LIFECO-541

ENGINEERED CLEAN AGENT

INERT GAS FIRE SUPPRESSION SYSTEM

DESIGN, INSTALLATION, OPERATION AND MAINTENANCE MANUAL

LICHFIELD FIRE & SAFETY EQUIPMENT CO LTD

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FOREWORD

This manual LFIGMAL-0541 is a comprehensive guide that comprises all the information that need to install, design and maintain IG-541 fire suppression systems manufactured by LIFECO.

LIFECO-541 Engineered total flooding fire suppression systems shall be designed, inspected, tested, maintained and recharged by qualified and trained personnel in accordance with requirement as follow:

- National Fire Protection Association 2001 (NFPA 2001) "Standard on Clean Agent Fire Extinguishing Systems".
- UL 2127 Standard for Safety Inert Gas Clean Agent Extinguishing System Units.
- FM 5600 Approval Standard for Clean Agent Extinguishing Systems
- All guidelines, limitations etc included in this manual P/N: LFIGMAL-0541.
- Local Authority having jurisdiction.

DENOTATIONS

System
The text "system" in this manual refers to the fire suppression components and does not cover fire alarm and detection system which may trigger an agent discharge.

Engineered
Hydraulic flow program used to predict the flow of Inert Gas through a pipe network.

IG-541
Inert Gas IG-541 is a clean agent fire suppression system using an inert gas consisting of 52% Nitrogen, 40% Argon and 8% Carbon Dioxide.

The following written remarks are used throughout this manual. They are important to the safe use of the Component described in this manual.

WARNING:
The instructions indicated under these remarks, which if not correctly adhered, could result in severe injury or death.

CAUTION:
The instructions indicated under these remarks, which if not correctly adhered, could result in minor injury or death.

IMPORTANT

Any questions concerning the information presented in this manual should be addressed to: -

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1.0 INTRODUCTION

LIFECO-541 Engineered Fire Suppression systems are Underwriters Laboratories Inc. (UL) listed and Factory Mutual (FM) Approved. These systems are designed for total flooding in accordance with NFPA 2001 "Standard on Clean Agent Fire Extinguishing Systems", UL 2127 Standard for Safety Inert Gas Clean Agent Extinguishing System Units and FM 5600 Approval Standard for Clean Agent Extinguishing Systems. In any situation not specifically covered by this manual, the application and installation of the system must meet the requirements of the standard as stated or Local Authority Having Jurisdiction.

1.1 AGENT

LIFECO-541 Engineered Fire Suppression systems consist of inert gas extinguishing agent: IG-541 (52% Nitrogen, 40% Argon and 8% Carbon Dioxide).

Inert gas is a colorless, odorless, electrically non-conductive gas. The gases do not support combustion, do not deplete the ozone layer and as well as no global warming potential. Inert gas is pressurized and stored in seamless cylinders assembly which hold at 200bar or 300 bar @ 15ºC (2900 psi or 4351psi @ 59ºF). LIFECO-541 systems are ideal for total flooding applications to suppress Class A, B and C hazards. The main extinguishing mechanism of inert gas is by lowering the oxygen content below the level that supports combustion.

IG-541 is listed under;

i. National Fire Protection Agency (NFPA®) 2001, Standard on Clean Agent Fire Extinguishing Systems.
ii. Underwriters Laboratories (UL)
iii. FM (Factory Mutual) Approved
iv. U.S. Environmental Protection Agency

1.2 PHYSICAL PROPERTIES AGENT

Table 1.0 Physical Properties of IG-541

Physical Properties	IG-541
Chemical Name	Nitrogen, Argon, Carbon Dioxide
Molecular Weight	34 g/mol
Boiling Point @ 1 atm (1.013 bar)	-196 °C (-320.8 °F)
Critical Pressure	N/A
Critical Temperature	N/A
Ozone Depleting Potential	0
Global Warming Potential	0

1.3 PRODUCT SPECIFICATIONS

Inert gas shall comply with the specification shown in Table 1.3.1.

Table 1.3.1 Inert Gas Quality Requirements

Agent	Composition, by volume			Water content, by weight
	Nitrogen	Argon	Carbon Dioxide	
IG-541	52% ± 4 %	40% ± 4 %	8% (+ 1 %, - 0 %)	0.005% (max)

1.4 SAFETY CONSIDERATIONS

LIFECO-541 Engineered Total Flooding Fire Suppression Systems shall not be used for fires which involving the following materials such as:

Table 1.4.1 – Limitation of Use

- Certain chemicals or mixtures of chemicals such as cellulose nitrate and gunpowder, which are capable of rapid oxidation in the absence of air.
- Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium
- Metal hydrides
- Chemicals capable of undergoing auto-thermal decomposition such as certain organic peroxides and hydrazine.

Based on NFPA 2001, Inert gas concentration are specified by "No Observable Adverse Effect Level" (NOAEL) and "Lowest Observed Adverse Effect Level" (LOAEL).

Note: NOAEL is the highest concentration that no adverse physiological or toxicological effect has been observed.
LOAEL is the lowest concentration, which an adverse physiological or toxicological effect

Table 1.4.2 Inert Gas NOAEL and LOAEL Values

Description	Concentration (% v/v)
No Observable Adverse Effect Level (NOAEL)	43
Lowest Observed Adverse Effect Level (LOAEL)	52

WARNING

Do not stand directly in front of the discharge line as the high pressure discharged from the nozzles can create noise loud enough to startle occupants. The high velocity discharge of this agent can be enough to dislodge objects located directly in the discharge path. Turbulence may be created in the enclosure which capable to move the lighter objects and unsecured paper. Direct contact with the vaporizing agent discharged from the nozzles will leave a strong chilling effect on objects and can cause frostbite burns to the skin. The liquid phase vaporizes rapidly when mixed with air and limits the chilling hazard to the immediate vicinity of the nozzle. Although inert gas is colorless, discharge in humid atmospheres may cause a reduction of visibility for a short time due to the condensation of water vapor.

WARNING

When inert gas is discharged, the vaporizing inert gas discharge mixture will have a significant cooling effect which could cause skin irritation. Unnecessary exposure of personnel either to the natural form of clean agent or to the products of decomposition shall be avoided.

Emergency Aid

Refer to the Inert gas SDS within Appendix A.

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2.0 IG SYSTEM COMPONENTS

LIFECO-541 Engineered Systems are intended to be designed and installed to suppress fire within the limitation mentioned in this manual. The systems described in this manual are FM approved and Underwriters Laboratories (UL) Listed. It is complied in accordance with UL 2127 and FM 5600.

2.1 IG CYLINDER ASSEMBLY

The cylinder assembly comprises of a cylinder factory fitted with a valve, filled with IG-541 and pressurized to 200 Bar or 300 Bar @ 15ºC (2900 psi or 4351 psi @ 59ºF). Cylinders are available in 80L or 140L. Cylinder color is RAL3001.

Table 2.1.1 ISO Cylinders Dimension

Size (L)	Working Pressure	Test Pressure	Height (mm), A	Height (mm), B	Cylinder Diameter (mm), C	Nominal Tare Weight (kg)
80	200 Bar	300 Bar	1840-1855	1775	267	92
140			1800-1820	1735	356	146
80	300 Bar	450 Bar	1870-1885	1805	267	110
140			1920-1940	1855	356	226

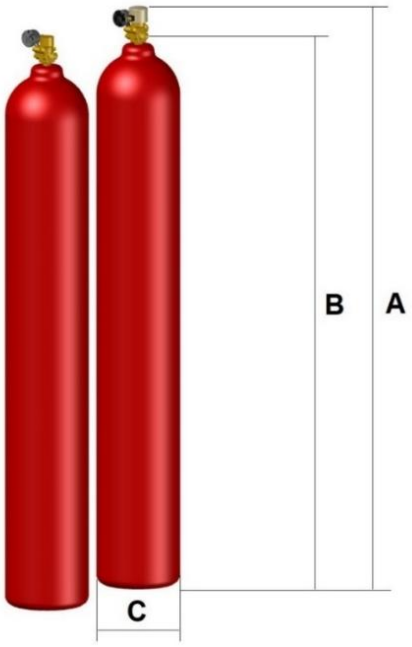


Figure 2.1.1 Cylinder Assembly

The filled and pressurized cylinder chosen location should protect against direct sunlight, mechanical, chemical or other types of damage. The suppression systems temperature limit from -20ºC (-4ºF) to 55ºC (131ºF).

Table 2.1.3 ISO Cylinder Details

Agent	Size	Working Pressure	Part Number	Valve Type	Agent Quantity		Gross Weight (kg)
					(m^3)	(kg)	
IG-541	**80**	200 Bar	**LF-IG54180200S**	Solenoid Valve	16.59	23.43	118
			LF-IG54180200	Discharge Valve			
	140		**LF-IG541140200S**	Solenoid Valve	29.02	41.01	189
			LF-IG541140200	Discharge Valve			
	80	300 Bar	**LF-IG54180300S**	Solenoid Valve	23.57	33.31	144
			LF-IG54180300	Discharge Valve			
	140		**LF-IG541140300S**	Solenoid Valve	41.26	58.29	283
			LF-IG541140300	Discharge Valve			

2.2 VALVE ASSEMBLY

Valve operates by means of pressure differential piston. The valves incorporated with the features to enable it to be connected with manual and pneumatic actuator for actuation purpose. Each valve is provided with an anti-recoil cap. Only removed when connecting cylinder to pipework and refit when disconnecting the cylinder from pipework. There are 2 types of valves:

1) Discharge valve
2) Solenoid discharge valve

Figure 2.2.1 Discharge Valve

Table 2.2.1 Discharge Valve Technical Information

Description	Valve Size	
Working Pressure	200 Bar	300 Bar
Part Number	LF-IGDV200	LF-IGDV300
Outlet	W21.8 x 1/14”	
Material	Brass	
Test Pressure	360 Bar	
Safety Disc Pressure	270 Bar (3916psi)	405 Bar (5874 psi)
Gauge Port	M12 x 1.0	
Equivalent Length	25.84m	
Weight	1.16kg	

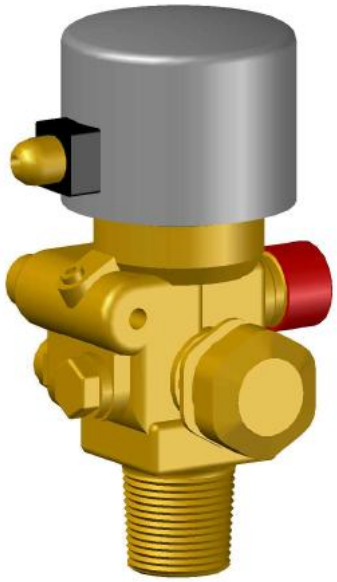


Figure 2.2.2 Solenoid Valve

Table 2.2.2 Solenoid Valve Technical Information

Description	Valve Size	
Working Pressure	200 Bar	300 Bar
Part Number	LF-IGEASV200	LF-IGEASV300
Outlet	W21.8 x 1/14”	
Material	Brass	
Test Pressure	360 Bar	
Safety Disc Pressure	270 Bar (3916psi)	405 Bar (5874 psi)
Gauge Port	M12 x 1.0	
Equivalent Length	25.84m	
Weight	1.55kg	
Voltage	24 VDC	
Max Current	0.4 A	
Power consumption	9.3 W	
Protection class	IP65	

2.3 PILOT ASSEMBLY

The cylinder assembly comprises of a cylinder factory fitted with a solenoid discharge valve (PN: LF-IGEASV200), filled with nitrogen and pressurized to 200 Bar @ 15ºC (2900 psi @ 59ºF). Cylinders are available in 4L and 10L. Pilot assembly is to actuate cylinders pneumatically in a system and selector valve if system available. Pilot valve adaptor (PN: LF-PVA) is available to adapt the pilot cylinder to the pilot line. (*4L is not FM approved)

Table 2.3.1 Pilot Cylinder Technical Information

Description	Specification	
Working Pressure	200 Bar @ 15ºC	
Size	4L	10 L
Part Number (ISO 9809)	LF-IGPC4	LF-IGPC10
Outlet	W21.8 x 1/14”	
Test Pressure	300 Bar	
Safety Disc Pressure	270 Bar (3916psi)	
Gauge Port	M12 x 1.0	
Equivalent Length	25.84m	
Weight	10kg	19kg
Voltage	24 VDC	
Max Current	0.4 A	
Power consumption	9.3 W	
Protection class	IP65	
Overall height	500mm	950mm
Cylinder diameter	140mm	

Figure 2.3.1 Pilot Cylinder Assembly

2.4 PILOT CYLINDER BRACKET

Pilot cylinder bracket designed to mount 4L and 10L Pilot cylinder to the wall. Pilot cylinder bracket features 2 strap design to give flexibility for adjustable height.

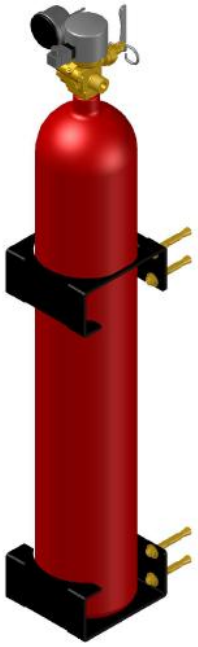


Figure 2.4.1 Pilot Cylinder Bracket

Table 2.4.1 Pilot Cylinder Bracket Technical Information

Description	Specification
Part Number	LF- CBP
Material	Mild Steel
Paint	Epoxy Powder Coating (Black)
Mounting	Wall

2.5 CYLINDER BRACKET

Cylinder brackets are available for 80L(200bar/300bar) and 140L(200bar/300bar) cylinders. It comes with an unistrut channel designed to securely fix the cylinders to a supporting structure or wall. Cylinder to be floor mounted only.

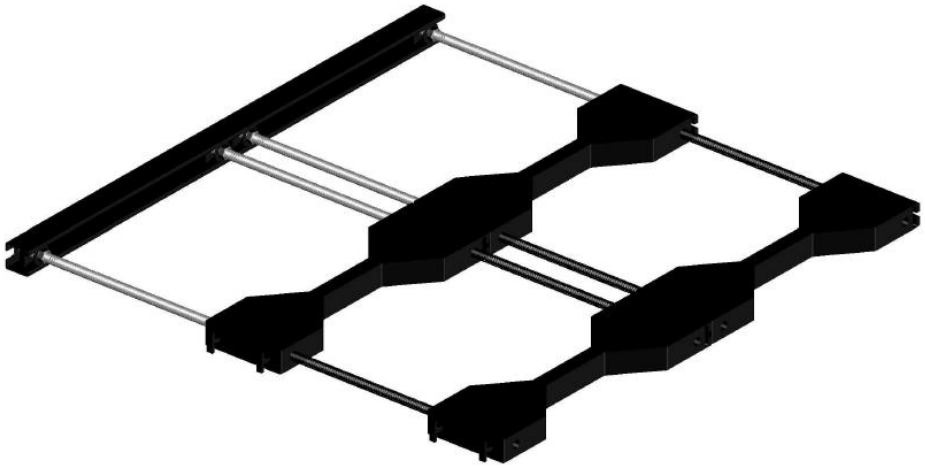


Figure 2.5.1 Cylinder Bracket

Table 2.5.1 Cylinder Bracket Technical Information

Description	Specification
Material	Mild Steel
Paint	Epoxy Powder Coating (Black)
Mounting	Unistrut Channel

Part Number	Cylinder Size	Unistrut Channel Length	Row	Set comes with
LF- CB-80	80L (200bar & 300bar)	360 mm (14.2 inch)	1st Row	1x Strap, 2x M12 stud with c channel stopper, 2x washer, 2x Nut, 1x Unistrut channel
LF- CB-140	140L (200bar & 300bar)	450 mm (17.7 inch)		
LF- CBX-80	80L (200bar & 300bar)	N/A	2nd Row and above	1x Strap, 2x M12 stud
LF- CBX-140	140L (200bar & 300bar)	N/A		

2.6 PRESSURE GAUGE

There are two types of pressure gauge;

1) Pressure gauge with switch 200 Bar
2) Pressure gauge with switch 300 Bar

Pressure gauge comes with electrical contact to monitor cylinder pressure and to report losses of cylinder contents. Cylinder assembly can be supply with pressure gauge with Normally Open switch or Normally Close switch. Both pressure gauge can be assembled and dissembled under pressure.

