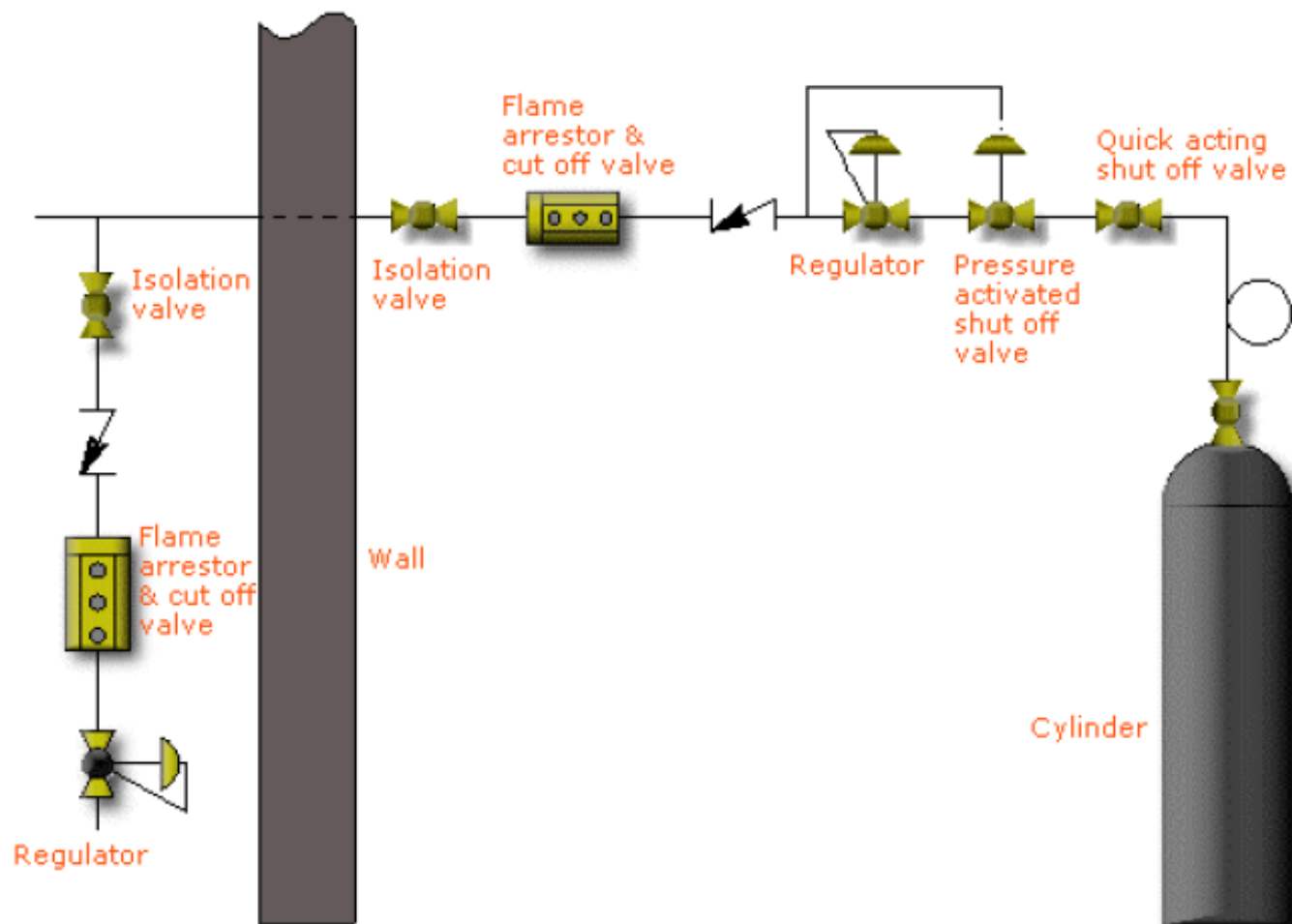
– Piping Separation from Exposures

Table 10.2.2 Separation Distances from Trailer Discharge Connection or Building Housing Trailer to Exposures

Exposure	Separation Distance	
	m	ft
Property line	7.6	25
Buildings constructed of combustible materials	15.2	50
Buildings constructed of noncombustible or limited-combustible materials	4.6	15
Bulk oxygen systems	15.2	50
All classes of flammable and combustible liquid storage aboveground	15.2	50
All classes of flammable and combustible liquid belowground		
Tank	6.1	20
Vent or fill opening of tank	7.6	25
Other flammable gas storage	15.2	50

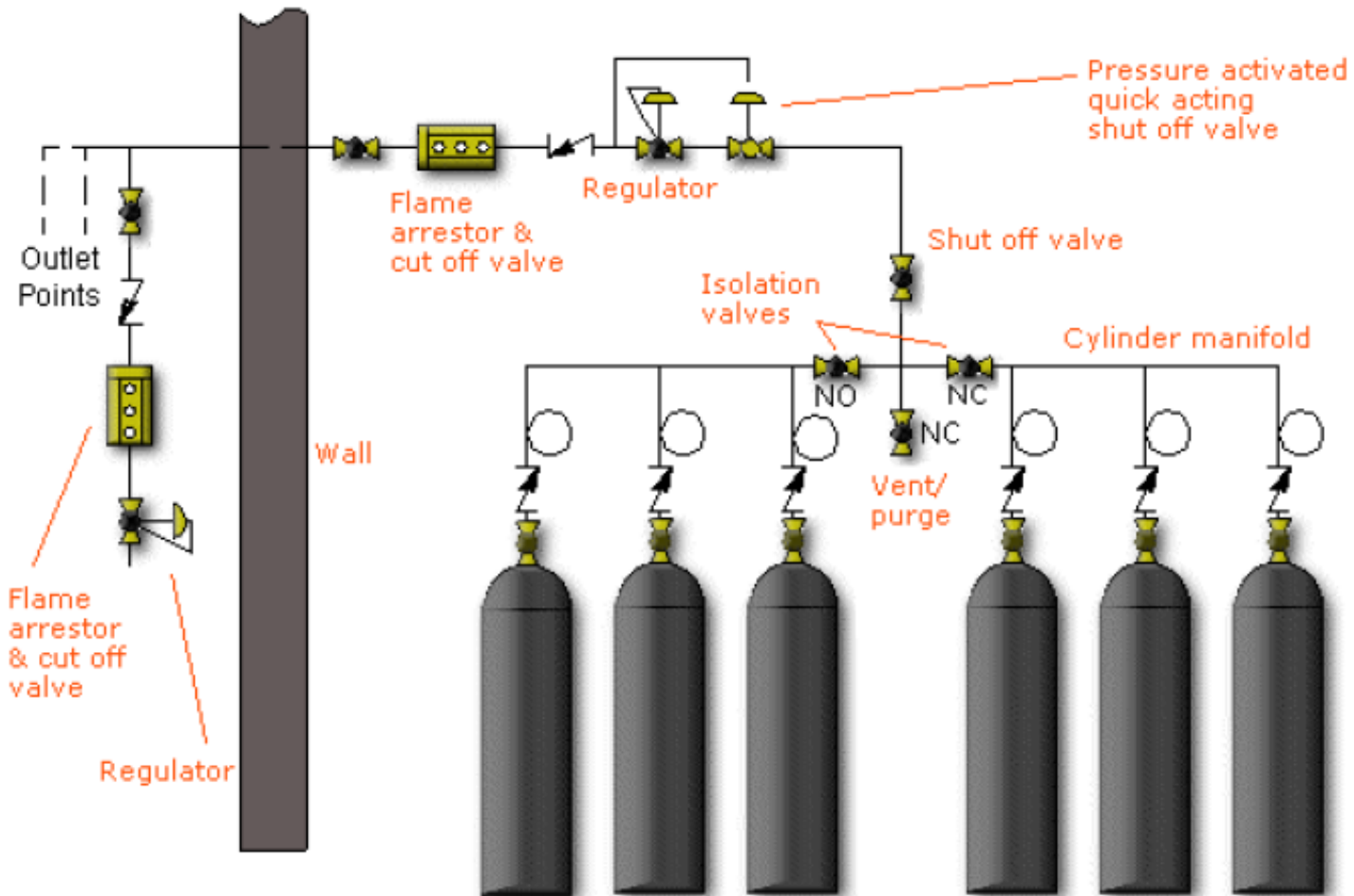
Example

Permanent installation using a single DA cylinder (ISO 14114 Standard)