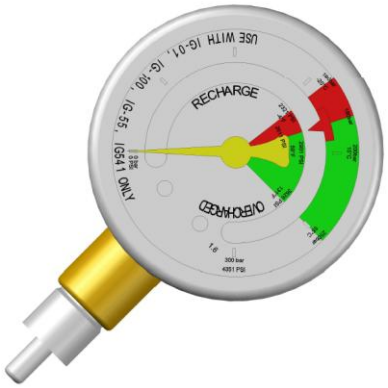


Figure 2.6.1 Pressure Gauge with switch

Table 2.6.1 Pressure Gauge Technical Information

Description	**Specification**			
Working Pressure	200 Bar	300 Bar	200 Bar	300 Bar
Part Number	LF-PGLPS4	LF-PGLPS3	LF-PGLPS6	LF-PGLPS5
Body	Stainless Steel Case			
Type	Bourdon Tube			
Gauge Size	50mm			
Pressure Range	0 – 300 Bar (0 – 4351 psi)	0 – 450 Bar (0 – 6527 psi)	0 – 300 Bar (0 – 4351 psi)	0 – 450 Bar (0 – 6527 psi)
Std. Connection	M12 x 1.0			
Set Point	180 Bar (2611 psi)	270 Bar (3916 psi)	180 Bar (2611 psi)	270 Bar (3916 psi)
Switching Type	Normally Open (NO)		Normally Close (NC)	
Switching voltage	4.5 – 24 VDC/VAC			
Switching current	5 – 100mA			
Contact Load	Max 2.4W			

2.7 MANUAL ACTUATOR

The manual actuator is designed to be used and installed with solenoid valve (PN: LF-IGEASV200 & LF-IGEASV300) for mechanically actuation. Safety pin is provided with every actuator to prevent accidental discharge. Actuation by removing safety pin and moving lever to 90˚. Manual actuator features retractable pin which reset when level back to original position.

Figure 2.7.1 Manual Actuator

Table 2.7.1 Manual Actuator Technical Information

Description	Specification
Part Number	LF-COMA
Body	Brass C3604BD
Level	Stainless Steel
Safety Pin	Stainless Steel
Piston Rod	Brass C3604BD
Connection	M20 x 1.5
Overall Size	48mm (H) x 28mm (W)
Mounting Torque	15 Nm ± 1

2.8 PNEUMATIC ACTUATOR

Pneumatic actuator is designed to be used and installed with valve (PN: LF-IGDV200 & LF-IGDV300) for pneumatically actuation. The pneumatic actuator features a pneumatically driven piston that used to depress the valve core and opening the valve. The pressure from the master cylinder is used to actuate the cylinder discharge valve of slave cylinder via flexible hose.

Figure 2.8.1 Pneumatic Actuator

Table 2.8.2 Pneumatic Actuator Technical Information

Description	Specification
Part Number	LF-COPA
Body	Brass C3604BD
Actuation Pin	Brass C3604BD
Valve Connection	M36 x 1.5
Pneumatic Connection	2 x 1/8” BSP
Overall Size	56.5mm (L) x 40mm (Diameter)
Pilot Pressure	Min 20 Bar (290 psi), Max 360 Bar (5221 psi)
Mounting Torque	25 Nm ± 2

2.9 PNEUMATIC MANUAL ACTUATOR

Pneumatic Manual actuator is designed to be used and installed on valve for mechanically or pneumatically actuation.

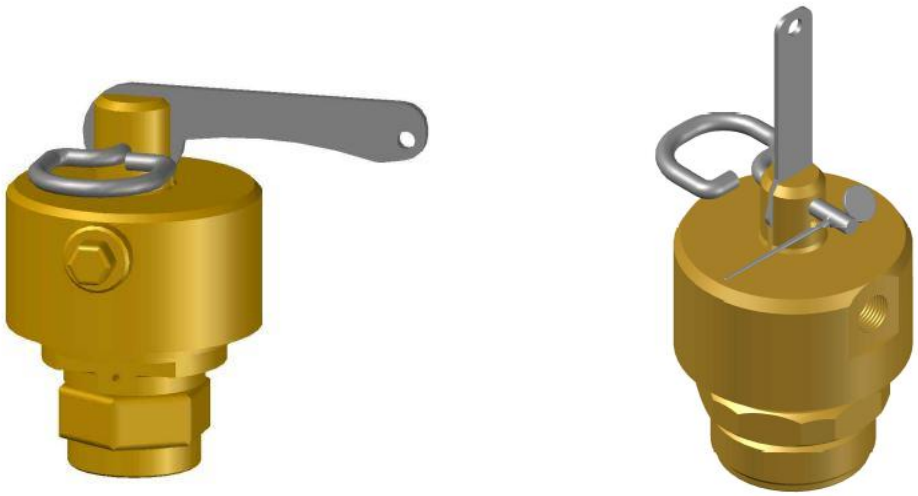


Figure 2.9.1 Pneumatic Manual Actuator

Table 2.9.1 Pneumatic Manual Actuator Technical Information

Description	Specification	
Part Number	LF-COMPA	LF-COMPA/1
Used with Valve	Discharge valve LF-IGDV200 & LF-IGDV300	Solenoid valve LF-IGEASV200 & LF-IGEASV300
Body	Brass C3604BD	
Actuation Pin	Brass C3604BD	
Valve Connection	M36 x 1.5	M20 x 1.5
Pneumatic Connection	2 x 1/8” BSP	
Overall Size	83mm (L) x 40mm (Diameter)	
Pilot Pressure	Min 8 Bar (116 psi), Max 300 Bar (4351 psi)	
Mounting Torque	15 Nm ± 1	

2.10 DISCHARGE HOSE

The discharge hose is equipped with a female swivel fitting at the inlet and enable to connect the cylinders to the manifold in multiple cylinder arrangements. This feature has enables cylinder to be disconnected during maintenance without any effort to remove other manifold connection and pipework.

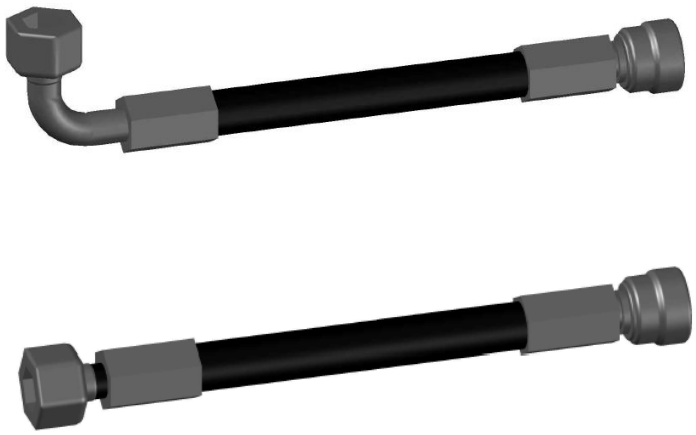


Figure 2.10.1 Discharge Hose

Table 2.10.1 Discharge Hose Technical Information

Description	Specification	
Part Number	LF-DH500E	LF-DH500S
Type	90˚ Elbow	Straight
Hose Material	Synthetic rubber	
Connection Material	Coated Steel	
Inlet Connection	W21.8 x 1/14”	
Outlet Connection	¾” BSP	
Min Bend Radius	250mm	
Max Working Pressure	360 Bar (5221 psi)	
Temperature Range	-20ºC to + 50ºC (-4 ºF to 122 ºF)	
Overall Length	500mm	
Size	DN12	

*Various length is available upon request.

2.11 CONSTANT PRESSURE REGULATOR

Constant Pressure Regulator provided constant flow throughout the discharge. It regulates the pressure to ≤ 60 Bar for 200 Bar and 300 bar system which enable a lower pressure rating piping can be used. It gives higher flow rates and achieve 95% of the discharge within 60 seconds.

Figure 2.11.1 Constant Pressure Regulator

Table 2.11.1 Constant Pressure Regulator Technical Information

Description	Specification
Part Number	LF-PR
Material	Brass
Inlet Connection	3/4” BSP Female
Outlet Connection	3/4” BSP Male
Inlet Pressure	Max 360 Bar (5221 psi)
Outlet Pressure	Static: 60 Bar (+2, -6 Bar), 870 psi (-29, +87 psi) Dynamic: Max 60 Bar (870 psi)
Overall Size	145mm (L) x 64mm (Diameter)
Mounting Torque	55 Nm ± 5

2.12 FLEXIBLE HOSE

The flexible hose is used to connect between the master cylinder valve port and slave cylinder pneumatic actuator and slave to slave cylinder pneumatic actuator. This flexible hose is act as a pressure connector.

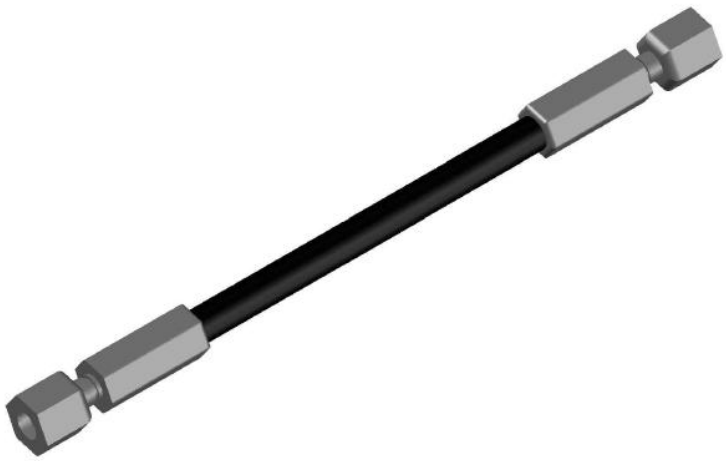


Figure 2.12.1 Flexible Hose

Table 2.12.1 Flexible Hose Technical Information

Description	**Specification**	
Part Number	LF-PH350	LF-PH450
Hose Material	Synthetic rubber	
Connection Material	Coated Steel	
Connection	M12 x 1.5	
Min Bend Radius	30mm	
Max Working Pressure	360 Bar (5221 psi)	
Temperature Range	-20ºC to + 65ºC (-4 ºF to 149 ºF)	
Overall Length	350mm (L)	450mm(L)
Size	DN5	

*Various length is available upon request.

2.13 BLEED VALVE

Bleed valve is used and installed in pneumatic pilot lines to prevent and release unintended pressure developed in the pilot line.

Figure 2.13.1 Bleed Valve

Figure 2.13.1 Bleed Valve Technical Information

Description	Specification
Part Number	LF-BVPL
Material	Stainless Steel
Connection	1/8” BSP
Max Working Pressure	360 Bar (5221 psi)
Temperature Range	-20ºC to + 65ºC (-4 ºF to 149 ºF)
Overall Size	64mm (L) x 22mm (W)
Pressure	Closing : 0.4 Bar Increasing Pressure Opening: 0.5 Bar Falling Pressure

2.14 CHECK VALVES

Check valve is connected between discharge hose and constant pressure regulator before the manifold to prevent backflow of the agent during a discharge.

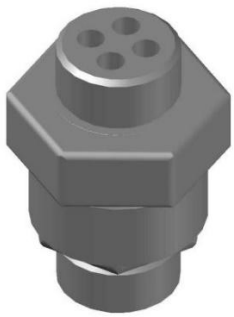


Figure 2.14.1 Check Valve

Table 2.14.1 Check Valve Technical Information

Description	Specification
Part Number	LF-CV
Nominal Size	12mm
Material	Stainless Steel
Connection	3/4" BSP Male
Working Pressure	360 Bar (5221 psi)
Overall Size	65mm (L) x 38mm (W)
Equivalent Length	0.48 m

2.15 DISCHARGE NOZZLES

Nozzles are devices through which the agent is discharged within the protected enclosure. Nozzles are available in 180º or 360º and available in size ⅜ inch, ½ inch, ¾ inch, 1 inch, 1 ¼ inch, 1 ½ inch and 2 inch. Orifices size determine by design software calculation.

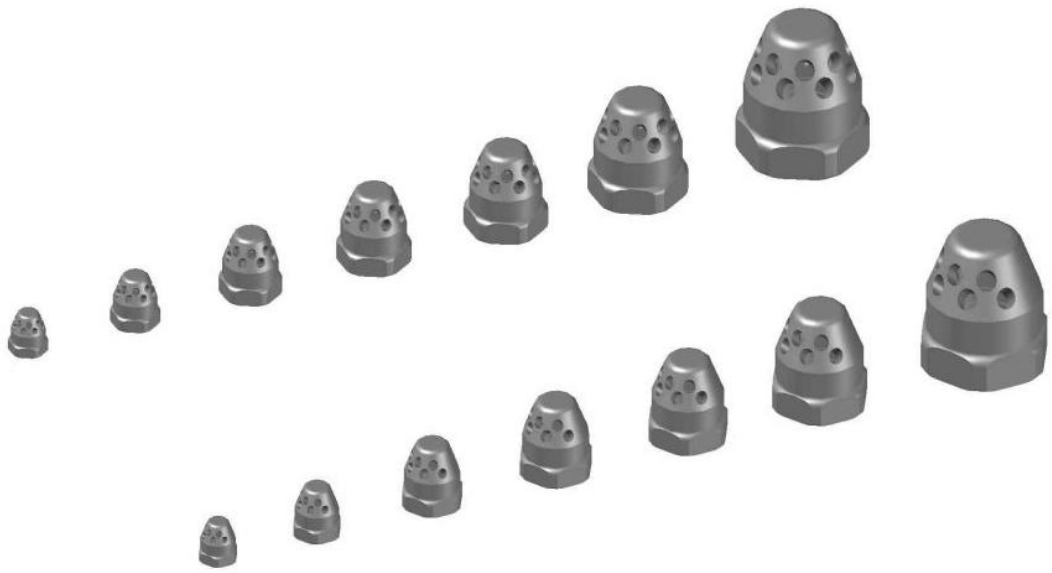


Figure 2.15.1 180º and 360º Discharge Nozzle

Table 2.15.1 Discharge Nozzle Technical Information

Description	Specification
Material	Brass (Nickel Plate)
Insert	Brass
Connection	BSP Female / NPT Female
Working Pressure	90 Bar (1305 psi)

Table 2.15.2 Discharge Nozzle Technical Information

Nozzle Size	Part Number	Nozzle Type	Port	Port Size	Height	Wrench Size	Orifice Size Range
10 mm (⅜ inch)	LF-180IG-10	180	5	4.5 mm	29 mm	24 mm	4.9 mm – 9.6 mm
15 mm (½ inch)	LF-180IG-15	180º	5	6.7 mm	36 mm	30 mm	6.2 mm – 12.2 mm
20 mm (¾ inch)	LF-180IG-20	180º	9	6.7 mm	46 mm	38 mm	8.2 mm – 16.2 mm
25 mm (1 inch)	LF-180IG-25	180º	9	8.4 mm	55 mm	45 mm	10.4 mm – 20.6 mm
32 mm (1 ¼ inch)	LF-180IG-32	180º	9	10.7 mm	64 mm	50 mm	14.0 mm – 27.0 mm
40 mm (1 ½ inch)	LF-180IG-40	180º	14	10.7 mm	77 mm	60 mm	16.0 mm – 31.5 mm
50 mm (2 inch)	LF-180IG-50	180º	14	13.4 mm	94 mm	80 mm	20.5 mm – 40.5 mm
10 mm (⅜ inch)	LF-360IG-10	360º	8	3.6 mm	29 mm	24 mm	4.9 mm – 9.6 mm
15 mm (½ inch)	LF-360IG-15	360º	8	5.4 mm	36 mm	30 mm	6.2 mm – 12.2 mm
20 mm (¾ inch)	LF-360IG-20	360º	16	5.0 mm	46 mm	38 mm	8.2 mm – 16.2 mm
25 mm (1 inch)	LF-360IG-25	360º	16	6.3 mm	55 mm	45 mm	10.4 mm – 20.6 mm
32 mm (1 ¼ inch)	LF-360IG-32	360º	16	8.0 mm	64 mm	50 mm	14.0 mm – 27.0 mm
40 mm (1 ½ inch)	LF-360IG-40	360º	24	8.2 mm	77 mm	60 mm	16.0 mm – 31.5 mm
50 mm (2 inch)	LF-360IG-50	360º	24	10.2 mm	94 mm	80 mm	20.5 mm – 40.5 mm

2.16 SELECTOR VALVE

Selector valves are flow control valves with open and closed condition. Selector valve used in application where multiple enclosure or areas require to be protected from a single bank cylinder system. All selector valves are equipped with pneumatic actuators and limit switches.

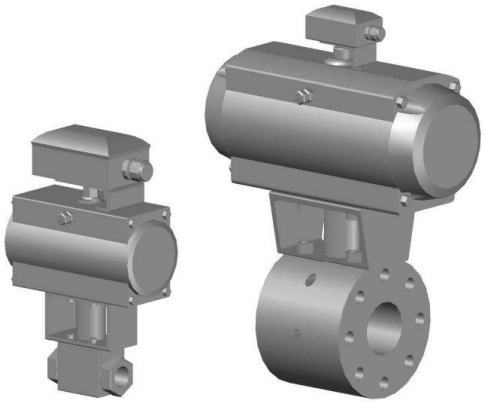


Figure 2.16.1 Selector Valve

Table 2.16.1 Selector Valve Technical Information

Description	Specification
Material	Stainless Steel
Connection	BSP
Working Pressure	140 Bar (2030 psi)
Nominal Control Pressure	6 Bar
Control Pressure zone	6 – 10 Bar
Complete Switching Time	≤ 3 s
Opening Angle	90˚C
Voltage	12 – 250 V AC/DC
Operating Current	0.1 – 10 A
Limit switch	2 change over contacts

Table 2.16.2 Selector Valve (threaded) Technical Information

Size	Part Number	Thread Connection	Weight
DN 20	LF-DIV20-BSP	¾" BSP	6.2 kg
	LF-DIV20-NPT	¾" NPT	
DN 25	LF-DIV25-BSP	1" BSP	7.0 kg
	LF-DIV25-NPT	1" NPT	
DN 32	LF-DIV32-BSP	1 ¼" BSP	11.0 kg
	LF-DIV32-NPT	1 ¼" NPT	
DN 40	LF-DIV40-BSP	1 ½" BSP	15.8 kg
	LF-DIV40-NPT	1 ½" NPT	
DN 50	LF-DIV50-BSP	2" BSP	18.5 kg
	LF-DIV50-NPT	2" NPT	

Table 2.16.3 Selector Valve (ISO Flange) Technical Information

Size	Part Number	Connection	Weight
DN 63	LF-DIV65-ISO	2-1/2"	48.4 kg
DN 80	LF-DIV80-ISO	3"	80.1 kg
DN 100	LF-DIV100-ISO	4"	113.4 kg

Table 2.16.4 Selector Valve (DIN Flange) Technical Information

Size	Part Number	Connection	Weight
DN 63	LF-DIV65-DIN	2-1/2"	59.5 kg
DN 80	LF-DIV80-DIN	3"	81.5 kg
DN 100	LF-DIV100-DIN	4"	105 kg

2.17 PILOT HOSE FITTING ADAPTOR

Connection adaptor and fitting for pilot line.

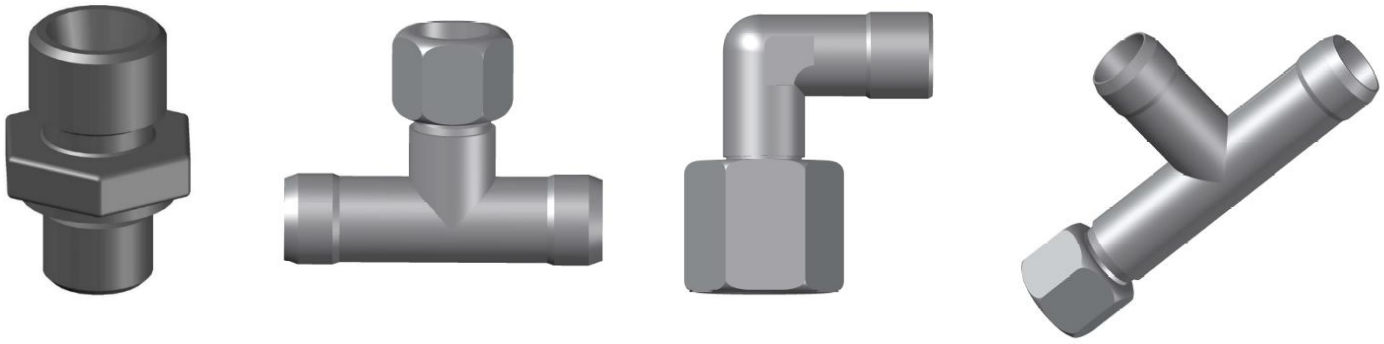


Figure 2.17.1 Connection adaptor and fitting

Table 2.17.1 Connection adaptor and fitting Technical Information

Description	**Specification**			
Part Number	LF-PHA	LF-SORS	LF-PVE	LF-SORT
Type	Straight	Tee (swivel on side)	Elbow	Tee (swivel on run)
Material	Steel (Zinc plated)			
Connection	1/8” BSP x M12 x 1.5	M12 x 1.5	M12 x 1.5	M12 x 1.5
Working Pressure	360 Bar (5221 psi)			

2.18 PILOT VALVE ADAPTOR

Connection adaptor for pilot cylinder to pilot line.

Figure 2.18.1 Pilot Valve Adaptor

Table 2.18.1 Pilot Valve Adaptor Technical Information

Description	Specification
Part Number	LF-PVA
Material	Brass
Connection (Pilot Hose)	M12 x 1.5
Connection (Valve)	M21.8 x 1/14”
Working Pressure	360 Bar (5221 psi)

2.19 PILOT LINE CHECK VALVE

The pilot line check valve is used to maintain pressure in a particular section of the pilot line or to ensure that nitrogen pressure from the pilot cylinder is operating the correct bank of cylinders.

A system using selector valve which consist of different numbers of cylinders for each hazard enclosure, can use the pilot line check valve to ensure the pilot pressure opens only the correct cylinder from the bank.

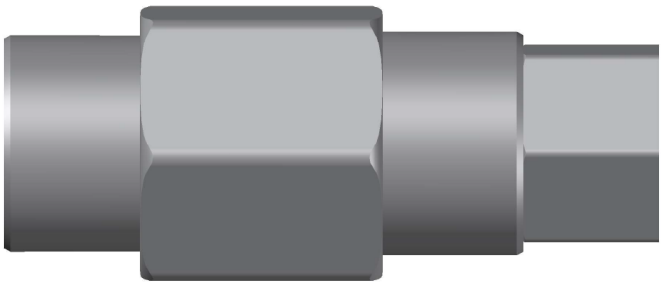


Figure 2.19.1 Pilot Line Check Valve

Table 2.19.1 Pilot Line Check Valve Technical Information

Description	Specification
Part Number	LF-CVPL
Material	Stainless steel
Connection	1/8” BSP Female
Working Pressure	360 Bar (5221 psi)

2.20 CYLINDER LABEL

The cylinder label consists of cylinder part number, cylinder serial number, filling date, tare weight, charge weight, gross weight, fill density and fill location.

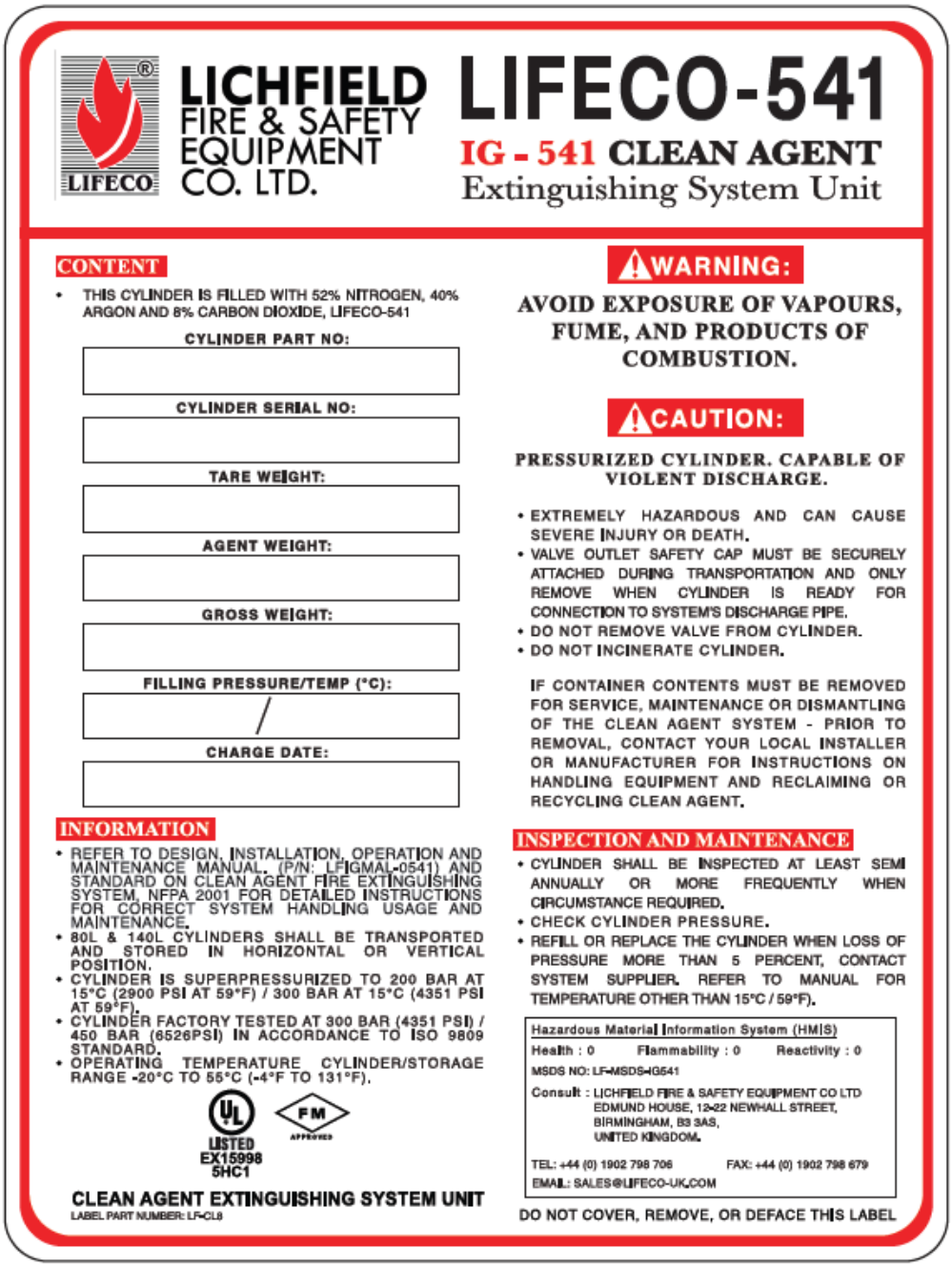


Figure 2.20.1 Cylinder Label

2.21 MANIFOLDS

Manifold is a steel pipework where contents of multiple cylinders discharged and direct connected to the appropriate pipe distribution system.

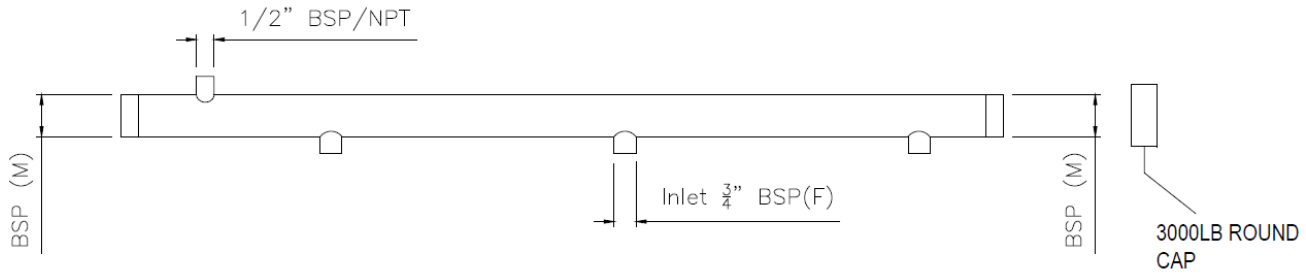


Figure 2.21.1 Manifold – Single Row

Table 2.21.1 Manifold Single Row Technical Information

Description	Specification	
Cylinder size	80 L	140 L
Class	Schedule 80	
Paint	Epoxy Powder Coating (Black)	
Working Pressure	90 bar	
Test Pressure	180 bar	
Port*	2-8	
Size	3/4", 1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4"	

*Additional ports upon request.