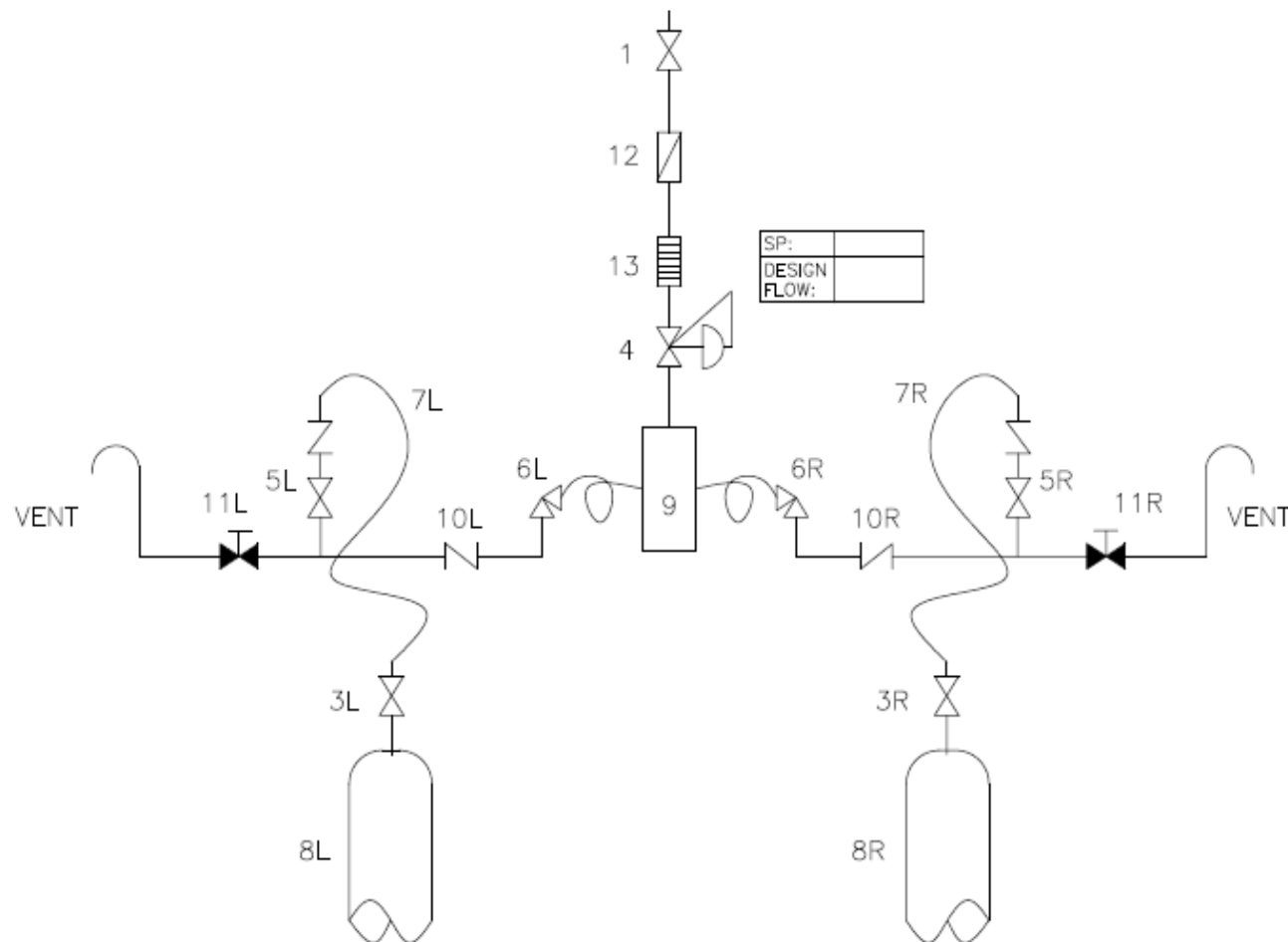
Example

Permanent installation using a cylinder manifold (ISO 14114 Standard)