Table 2.21.3 80L Manifold Single Row Part Number

MANIFOLD SIZE	20mm	25mm	32mm	40mm	50mm	65mm	80mm	100mm
No. of Port = 2	LF-2COM20-80	LF-2COM25-80	LF-2COM32-80	LF-2COM40-80	LF-2COM50-80			
No. of Port = 3	LF-3COM20-80	LF-3COM25-80	LF-3COM32-80	LF-3COM40-80	LF-3COM50-80	LF-3COM65-80	LF-3COM80-80	
No. of Port = 4		LF-4COM25-80	LF-4COM32-80	LF-4COM40-80	LF-4COM50-80	LF-4COM65-80	LF-4COM80-80	
No. of Port = 5		LF-5COM25-80	LF-5COM32-80	LF-5COM40-80	LF-5COM50-80	LF-5COM65-80	LF-5COM80-80	LF-5COM100-80
No. of Port = 6			LF-6COM32-80	LF-6COM40-80	LF-6COM50-80	LF-6COM65-80	LF-6COM80-80	LF-6COM100-80
No. of Port = 7			LF-7COM32-80	LF-7COM40-80	LF-7COM50-80	LF-7COM65-80	LF-7COM80-80	LF-7COM100-80
No. of Port = 8				LF-8COM40-80	LF-8COM50-80	LF-8COM65-80	LF-8COM80-80	LF-8COM100-80

Table 2.21.4 140L Manifold Single Row Part Number

MANIFOLD SIZE	25mm	32mm	40mm	50mm	65mm	80mm	100mm
No. of Port = 2	LF-2COM25-140	LF-2COM32-140	LF-2COM40-140	LF-2COM50-140			
No. of Port = 3	LF-3COM25-140	LF-3COM32-140	LF-3COM40-140	LF-3COM50-140	LF-3COM65-140	LF-3COM80-140	
No. of Port = 4		LF-4COM32-140	LF-4COM40-140	LF-4COM50-140	LF-4COM65-140	LF-43COM80-140	
No. of Port = 5		LF-5COM32-140	LF-5COM40-140	LF-5COM50-140	LF-5COM65-140	LF-5COM80-140	
No. of Port = 6			LF-6COM40-140	LF-6COM50-140	LF-6COM65-140	LF-6COM80-140	
No. of Port = 7				LF-7COM50-140	LF-7COM65-140	LF-7COM80-140	LF-7COM100-140
No. of Port = 8				LF-8COM50-140	LF-8COM65-140	LF-8COM80-140	LF-8COM100-140

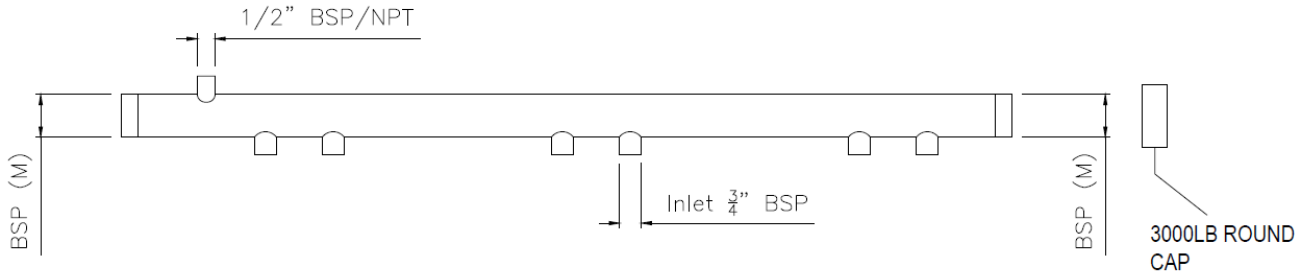


Figure 2.21.2 Manifold – Double Row

Table 2.21.2 Manifold Double Row Technical Information

Description	**Specification**	
Cylinder size	80 L	140 L
Class	Schedule 80	
Paint	Epoxy Powder Coating (Black)	
Working Pressure	90 bar	
Test Pressure	180 bar	
Port*	6	
Size	Part Number	
2”	LF-DR6COM50-80	LF-DR6COM50-140
2-1/2”	LF-DR6COM65-80	LF-DR6COM65-140
3”	LF-DR6COM80-80	LF-DR6COM80-140
4”	LF-DR6COM100-80	LF-DR6COM100-140

*Additional ports upon request.

2.22 DISCHARGE PRESSURE SWITCH

The discharge pressure switch function by sending signal to a control panel during a system discharged. It activates by the agent pressure during discharged and can be reset manually by pushing the top stem after activation.

Table 2.23.1 Discharge Pressure Switch Technical Information

Description	Specification
Part Number	LF-DPS
Body Material	Brass
Cover Plate	Mild Steel
Connection	1/2” NPT
Switch Configuration	3PDT, Three Pole Double Throw
Minimum Actuation Pressure	4 bar (58psi)
Maximum Operating Pressure	60 bar (870psi)
Electrical Rating	10A 250VAC 15A 125VAC 3/4HP, 250VAC 1,2, or 3 phase
Overall Size	100 mm (L) x 92mm (W) x 123mm(H) 3.94 inch(L) x 3.62 inch(W) x 4.84 inch(H)

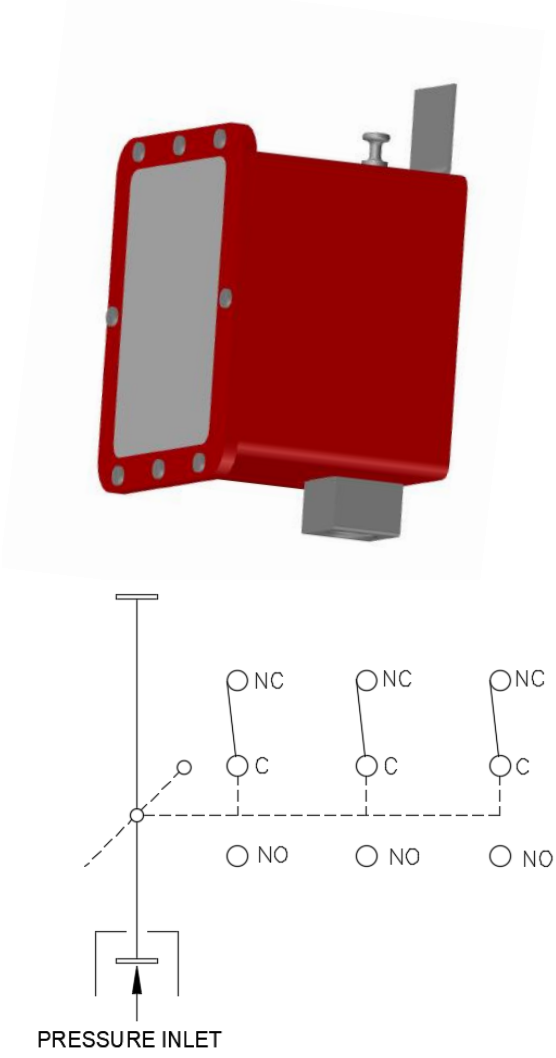


Figure 2.23.1 Discharge Pressure Switch & Wiring Diagram

3.0 SYSTEM DESIGN

The design section provides information to understand the characteristics of LIFECO-541 especially its flow from storage cylinder to the piping network and discharge via nozzle. The systems shall be designed, installed and maintained in accordance with NFPA 2001 and all regulations mentioned in this manual.

3.1 ENCLOSURE DATA

The following are steps to follow to design a LIFECO-541 Engineered Total Flooding Fire Suppression system:

3.1 It is important for system designer to conduct a hazard evaluation and survey of the enclosure that needs automatic suppression system protection to obtain specific information appertaining to the enclosure. In the absence of a site survey, the accurate information must be obtained from the drawing and customer confirmation prior to install.

3.2 Typical data and information such as enclosure volume, raised floor volume, above ceiling volume, Air conditioning and ventilation system configuration, smoke ventilator system and other related characteristic of the enclosure can be crucial to assist the LIFECO-541 system designer to calculate and design to appropriate requirement.

3.3 Based on the hazard class fire (Class A, B & C), the design concentration by volume will be assigned. (Refer to Table 3.2.1)

3.4 The minimum and maximum ambient temperatures within the protected space. (Hazard enclosure temperature will affect the agent quantity required. The higher the enclosure temperature, the less Inert gas agent is required. Conversely, the lower the enclosure temperature, the more Inert gas agent is required.

3.5 Calculating Inert gas agent quantity shall require the net protected volume of the enclosure multiply by the design concentration at minimum ambient temperature.

3.6 The extinguishing requirements per volume of protected space are shown in Table 3.2.2 for various level of concentration.

3.7 Determination of the ventilation system requirement. (Refer to Section 3.4)

When the system is discharged into a complete enclosure, normal gaps under doorways shall not affect system working performance. If there are openings in the protected volume, they must be sealed. Doors, air conditioner duct vents and dampers should be shut down prior to the time of discharge. Sufficient time must be allowed for the dampers to close before system discharge.

3.2 LIFECO-541 DESIGN CONCENTRATIONS

Table 3.2.1 – LIFECO-541 Fire Suppression Minimum Design Concentration Tested to UL2127 & FM5600

Hazard	Minimum design concentration, % v/v
	IG-541
Class A	34.65%
Class B (Commercial heptane fuel)	45.10%
Class C	38.98%

The minimum requirements for total flooding clean agent fire extinguishing systems are determined according to NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems. Minimum design concentration shown in Table 3.2.1 is the minimum extinguishing concentration (MEC) plus a safety factor.

Class A hazards: safety factors of 1.2

Class B hazards: safety factors of 1.3

Class C hazards: safety factors of 1.35

Table 3.2.2 – IG-541 Total Flooding Quantity (SI Units)

Temp (t) (°C)[c]	Specific Vapor Volume (s) (m^3/kg)[d]	Volume Requirements of Agent per Unit Volume of Hazard ($V_{agent}/V_{enclosure}$)[b] Design Concentration (% by Volume)[e]							
		34	38	42	46	50	54	58	62
–40	0.562	0.524	0.602	0.686	0.776	0.873	0.978	1.093	1.219
–30	0.586	0.502	0.578	0.658	0.745	0.838	0.938	1.048	1.169
–20	0.610	0.482	0.555	0.633	0.716	0.805	0.902	1.007	1.124
–10	0.634	0.464	0.534	0.609	0.689	0.775	0.868	0.969	1.081
0	0.659	0.447	0.515	0.587	0.664	0.746	0.836	0.934	1.042
10	0.683	0.432	0.497	0.566	0.640	0.720	0.807	0.901	1.005
20	0.707	0.417	0.480	0.547	0.619	0.696	0.780	0.871	0.971
30	0.731	0.403	0.464	0.529	0.598	0.673	0.754	0.842	0.940
40	0.755	0.391	0.449	0.512	0.579	0.652	0.730	0.816	0.910
50	0.779	0.379	0.436	0.496	0.562	0.632	0.708	0.791	0.882
60	0.803	0.367	0.423	0.482	0.545	0.613	0.687	0.767	0.855
70	0.827	0.357	0.410	0.468	0.529	0.595	0.667	0.745	0.831
80	0.851	0.347	0.399	0.455	0.514	0.578	0.648	0.724	0.807
90	0.875	0.337	0.388	0.442	0.500	0.563	0.630	0.704	0.785
100	0.900	0.328	0.378	0.430	0.487	0.548	0.613	0.685	0.764

This information was taken from **NFPA 2001: 2018 Edition under Annex A**, Table A.5.5.2 (f) IG-541 Total Flooding Quantity (SI Units).

X [agent volume requirements (m^3/m^3)] = volume of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \times \left(\frac{s_0}{s}\right) \times \log_{10}\left(\frac{100}{100-C}\right) = \left(\frac{s_0}{s}\right) \times \ln\left(\frac{100}{100-C}\right)$$

Where:

S_0 [specific volume (m3/kg)] = specific volume of inert gas agent at 21 °C and 1.013 bar absolute

t [temperature (°C)] = design temperature in the hazard area

C [Concentration (%)] = volumetric concentration of inert gas agent in air at the temperature indicated.

IG-541

S [specific volume (m3/kg)] = specific volume of IG-541 can be approximated by s = 0.65799 + 0.00239t

The quantity of inert gas agent designed shall be corrected to compensate for ambient pressure that vary more than 11 percent (equivalent to approximately 3000ft (915m) of elevation change) from standard sea level pressure. The corrected agent quantity is calculated by multiplying the calculated weight, W by the elevation correction factor. (See Table 3.2.3)

Table 3.2.3 Atmospheric Correction Factor

Altitude	Enclosure Pressure	Atmospheric Correction Factor
-3000ft (-0.92km)	16.25psi (840mm Hg)	1.11
-2000ft (-0.61km)	15.71psi (812mm Hg)	1.07
-1000ft (-0.30km)	15.23psi (787mm Hg)	1.04
0ft (0.00km)	14.70psi (760mm Hg)	1.00
1,000ft (0.30km)	14.18psi (733mm Hg)	0.96
2,000ft (0.61km)	13.64psi (705mm Hg)	0.93
3,000ft (0.91km)	13.12psi (678mm Hg)	0.89
4,000ft (1.22km)	12.58psi (650mm Hg)	0.86
5,000ft (1.52km)	12.04psi (622mm Hg)	0.82
6,000ft (1.83km)	11.53psi (596mm Hg)	0.78
7,000ft (2.13km)	11.03psi (570mm Hg)	0.75
8,000ft (2.45km)	10.64psi (550mm Hg)	0.72
9,000ft (2.74km)	10.22psi (528mm Hg)	0.69
10,000ft (3.05km)	9.77psi (505mm Hg)	0.66

3.3 INERT GAS AGENT CALCULATION EQUATION

The quantity of agent required for hazard protection can be calculated from the equation below:

$$X = 2.303\ x\ \left(\frac{S_0}{S}\right) x\ log_{10}\left(\frac{100}{100-C}\right) = \left(\frac{S_0}{S}\right) x \ln\left(\frac{100}{100-C}\right) x\ EC$$

Where:

X [agent volume requirements (m^3/m^3)] = volume of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

S_0 [specific volume (m3/kg)] = specific volume of inert gas agent at 21 °C and 1.013 bar absolute

t [temperature (°C)] = design temperature in the hazard area

C [Concentration (%)] = volumetric concentration of inert gas agent in air at the temperature indicated.

EC = Elevation Correction

IG-541

S [specific volume (m3/kg)] = specific volume of IG-541 can be approximated by s = 0.65799 + 0.00239t

3.4 VENTING REQUIREMENTS

Protected enclosure by an inert gas clean agent fire suppression system may requires a pressure vent which designed to allow pressure relief within the enclosure during the system discharge. Venting is important to prevent over or under pressurization to the hazard enclosure which also prevent consequences such as structural damage which can lead to loss of extinguishant.

Other than venting, integrity of the enclosure is also a requirement to determine by conducting room integrity test to ensure the agent is able to retain in the enclosure no less than retention time of 10 minutes. Longer retention time means holding of the agent in the enclosure is longer which in favor to extinguish deep seated hazard. Due to the discharge of the fire suppression agent into the enclosure will give rise in pressure within the enclosure which can affect the structural integrity of the enclosure.