Example

P & ID of Permanent Installation of 1+1 DA cylinder manifold



NOTES:
L - LEFT
R - RIGHT

TAG NO.	ITEM	DESCRIPTION	QTY
1	BALL VALVE		1
2	SAFETY RELIEF VALVE		
3L&3R 5L&5R	HP CYLINDER VALVE		4
4	REGULATOR		1
6L&6R	HP CYLINDER ANGLE VALVE	HP CYLINDER ANGLE VALVE	2
7L&7R	SS FLEXIBLE HOSE	1/4" HP (SS) WITH CHECK VALVE	2
8L&8R	CYLINDER		2
9	REGULATOR BLOCK		1
10L&10R	CHECK VALVE		1
11L&11R	PURGE VALVE	HP CYLINDER VALVE	2
12	FLASHBACK ARRESTOR		1
13	DECOMPOSITION VALVE		1
N.A	PIPING	CARBON STEEL/ STAINLESS STEEL	1

DA Gas Supply Units & Storage

– Bundle Discharge Manifold Installations

- Provide pressure reduction equipment at the bundle outlet connection
- The supply flexible line is low or medium pressure system. This is primarily to avoid any adiabatic compression flashes or air gas mixture flash at high pressures.
- Further guidelines can be obtained from the following documents to help siting the bulk installations:
 - ✓ NFPA 51, 51A, 55, National Fire Protection Association – USA
 - ✓ TIS-No:4 Rev 1 – BS-EN ISO 14114 Acetylene manifold systems for welding, cutting and allied process – General requirements.
 - ✓ CP-6 : Code of Practice –EU- Safe distribution of acetylene in the pressure ranges 0-1.5 bars Rev1, 1998.
 - ✓ CGA -G 1.6 Acetylene Trailer.

DA Gas Supply Units & Storage

– Bundle Discharge Manifold Installations

- Install bulk installation outside the building open to atmosphere
- If installed indoors, all electrical inside the building shall be classified for Class1 Div 2
- Ventilation shall be provided : 0.1 m² per 28.3 M³ of room volume
- Explosion venting shall be provided: min: 0.1 M² per 1.4 M³ of room volume.

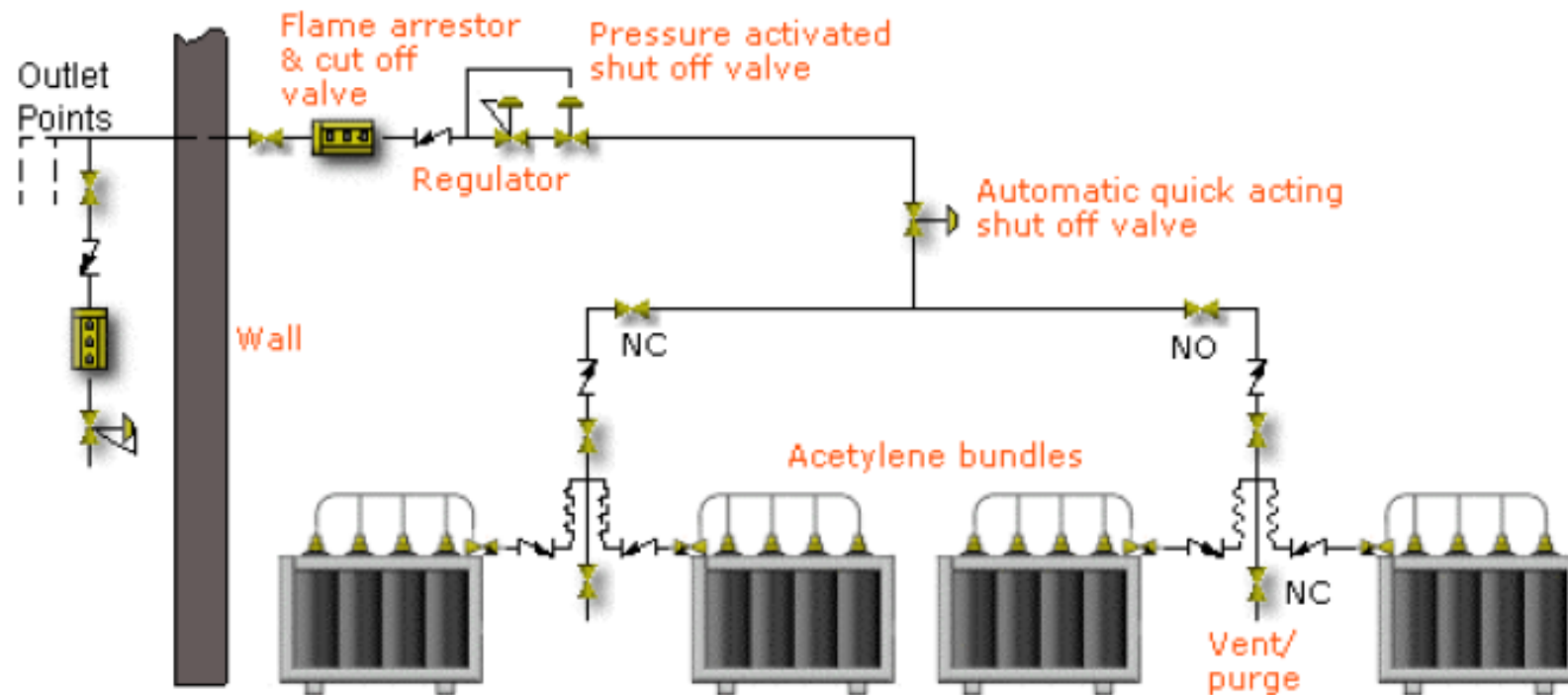
DA Gas Supply Units & Storage

– Bundle Discharge Manifold Installations

- Bundle frame: Designed to meet local road worthy requirements: If local not available reference documents:
 - ✓ DOT
 - ✓ ADR
- Bundle frame work is designed to restrict lateral & vertical movement during transportation and use.
- Deluge or sprinkler system to protect during fire.
- Containment or restraint of cylinders from ejection from the unit during fire situations.
- Proper flash arrestors.
- Vehicular damage protection.
- Proper withdrawal flow design.
- Purging of piping before gas introduction.
- Units have signs or systems to protect from inadvertent removal of units when connected to the system.

Example

Permanent installation using a bundle manifold (ISO 14114 Standard)



Note: The automatic quick acting shut off valve may also be a manual quick acting shut off valve.

THANKS
Any Questions?

Acknowledgement
For materials drawn from Syed Razzack

Supplementary information on:

- Piping design.
- Equipment design and specs.
- Safety equipment.

Information in the following slides are on general safety requirements and best practices followed by the industry to ensure the system is safe and also to eliminate possibilities of any catastrophic event.

Piping Design

Reference standards

TIS-No:4 Rev 1 – BS-EN ISO 14114:

Acetylene manifold systems for welding, cutting and allied process – General requirements.

CP-6 :

Code of Practice –EU- Safe distribution of acetylene in the pressure ranges 0-1.5 bars Rev1, 1998.

G 1.2

Compressed gas Association document – USA. -Acetylene transmission in pipelines and metering.

NFPA 51 :

National Fire Protection Association – USA – Design & installation of oxy-fuel gas systems for welding and cutting.

Piping Design

Following slides highlight some key aspects to be considered in piping design based on the referenced standards and best practice in the industry.

- ✓ Pressure Rating
- ✓ Materials Compatibility.
- ✓ Type of Valves.
- ✓ Piping Protection.
- ✓ Flow Velocity & Cylinder Discharge Rate
- ✓ System Protection.
- ✓ Supply Manifold design.
- ✓ Gas Station Drops.

Piping Design

PRESSURE RATING

Piping System Pressure rating:

- ✓ The limit of medium pressure piping in Europe is 1.5 bars (22 psig) and in North America is 1 bar (15 psig).
- ✓ For medium and low pressure piping, minimum Sch. 40 standard pipe to be used.

Piping Design

BURST PRESSURE RATING

Piping system burst pressure rating based on deflagration:

- ✓ What is Deflagration & Detonation: When a flash occurs, it can develop into a deflagration or detonation. In deflagration the final pressure in the piping reaches to approximately 11 times the initial pressure in the pipeline. While in detonation pressures can reach up to 35 to 50 times the initial pressure.
- ✓ The flame starts with deflagration and develops into detonation based on certain piping configurations and conditions and mainly dependent of initial pressure in the piping.
- ✓ Tests performed by the industry has shown that detonation typically occurs in pressures above 1.5 bars.
- ✓ Therefore, the consumer piping system pressure is limited to 1.5 bars (maximum) and piping burst pressure rating of piping is calculated 11 times 2.5 bars (absolute) = 27.5 bars (absolute).
- ✓ For high pressure systems the burst pressure rating is minimum of 35 times initial pressure about (10,000-12,000 psig).

Piping Design

MATERIALS COMPATIBILITY

Piping material typically Wrought Iron, forged steel, carbon steels ASTM-A105, A106, A192, A333, A234, A181 & A216, Stainless Steel, Brass (less than 65% copper) is used.