Venting area can be calculated in the hydraulic flow calculation software provided. For the calculation, information requires the maximum strength of the weakest wall, floor or ceiling of the enclosure.

Note: It is client's responsibility to provide all the information required for venting calculation.

3.5 ENGINEERED SYSTEMS

Inert LIFECO System use of LIFECO-UK Flow Calculation Software v4.10 for predicting the flow of agent through a pipe network from storage cylinder to the discharge nozzle developed by Jensen Hughes, Inc.

The calculation software requires the designer to input the information of the protected enclosure to calculate the required pipe sizes, nozzle sizes, nozzle drill sizes, average nozzle pressure and discharge time as well. Due to the system design calculation is important and critical to the success of the suppression system, hence, only trained designers are allowed to perform system calculations and these are conducted in house or by authorized suppliers. The system design shall be within the listed limitations.

Note: The calculation method has been investigated for specific types of fittings, types of pipe and pipe inside diameter. When the specified limitations are not maintained there is the risk that the system will not supply the required quantity of extinguishing agent.

3.6 PIPE & FLOW LIMITATIONS

The Hydraulic Flow Calculation Software will select the pipe sizes for each section in the piping network based on the Inert Gas flowrate for each section. However, the pipe sizes also can be input manually into the program if desired. The selected pipe sizes must fall within the minimum and maximum range of flowrate as shown in general guideline in Table 3.6.1.

Table 3.6.1 Minimum and Maximum Flow Rate Guidelines

Nominal Pipe Size mm (in)	Flow Rate Range		Type of Pipe
	CFM	CMM	
6 (1/4)	47.41 – 266.07	1.34 – 7.54	Schedule 40
10 (3/8)	86.97 – 488.08	2.46 – 13.81	Schedule 40
15 (1/2)	138.43 – 776.92	3.92 – 22	Schedule 40
20 (3/4)	250.38 – 1403.4	7.09 – 39.74	Schedule 40
25 (1)	415.65 – 2331.12	11.77 – 66.01	Schedule 40
32 (1 -1/4)	740.2 – 4149.12	20.96 – 117.49	Schedule 40
40 (1-1/2)	1023.42 – 5737.22	28.98 – 162.46	Schedule 40
50 (2)	1730.42 – 9701.29	49 – 274.71	Schedule 40
65 (2-1/2)	2514.05 – 14095.85	71.19 – 399.15	Schedule 40
80 (3)	3969.37 – 22254.24	112.4 – 630.17	Schedule 40
100 (4)	7027.97 – 39402.34	199.01 – 1115.75	Schedule 40
125 (5)	11304.22 – 63369.7	320.1 – 1794.43	Schedule 40
150 (6)	16632.5 – 93248.38	470.98 – 2640.5	Schedule 40
6 (1/4)	42.35 – 237.69	1.2 – 6.73	Schedule 80
10 (3/8)	83.09 – 466.31	2.35 – 13.19	Schedule 80
15 (1/2)	138.43 – 776.92	3.92 – 22	Schedule 80
20 (3/4)	250.38 – 1403.4	7.09 – 39.74	Schedule 80
25 (1)	415.65 – 2331.12	11.77 – 66.01	Schedule 80
32 (1 -1/4)	740.2 – 4149.12	20.96 – 117.49	Schedule 80
40 (1-1/2)	1023.42 – 5737.22	28.98 – 162.46	Schedule 80
50 (2)	1730.42 – 9701.29	49 – 274.71	Schedule 80
65 (2-1/2)	2514.05 – 14095.85	71.19 – 399.15	Schedule 80
80 (3)	3969.37 – 22254.24	112.4 – 630.17	Schedule 80
100 (4)	7027.97 – 39402.34	199.01 – 1115.75	Schedule 80
125 (5)	11304.22 – 63369.7	320.1 – 1794.43	Schedule 80
150 (6)	16632.5 – 93248.38	470.98 – 2640.5	Schedule 80

This guideline table is applied for the schedule 40/80 pipe and acts as an approximate only. An actual hydraulic calculation must be performed to confirm both pipe sizes and the feasibility of the piping network.

Table 3.6.2 Hydraulic Flow Calculation Program Limitation

Description	Program Parameters
Discharge Time Interval	30 – 120 seconds
Maximum Pipe Volume to Cylinder Volume Ratio	104 %
Minimum Pipe Volume Ratio Before First Tee	5 %
Minimum Nozzle Orifice Area to Pipe Ratio	15%
Maximum Nozzle Orifice Area to Pipe Ratio	60%
Minimum Average Nozzle Pressure	10.1 Bar (146.49 psi)
Maximum Arrival Time Imbalance	1.0 second
Critical Pipe Length	17 diameters
Bull Tee Split	10:90 (Min); 50:50 (Max)
Side Tee Split	10:90 (Min); 50:50 (Max)

When the above conditions are not met, the computer screen displays a warning. It is then up to the designer to correct them.

3.7 TEE LIMITATIONS

To maintain the turbulent flow in piping and predictable flow characteristics at tee splits, certain guidelines relating to tee orientation must be taken into consideration. The exit branches of the tees must be in the horizontal plane. There are two types of tee used for this system, bull tee and side tee.

Figure 3.7.1 Minimum Bull Tee Imbalance

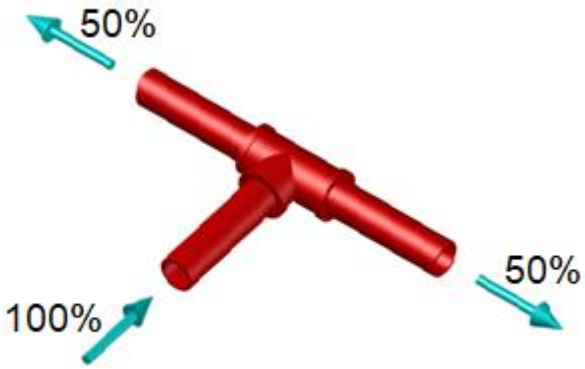


Figure 3.7.2 Maximum Bull Tee Imbalance

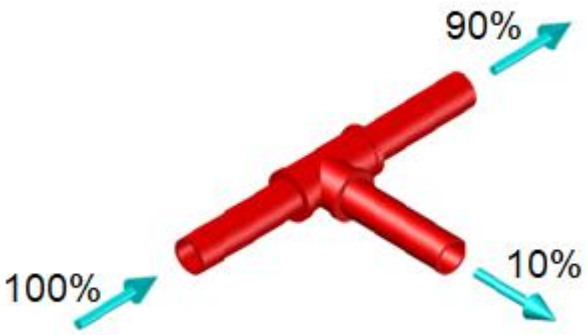


Figure 3.7.3 Minimum Side Tee Imbalance

Figure 3.7.4 Maximum Side Tee Imbalance

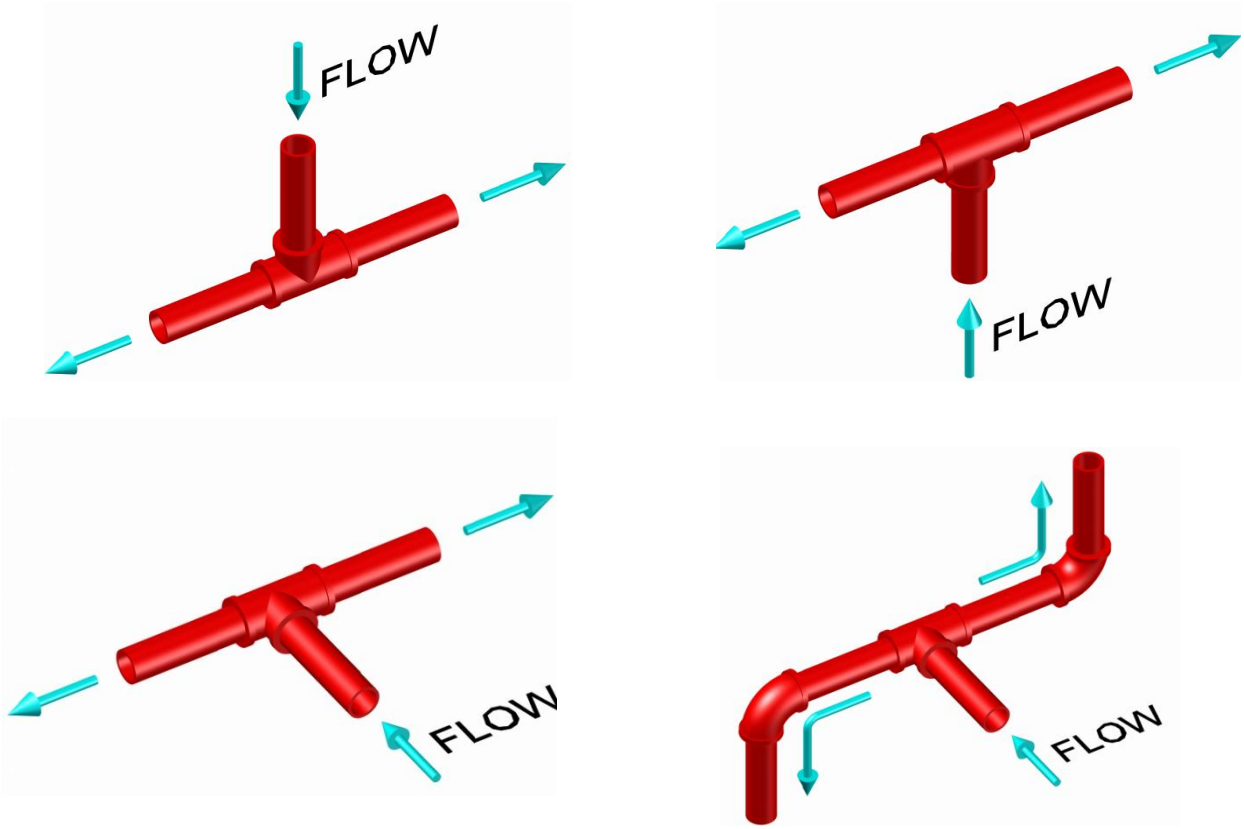


Figure 3.7.5 Correct Bull Tee Splits Orientation

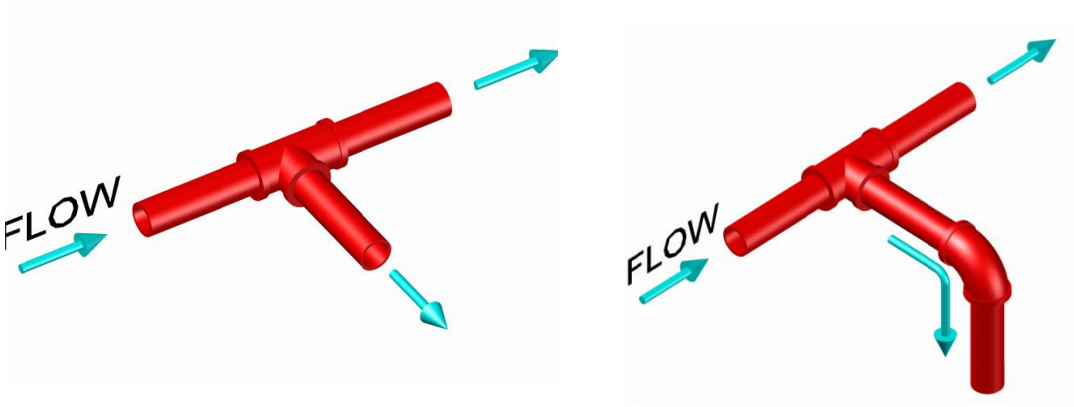


Figure 3.7.6 Correct Side Tee Splits Orientation

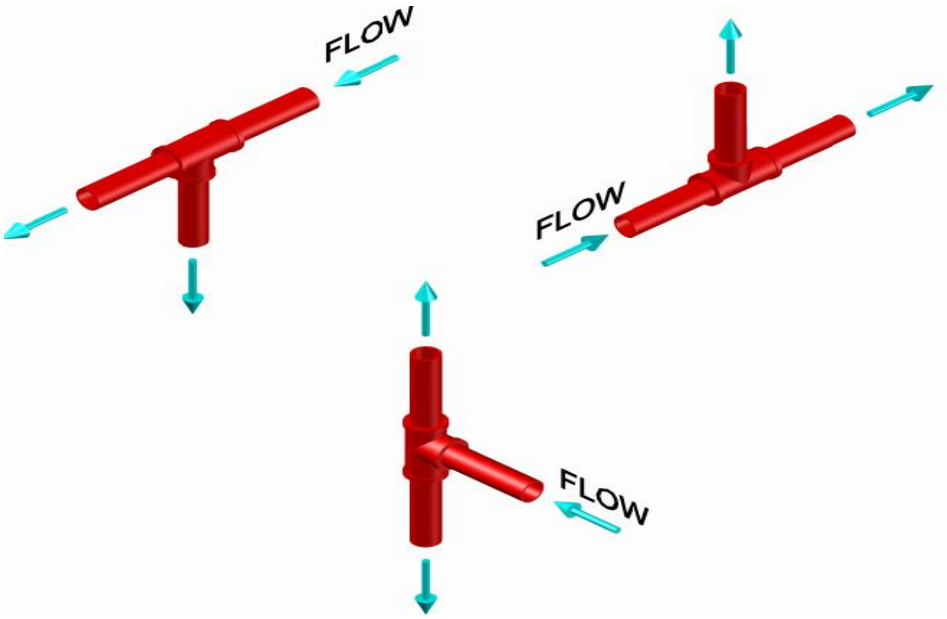


Figure 3.7.7 Incorrect Side Tee Splits Orientation

Table 3.7.1 Equivalent Length for Pipe Fittings

Nominal Size mm (in)	90° Elbow		45° Elbow		Through Tee		Side Tee		Union	
	ft	m	ft	m	ft	m	ft	m	ft	m
6 (1/4)	1.3	0.4	0.6	0.18	0.8	0.24	2.7	0.82	0.3	0.09
10 (3/8)	1.3	0.4	0.6	0.18	0.8	0.24	2.7	0.82	0.3	0.09
15 (1/2)	1.7	0.52	0.8	0.24	1.0	0.3	3.4	1.04	0.4	0.12
20 (3/4)	2.2	0.67	1.0	0.3	1.4	0.42	4.5	1.37	0.5	0.15
25 (1)	2.8	0.85	1.3	0.4	1.8	0.55	5.7	1.74	0.6	0.18
32 (1-1/4)	3.7	1.13	1.7	0.52	2.3	0.7	7.5	2.29	0.8	0.24
40 (1-1/2)	4.3	1.31	2.0	0.61	2.7	0.82	8.7	2.65	0.9	0.27
50 (2)	5.5	1.68	2.6	0.79	3.5	1.06	11.2	3.41	1.2	0.37
65 (2-1/2)	6.6	2.01	3.1	0.94	4.1	1.25	13.4	4.08	1.4	0.43
80 (3)	8.2	2.5	3.8	1.16	5.1	1.55	16.6	5.06	1.8	0.55
100 (4)	10.7	3.26	5.0	1.52	6.7	2.01	21.8	6.64	2.4	0.73
125 (5)	13.4	4.08	6.3	1.92	8.4	2.56	27.4	8.35	3.0	0.91
150 (6)	16.2	4.94	7.6	2.32	10.1	3.08	32.8	10.0	3.5	1.07

3.8 DISCHARGE TIME

The discharge time required to achieve 95% of the minimum design concentration for flame extinguishment shall not exceed 60 seconds for Class B fuel hazards, 120 seconds for Class A surface-fire hazards or Class C hazards specified in NFPA 2001.