Cast Iron fittings are not recommended.

Carbon steel piping can be galvanized to avoid any rust formation.

Copper alloys having less than 65% copper shall be used.

Aluminum alloys and higher than 40% silver alloys and silver not acceptable.

Common non-metallic materials used for gaskets or seats are found satisfactory. It is recommended to avoid using the following material because of non-compatibility to solvents used in acetylene cylinders:

- ✓ Neoprene, Viton
- ✓ Buna-N, Nitrile Rubber, Epoxy, Natural rubber
- ✓ Consider compatibility to Acetone & DMF in addition to Acetylene when selecting materials.

Piping Design

TYPES OF VALVES

- Frequently opening and closing valves needs to be Globe valves to avoid any possibility of fast opening and consequently adiabatic compression and flash.
- Line isolation can be Globe or Ball valves.
- Avoid Needle valves – because of **venturi** effect could cause auto-ignition because of liquefaction or spot heating.

Piping Design

PIPING PROTECTION

Under-ground piping :

- ✓ Needs to be corrosion protected by pipe coatings.
- ✓ Cathodic protection required.
- ✓ Vehicular damage protection under roadways.

Above-ground piping :

- ✓ Proper supports & anchorage.
- ✓ Galvanizing
- ✓ Painted.
- ✓ Installed such that, protected from vehicle damage.

Pressure Relief valves:

- ✓ It is recommended to provide safety relief down stream of pressure reducing equipment. To protect piping in case of a regulator failure.

Piping Design

Flow velocity or Cylinder discharge rate

Maximum gas withdrawal from individual cylinders :

- ✓ $1/7^{\text{th}}$ of the cylinder capacity per hour

To minimize solvent withdrawal it is recommended that heavy or bulk users (like cylinder manifolds or cluster/bundle or trailer) should consider the following rates :

- ✓ Intermittent withdrawal service: $1/10^{\text{th}}$ per hour.
- ✓ Continuous withdrawal service: $1/15^{\text{th}}$ per hour.

of total number of cylinders capacity in one bank of manifold or in cluster/bundle or trailer connected and opened at one time.

Piping Design

System Protection

Flash arrestors are provided at critical points in the piping system. As a general rule flash arrestor is recommended between followings sections:

- ✓ Between high pressure cylinder manifold and system piping. (typically installed at de-compression manifolds)
- ✓ At every 300 ft piping lengths.
- ✓ Between gas station drops connection and consumption apparatus (regulators, hose connections, etc.).

Install piping away from heat sources (flames, furnace, boilers, etc).

Piping should not pass through heated enclosures.

Frequent make and break connections shall be at least 5 feet away from the non-classified electrical connections, switches, panels, equipment and fixtures.

Do not cross piping under bare electrical power supply lines without protection. Piping shall be at least 15 ft away from the bare power lines (insulated wiring is excluded from this requirement).

Piping Design

Typical Supply Manifold Design

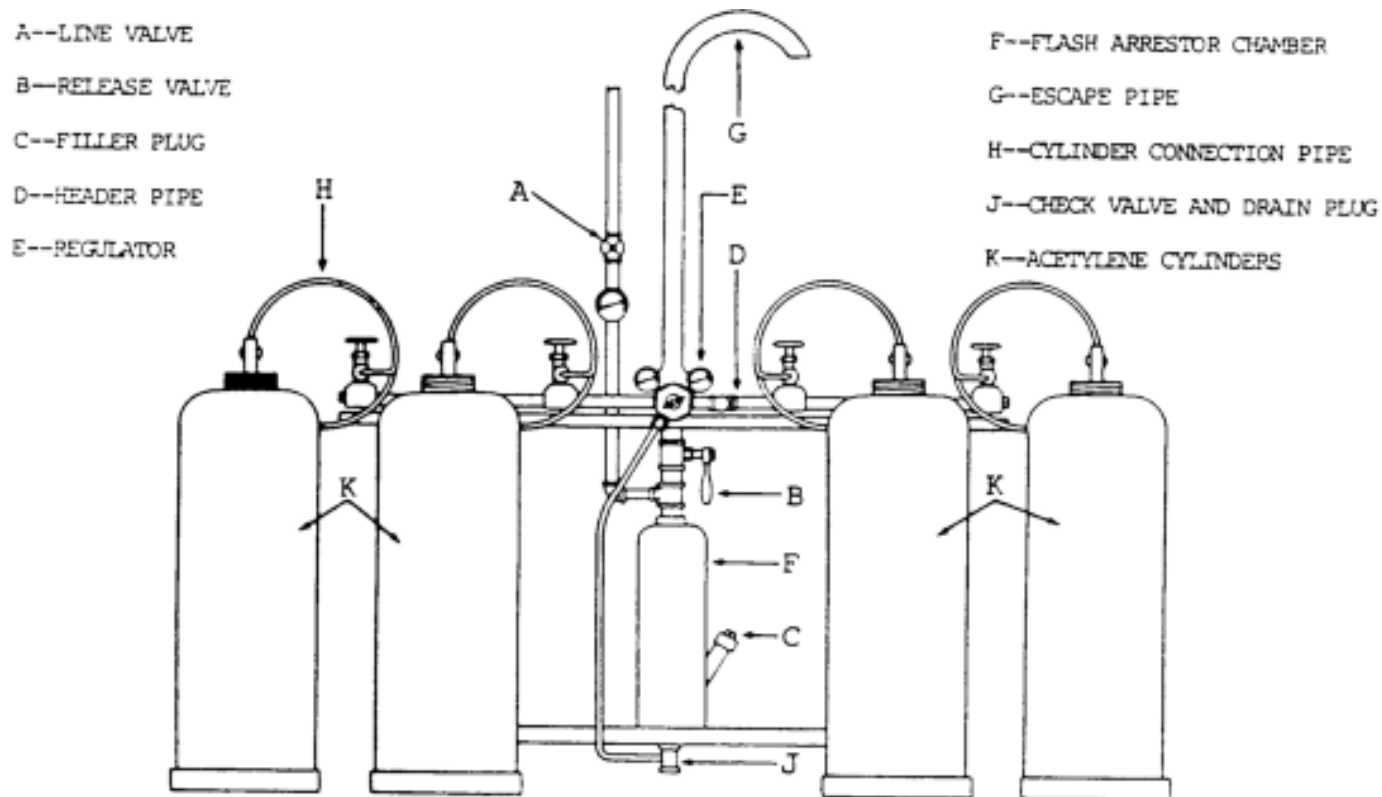
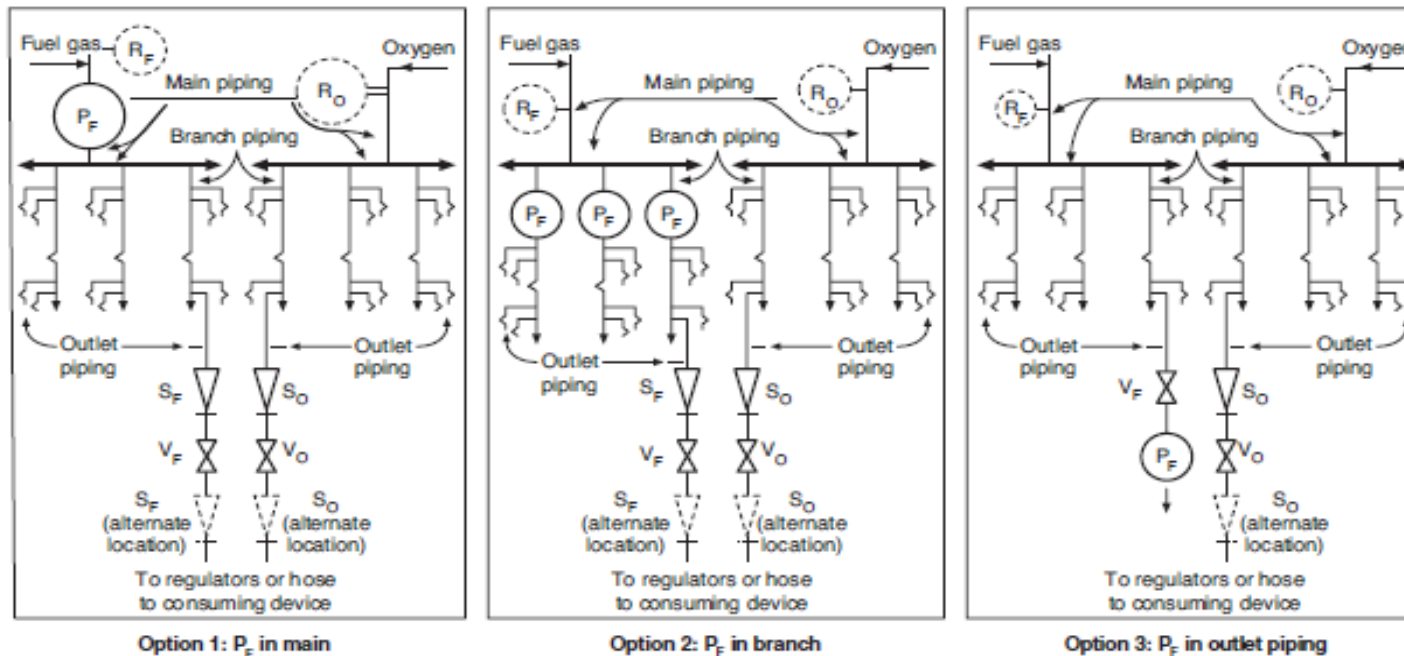