3.9 AGENT STORAGE CYLINDER

Inert gas agent shall be stored in approved cylinders to retain specific amount of compressed gas at ambient temperature. The cylinders shall be filled as according to Table 5.0 and pressurized to 200 Bar or 300 Bar @ 15ºC (2900 psi or 4351 psi @ 59ºF). The filled cylinders shall be allowed to be located within or outside the protected hazard enclosure. However, they shall not be placed where they can be rendered inoperable due to exposure to direct sunlight, chemicals, mechanicals and bad weather condition (temperature other than the operating temperature range of -20ºC to 55ºC (-4ºF to 131ºF). The hydraulic flow calculations assume an agent temperature of 15ºC (59ºF). **When the storage temperature varies by ± 5.5ºC (42ºF) from the normal ambient temperature, there is the risk that the system will not supply the designated quantity of extinguishing agent.**

3.10 MANIFOLDS / PIPING

For Inert gas in a multiple cylinder system, all cylinders are connected to the same manifold or pipe must be the same size and filled with same agent weight and pressure (200 bar or 300 bar) system. System can be connected with reserves. Reserves cylinders are duplication of the same bank of agent cylinders from the main and connected into a common manifold.

3.11 DISCHARGE NOZZLE

There are two type of discharge nozzle configurations namely:

- The 180º discharge nozzle which provides a 180º discharge pattern and designed to be mounted adjacent to a wall of the hazard.
- The 360º discharge nozzle which provides a 360º discharge pattern and designed to be installed in the center of the hazard.

There are certain factors such as coverage area and height limitation must be observed with each nozzle configuration to ensure proper agent distribution during discharged.

Nozzle Maximum Coverage Area		108.16m^2
*Maximum Protection Height		6.33m
Minimum Void Height		300mm
Maximum elevation change		No Limit
Nozzle Position (minimum void height)	180º	Pendant / Upright
	360º	
Maximum Nozzle Spacing	180º	300mm from Wall
	360º	Centerline, 300mm from Ceiling

*If the hazard's height exceeds 6.33m, multiple tiers of nozzles must be used for each 6.33m increment of the enclosure height.

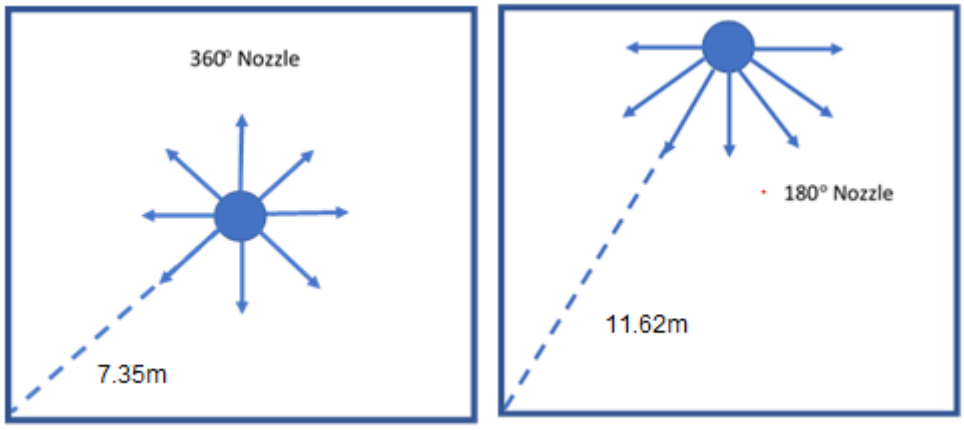


Table 3.11.1 Discharge Nozzle Discharge Radius

Nozzle Configuration	Radius
180º	11.62 m
360º	7.35 m

3.12 AGENT CALCULATION SAMPLE

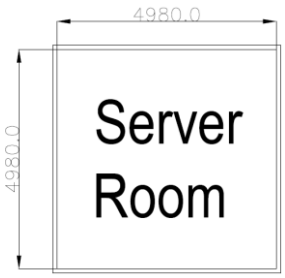


Figure 3.12.1 Server Rooms size

For example, A server room with dimension 4.98m (L) x 4.98m (W) x 3.50 m (H) is protected with an IG-541 system. The rooms is classified as Class C hazards. At minimum ambient temperature, 15ºC (59ºF).

Example:

To calculate the volume of Switch Room,

Server Room Volume, V = 4.98 m x 4.98 m x 3.5 m

= 86.8014 m^3

To calculate the specific volume at 15 ºC,

S [specific volume (m3/kg)] = 0.65799 + 0.00239t

=0.65799 + 0.00239(15)

=0.69384

To calculate the specific volume at 21 ºC,

S_0 [specific volume (m3/kg)] = 0.65799 + 0.00239t

=0.65799 + 0.00239(21)

=0.70818

To calculate the agent required per protected volume,

IG-541 Class C Design Concentration = 38.65%

$$X = 2.303\ x\ \left(\frac{S_0}{S}\right) x\ log_{10}\left(\frac{100}{100-C}\right) = \left(\frac{S_0}{S}\right) x \ln\left(\frac{100}{100-C}\right)$$

X =0.4987m^3/m^3

To calculate the agent required,

V = 86.8014m^3

Agent required = X x V

= 0.4987 x 86.8014 = 43.29m^3

To calculate Number of cylinders required,

Agent capacity per 80L 300bar cylinder = 23.57m^3

Total number of cylinders = 43.29m^3 / 23.57m^3 = 1.84 ≈ 2 nos of 80L 300bar cylinders.

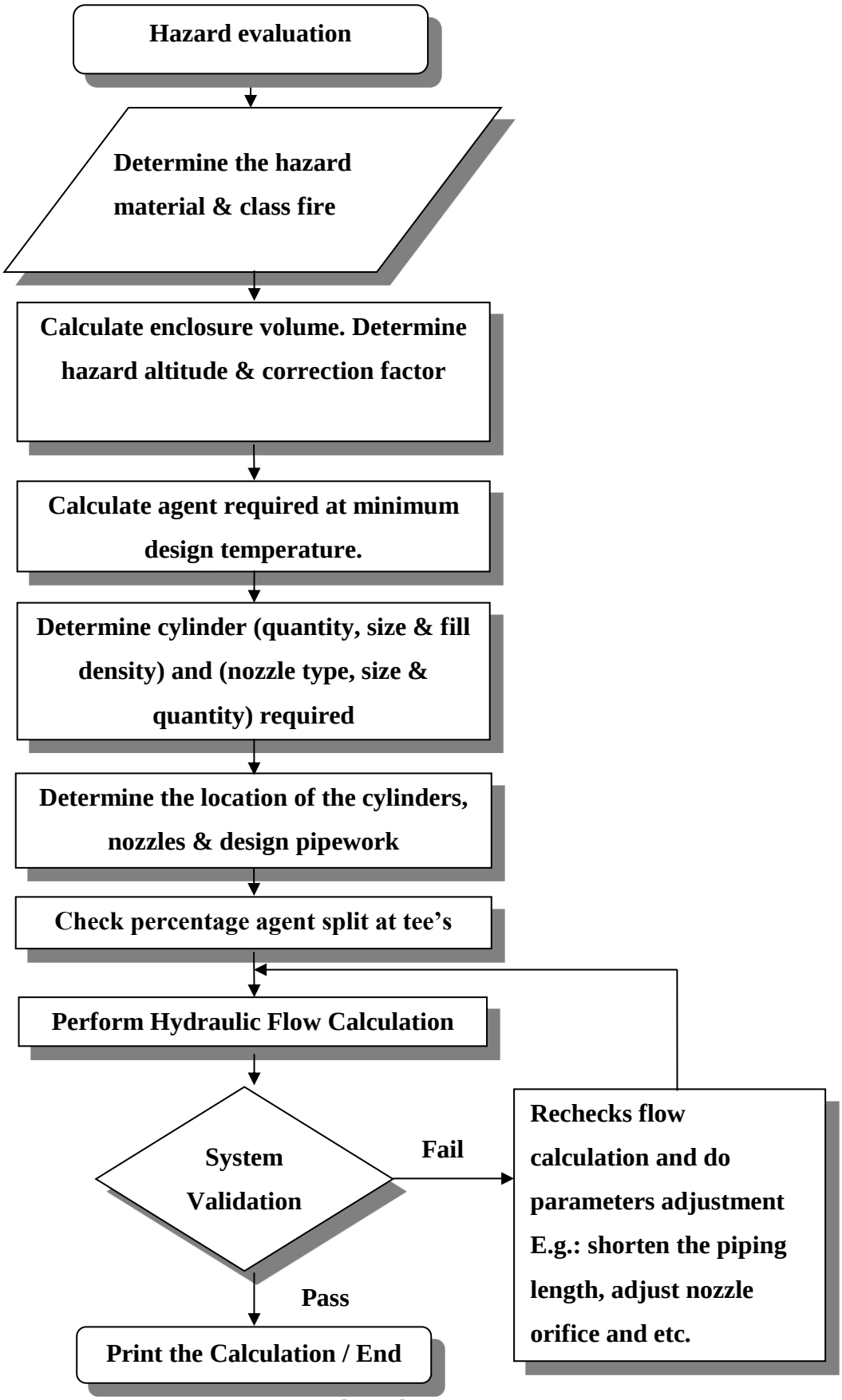


Figure 3.12.2 System Design Flow Chart

4.0 SYSTEMS MECHANICAL INSTALLATION

- General Information

All mechanical installation work carried out shall be performed by a trained total flooding system installation contractor with the correct equipment and the relevant experience in gaseous extinguishing systems. Prior to installation commence, installing contractor shall refer to system installation drawing prepared for the specific hazard or appropriately endorsed working drawing and be satisfied with the system designed complies to requirement. Installation drawing shall contain information as follow:

i. Detailed hazard's layout drawing
ii. Net volume of enclosure
iii. Quantity of Agent designed
iv. Cylinder location with indication of master unit / slave units
v. Detection system layout
vi. Suppression control panel's line drawing

- For all installations the detection, manual pull stations, and fire suppression control panel shall be accepted by the Authority Having Jurisdiction.
- The cylinder location is identified on the system drawings and should be protected from bad weather and easy for accessible when service and maintenance. The cylinders must be firmly secured to a wall in a vertical orientation only.
- The back channel of the mounting bracket is fitted to a wall by using suitable bolt.
- The cylinder is position with pressure gauge face outside / valve outlet pointing left.
- The cylinder is then strap and secure with bolt.
- Remove the safety cap from the discharge valve outlet.
- Fit and connect all the cylinder with discharge hose, check valve and constant pressure regulators to the manifold.
- The cylinder is disconnected and refit with safety cap. Once the pipework and nozzle has been installed, then reconnect the pipe to the cylinder.

CAUTION

Do not tight the pipe to the valve outlet excessively. This may cause the valve outlet thread to be damaged and indirectly affected the system operation.

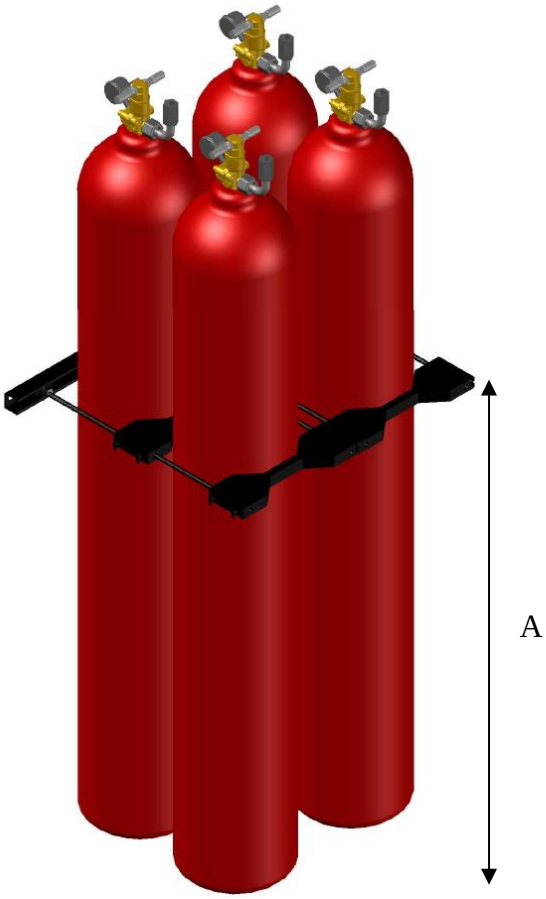


Figure 4.0.1 Bracket Fixing Heights

Cylinder Size	Height from Floor to Bracket A	Label Location from Floor
80L 200bar	1200 mm (47.25 inch)	1550 mm (61 inch)
80L 300bar		1550 mm (61 inch)
140L 200bar		1500 mm (59 inch)
140L 300bar		1550 mm (61 inch)

Bracket Installation:

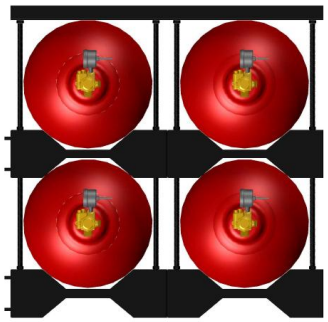
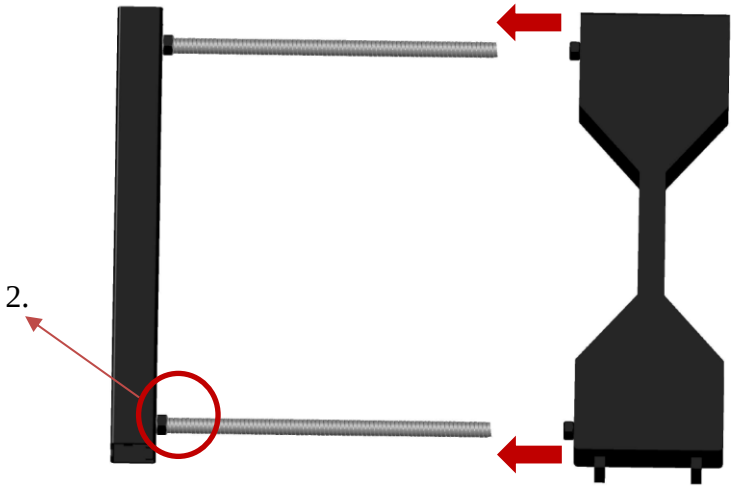
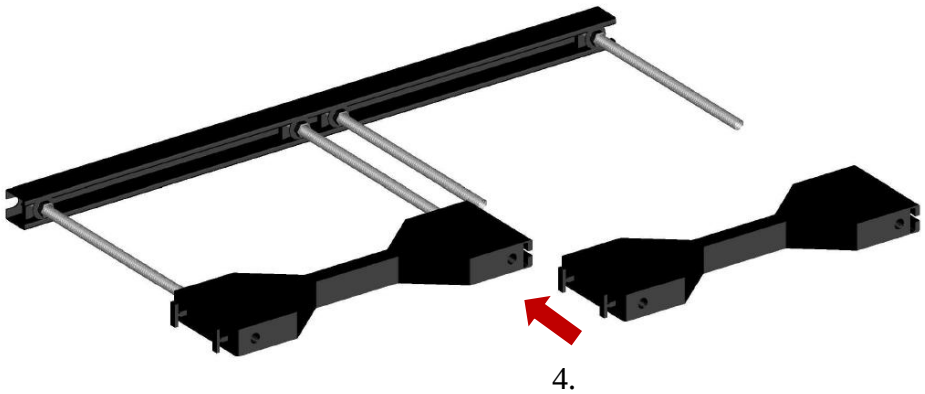


Figure 4.0.2 Bracket Top View

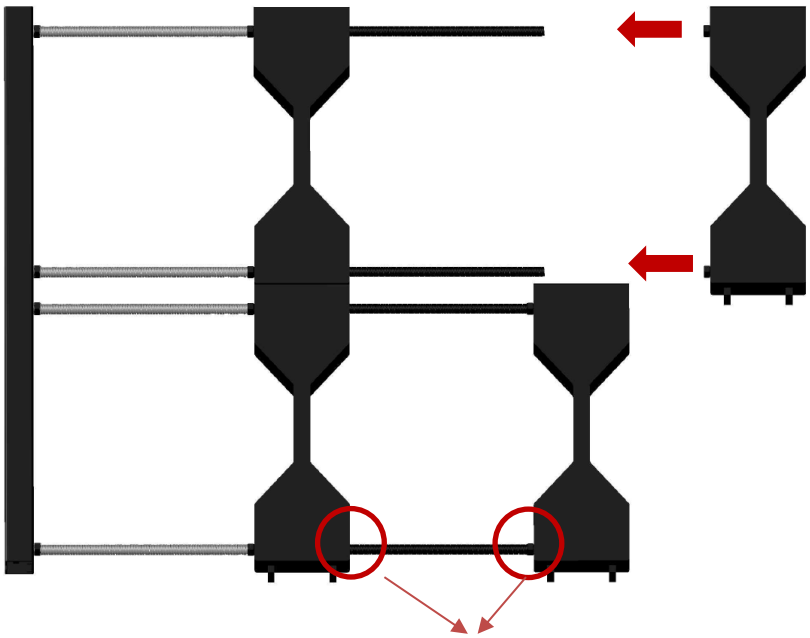
1. Install Unistrut channel to wall or supporting structure.
2. Install Stud with C channel stopper into Unistrut channel. Tighten stud with spanner.
3. Fit stud into bracket strap nut. Tighten nut with spanner.



4. Repeat step 2 and slot the second strap to the first strap channel. Then tighten nut with spanner.



5. Install additional stud provided to first row strap and connect to second row strap.



5.

4.1 PIPE INSTALLATION

The pipework installs according to the as built installation drawing and followed to:

- The piping material must conform to the requirements of NFPA 2001. Joint compound, tape, or thread lubricant shall be applied only to the male threads of the joint.
- The piping system should comply with the pressure requirements specified in the Table below.

Table 4.1.1 Steel Pipe Requirements

Pipe Size	Connection	Pipe Class
½ inch – 6 inch	Threaded	Schedule 40/80

A dirt trap consisting of a tee with a capped nipple, at least 2 inch long, shall be installed at the end of each pipe run. (Source: section 4.2.1.6, NFPA 2001: 2018 Edition)

Each of the pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, utilizing a suitable nonflammable cleaner. The pipe network shall be free of particulate matter and oil residue before installation of nozzles or discharge devices.

4.2 ACTUATION INSTALLATION

4.21 Installation of Electrical Actuator

Location of Installation

The electrical actuator is built in with Solenoid discharge valve 200bar (PN: LF-IGEASV200) and 300bar (PN: LF-IGEASV300).

Figure 4.2.1 Solenoid valve with built in electrical actuator

CAUTION

The pilot wire must be free of any voltage when assembling the connector, otherwise accidental discharge of the extinguishing system may occurred.

- Interchanging polarity of the contacts Positive and Negative do not lead to malfunction of the valve. Ensure the ground connection is connected correctly.

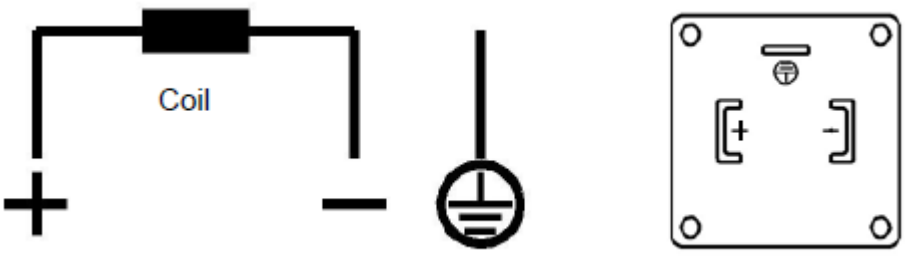


Figure 4.2.2 Electrical Actuator Wiring Diagram

4.22 Installation of Manual & Pneumatic Actuator

- Release devices compatibility.

	Manual Actuator (PN: LF-COMA)	Pneumatic Manual Actuator (PN: LF-COMPA/1)	Pneumatic Manual Actuator (PN: LF-COMPA)	Pneumatic Actuator (PN: LF-COPA)
Solenoid discharge Valve 200 bar (PN: LF-IGEASV200)	✓	✓		
Solenoid discharge Valve 300 bar (PN: LF-IGEASV300)	✓	✓		
Discharge Valve 200bar (PN: LF-IGDV200)			✓	✓
Discharge Valve 300bar (PN: LF-IGDV300)			✓	✓

- Check the thread for impurities and damages.
- Mount and tighten the release devices with a requirement of 15Nm ± 1 (Solenoid valve), 25Nm ± 2 (Discharge valve).
- Do not transport cylinder with release devices mounted. Only installed when system is commissioned.
- Actuated release devices must be reset before mount.

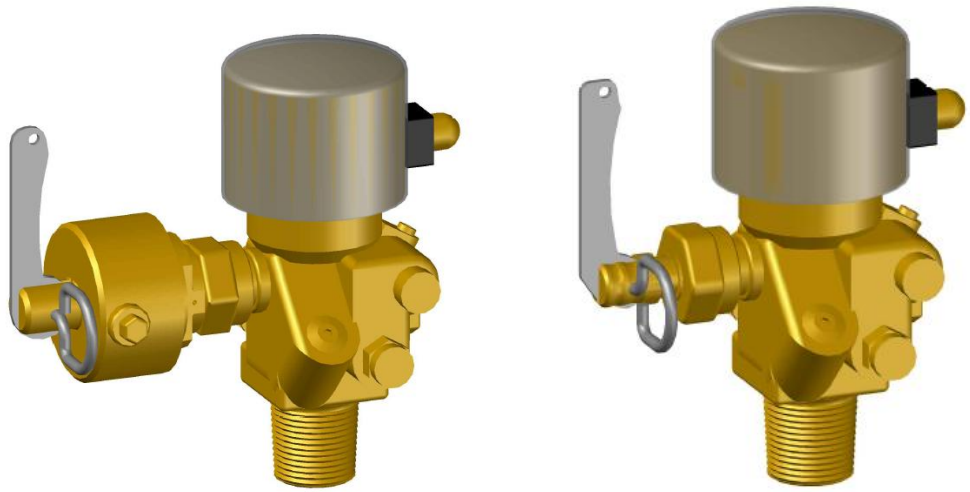


Figure 4.2.3 Solenoid valve with manual, pneumatic manual actuator

Manual actuator (PN: LF-COMA) and Pneumatic Manual actuator (PN: LF-COMPA/1) to be mount to the side of the discharge valve thread M20 x 1.5. Both actuators feature retractable pin which reset when level back to original position.

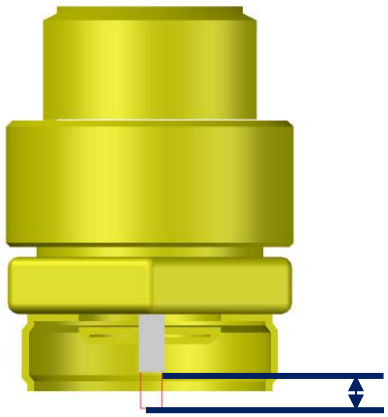


Figure 4.2.4 Pneumatic Actuator in Non-Fire/Fire Position

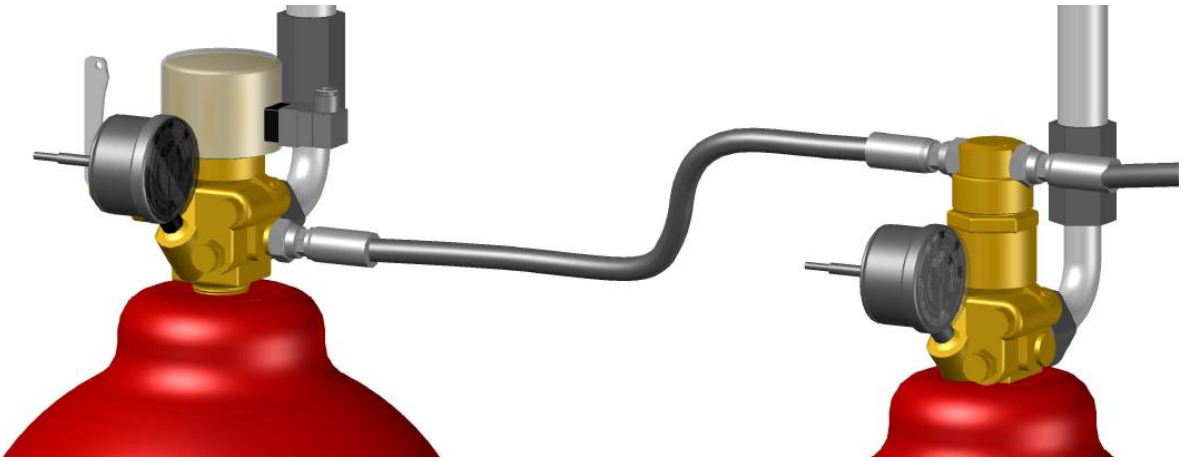


Figure 4.2.5 Pilot Hose installation

- Pneumatic actuator (PN: LF-COPA) must be installed on the slave cylinders only. Pin must be reset before mount.
- The pneumatic actuators / pneumatic manual actuators are triggered thru the 1/8” connection thread.
- The pneumatic connection of slave cylinders is achieved by removing the ¼” pressure plug of the master cylinder valve and fit the male adaptor. Install tee adaptor onto the pneumatic actuators.
- Connect one end of flexible hose to the male adaptor on the master cylinder and another end to the tee adaptor on the pneumatic actuator.

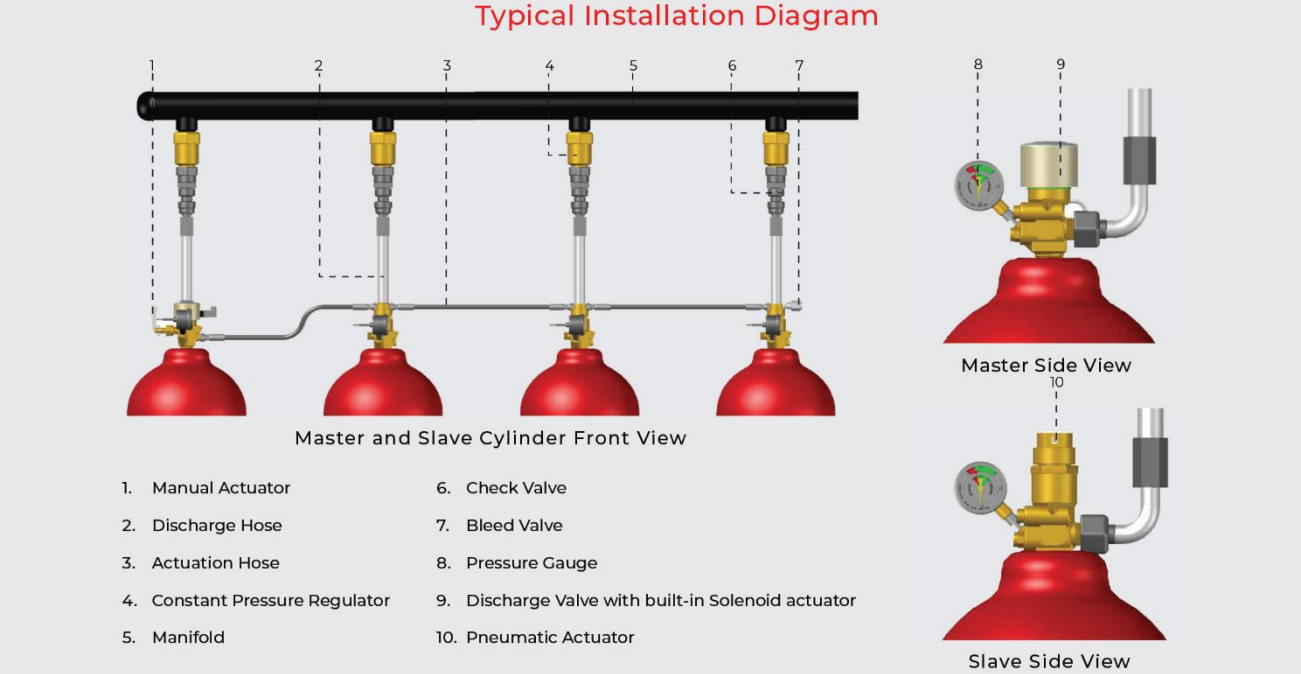


Figure 4.2.6 Cylinder Configuration

- One master cylinder and others slave cylinders are designated for multiple cylinders installed for intended to discharge simultaneously. In case there is a fire occurs, the master cylinder can be activated either electrically or manually. Whereas, the slave cylinders are activated pneumatically from the discharge action of master cylinder.
- Manual actuator (PN: LF-COMA) must be installed onto the master cylinder.
- For system with 2 or more master cylinder in between, pneumatic manual actuator (PN: LF-COMPA or LF-COMPA/1) must be installed on the second master cylinder and so on.

Table 4.2.1 Multiple Cylinders

Cylinder Size	Master Cylinder (Quantity)	Maximum Slave Cylinder (Quantity)	Maximum Cylinder in total (Quantity)
80L/140L	1	32	33

Table 4.2.2 Multiple Cylinders (Pilot Actuation)

Pilot Cylinder Size	Pilot Cylinder (Quantity)	Maximum Cylinder (Quantity)
4L/10L	1	64

4.3 INSTALLATION OF SELECTOR VALVE

Location of Installation

The selector valve installed between the end of the manifold and the discharge pipe system of the protected hazard.