Figure 5-3. Stationary acetylene cylinder manifold and other equipment.

Piping Design

Typical Station Drops Schematics (NFPA-51)



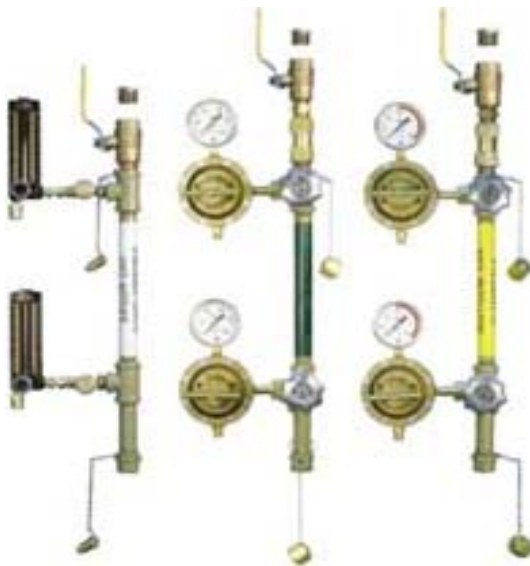
Legend:

P_F = Protective equipment in fuel gas piping
 V_F = Fuel gas station outlet valve
 V_O = Oxygen station outlet valve
 S_F = Backflow check valve
 S_O = Backflow check valve
 R_O = Pressure-relief device (oxygen)
 R_F = Pressure-relief device (fuel gas)

FIGURE 7.2.1 Schematic Arrangements of Piping and Station Outlet Protective Equipment. (See Sections 7.2, 7.3, and 7.4.)

Piping Design

Station drops



S

Equipment & Fittings

Major low and medium pressure Equipment:

- ✓ Station Regulators
- ✓ Piping fittings
- ✓ Valves
- ✓ Instruments

Equipment & Fittings

Station Regulators :

- Standard welding regulators which are available in market do work on station drops but, the pressure drop or lag on demand is very high therefore, not good for applications which are very sensitive to pressure drops below certain set points.
- Intermediate in-line pressure regulators are designed for this applications and are good for use. They have high capacity, very low pressure drop or lag time on demand.

Equipment & Fittings

Piping Fittings:

Fittings: Use fittings like elbows, tees, unions, etc of same material as of pipe.

Steel fittings: CGA recommends to use forged fittings made of ASTM-106

Stainless fillings : 304 or 316

Brass fitting: Brazing type do not use solder fittings.

Copper fitting: Not acceptable.

Equipment & Fittings

Valves

Globe valves recommended normal use valves.

Ball valves can be used for shutoff applications.

Use fire rated valves.

Valves pressure rating as per the system burst pressure rating.

Solenoid valve rated for acetylene service.

Equipment & Fittings

Instruments:

Material compatibility needs to be reviewed for all instruments used.

Electrical instruments used shall be rated : explosion proof or Class1 Div1 A, or Intrinsically safe.

Rated for flammable gas – acetylene service.

Safety Equipment

Deluge / sprinkler system:

The system shall be designed as per NFPA 13 requirement or Local code requirements.

NFPA recommends the deluge system coverage capacity to be 10 LPM/m² (0.25 GPM/sq ft).

The capacity of water required at the site is typically based on the fire-department response time.