Installation Instructions

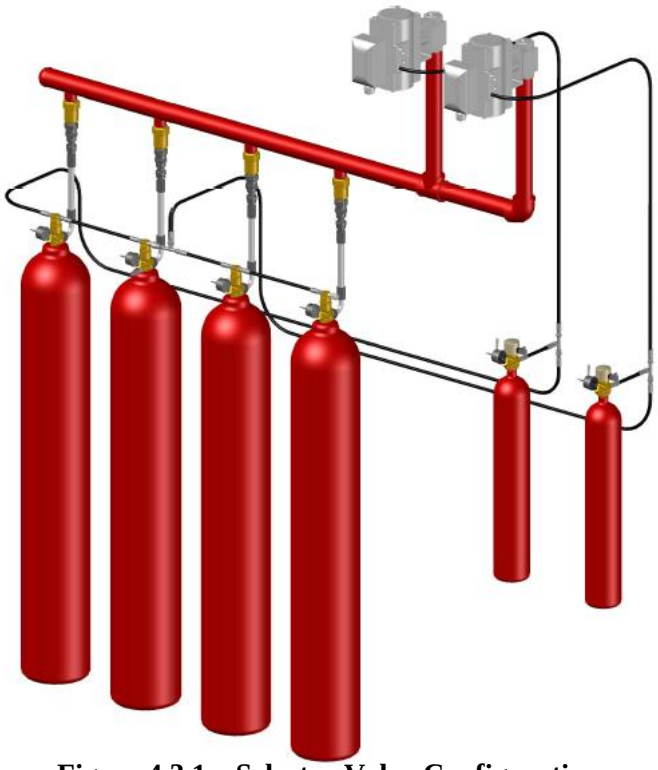


Figure 4.3.1 Selector Valve Configuration

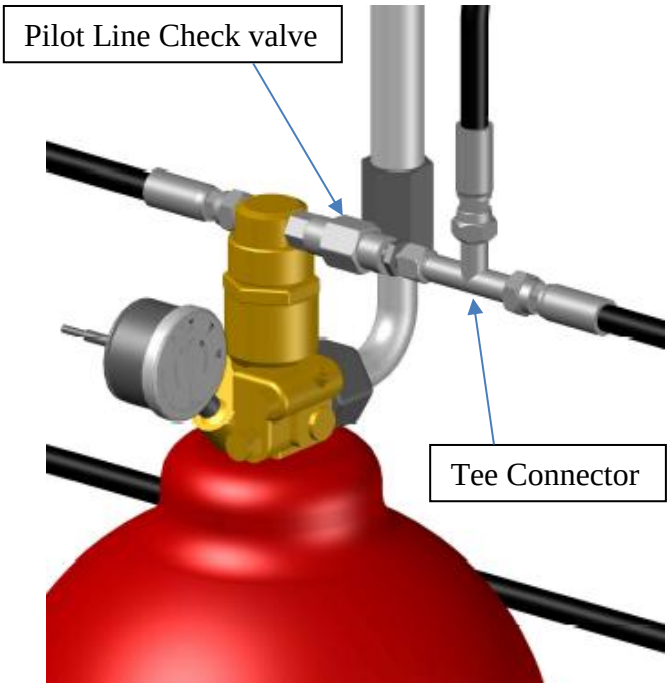
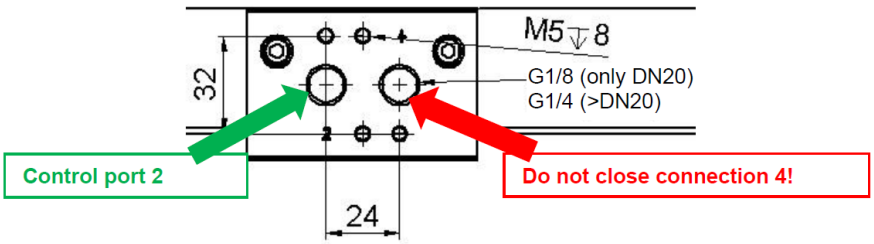


Figure 4.3.2 Pilot Line Check Valve Connection



a. Fit the selector valve to the selector valve manifold.
b. Attach the pneumatic tubing from pilot cylinder to the selector valve pressure connection “2”.
c. Do not close connection “4”. Connection “4” is for venting purpose.
d. The control pressure must be maintained within 6 – 10 bar.
e. Connecting thread and flange connection must be free of impurities, grease and adhesive residue.
f. Fit the pilot line check valve to the pneumatic actuator. Using pilot line check valve to control the number of cylinders discharged into designated hazard.
g. Various fittings (adaptors, tee and elbow) are available to fit pilot line check valve and pilot hoses.

h. After a discharge, the pilot line remains pressurized. To ensure the selector valve is in a depressurized state, the pilot hose connected from the pilot cylinder to the selector valve must be disconnected or vented.

i. The selector valve can be manually reset (closed) using a suitable tool (e.g., a wrench), but only when the system is in a depressurized state. The operation should be performed via the wrench flats on the drive shaft.

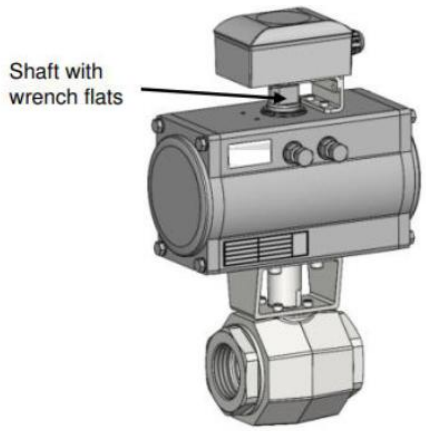


Figure 4.3.3 Selector valve resetting

4.4 DETECTION OF CONTROL EQUIPMENT

- The design of a system for automatic detection, signal distribution, alarms, etc. is not always of LIFECO's supply. Therefore, details pertaining to fire detection and alarm operation and maintenance are not included in this manual.

- Control Devices require the use of a UL Listed / FM Approved Fire Alarm Control Panel, that is compatible with the actuation devices and the manual pull stations used to operate LIFECO-541 Engineered Total Flooding Fire Suppression System units. Reference the control panel manual for compatibility information.

- Detection and notification appliances and devices shall be UL Listed / FM Approved and compatible with the control panel. Reference the detectors manual for compatibility information.

- For installations and locations that do not require a UL Listed/FM Approved/NFPA Standard type control panel, detection, and notification, the authority having jurisdiction shall be consulted to determine the appropriate type of control panel, detectors, and notification appliances to be used.

4.5 INSTALLATION OF DISCHARGE PRESSURE SWITCH

Discharge pressure switch can be install on the distribution pipe/ manifold.

- Discharge pressure switch can be installed on the distribution pipe or manifold after constant pressure regulator. It can be install with a ½" Pipe with Union or it can direct to the manifold with a ½" nipple.

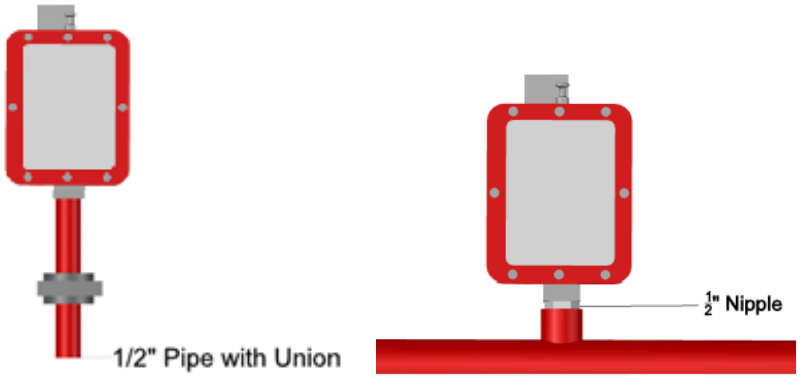


Figure 4.5.2: Distribution pipe / Manifold- Discharge Pressure Switch Installation

For electrical connection, remove the cover plate and refer to Figure 4.5.3.

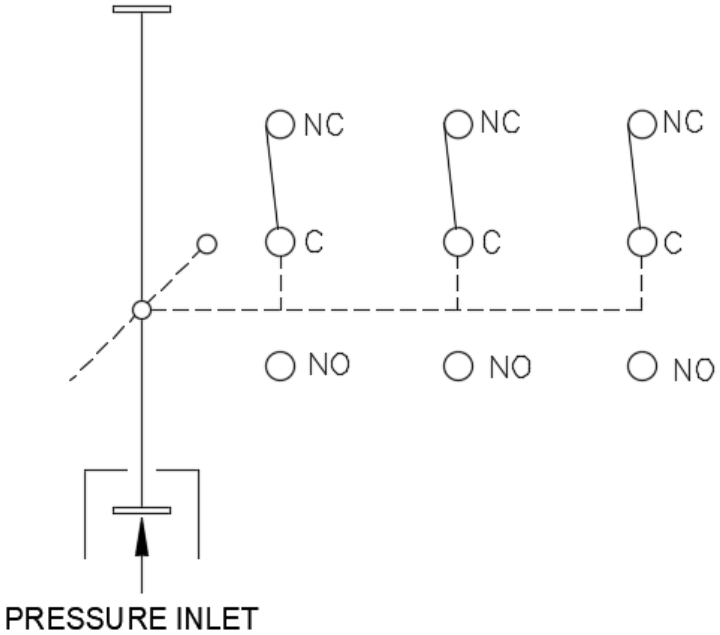


Figure 4.5.3: Discharge Pressure Switch Installation Wiring Diagram

IMPORTANT

Clause 8.1.2 Fire Protection Service Technician. Personnel that inspect, service, test, and maintain clean agent fire extinguishing systems shall have knowledge and experience of the maintenance and servicing requirements contained in this standard, of the equipment being serviced or maintained, and of the servicing or maintenance methods and requirements contained in the manufacturer's design, installation, and maintenance manual and any applicable bulletins.

Clause 8.8 Training All personnel who could be expected to inspect, service, test, or maintain fire extinguishing systems shall be trained and kept trained in the functions they are expected to perform.
(Source: NFPA 2001)

5.0 INSPECTION OF SYSTEM AFTER INSTALLATION

A regular program of systematic inspection is established for the continuous proper operation of all LIFECO-541 systems installed. The inspection work shall be conducted by trained and competent personnel. This **system periodically be inspected by trained personnel.** The purpose of periodic inspection is to assure that the system is in full operating condition at all times. Its activity shall identify problems due to wear and tear, and accidental and environmental damages, tampering, changes to hazard characteristic or intended uses or other related changes that could adversely affect the proper performance of the LIFECO-541 system. **This system is made up of units tested within limitations contained in the detailed installation manual. The system designer must be consulted whenever changes are planned for the system or area of protection. An authorized installer or system designer must be consulted after the system has discharged.**

- The openings or sources of agent loss such as cable and duct penetrations into the hazard area should be permanently sealed. Door entering the hazard area should be checked for tightness. Joints where walls contact floors should be sealed as these are potential leak points most often overlooked.

- Inspect hazard layout for any deviation of its initial designed volume. If there are any changes to its initial designed volume, the LIFECO-541 system especially the quantity of the agent must be recalculated and corrected.

- Access passage to the fire suppression system must not be obstructed. A trained and competent personnel must be able to have access to the system within reasonable time determine by fire authorities, insurance authorities and/or by the system user.

- Make sure that the nozzle(s) is(are) cleared of obstruction and free from signs of corrosion or rust. The nozzle(s) must not be painted or tampered by a trained installer or the system user. Use the proper type of nozzle(s) and check that they are correctly installed and properly orientated.

- Inspect all LIFECO-541 cylinders, valves, hoses and other equipment for damages such as cracks, dents, distortions, and worn out or missing parts.

- Cylinders must be checked for pressure drop to determine for any loss of agent due to leakages if any of the above-mention is identified. Check cylinder pressure information label against system's agent requirements.

- Check LIFECO-541 cylinder safety brackets and mounting hardware for damages, broken parts, signs of corrosion and that all cylinder(s) and pipe works are securely fixed and able to hold them in position during system discharge. Ensure no welded pipe works are used for the system installation.

- Check actuator(s) for physical damages, corrosion or dirt. Check electric actuator's connecting wiring for wear and tear or damages. Check wiring voltage is correct for actuation when system is triggered. Check connection faulty if not fully assembled.

- Have a final check that the system is armed and the detecting and actuating systems are operational.

- Perform door fan testing to evaluate enclosure leakage and determine the system ability to maintain the design concentration after system discharge. The software provided for this testing is able to predict the time it will take for a descending interface to fall to a given height. The door fan testing provides a worst-case leakage estimation that is very useful for enclosures with complex hidden leaks, but will generally require more necessary sealing to pass a discharge test. (Refer to NFPA 2001, Appendix C Safety Bulletins)

6.0 MAINTENANCE

WARNING

BEFORE PERFORMING MAINTENANCE PROCEDURES, PLEASE REFER TO THE MATERIAL SAFETY DATA SHEET AND SAFETY BULLETINS IN THE APPENDIX AT THE BACK OF THIS MANUAL.

The user's maintenance program is intended to avoid the consequences of failure of equipment by preserving and/or restoring equipment reliability. This is to assure that the system and equipment is in full operating condition at all times. If inspection indicates areas of rust and corrosion is present, immediately contact your local supplier for the next course of action.

6.1 MONTHLY PREVENTIVE MAINTENANCE PROCEDURES

6.1.1 Make a general inspection survey of all cylinders and equipment for damage, leakage or missing parts.

6.1.2 Inspect the hazard area against the original layout to ensure that there have been no changes that might affect the proper performance of the LIFECO-541 system. Changes might include partitioning, floor and/or ceiling voids, renovating and openings in an enclosure boundary that the inert gas agent can flow out of.

6.1.3 Ensure access to hazard areas, control panel, manual pull stations, nozzle(s), and cylinder(s) are unobstructed and that there are no obstructions to the operation of the equipment or distribution of inert gas agent.

6.1.4 Ensure warning signs, safety precautions and operating instructions are posted and clearly visible.

6.1.5 Inspect cylinder safety bracket and piping brackets for loose, damaged, or broken parts. Check cylinder brackets and associated parts for corrosion, oil, grease, grime, etc. Tighten loose hardware. Replace damaged parts.

6.2 SEMI-ANNUALLY PREVENTIVE MAINTENANCE PROCEDURES

6.2.1 Externally inspect cylinder(s) for signs of damage or unauthorized modifications. Check cylinder labels for damage and that the label descriptions are still visible. Check cylinder brackets and fittings.

6.2.2 Inert gas agent must be checked and weighted to ensure quantity tallies with charged weight as indicated on the cylinder label.

6.2.3 Inspection procedures:

CAUTION

DISCONNECT ALL ELECTRICAL ACTUATOR(S) TO PREVENT ACCIDENTAL SYSTEM DISCHARGE. **FOR SYSTEM SUPERVISION – DO NOT USE LOOPED WIRE UNDER TERMINALS, BREAK WIRE RUN TO PROVIDE SUPERVISION OF CONNECTIONS.**

- Remove electric actuator's electrical port from the cylinder valve.
- Remove all release device from the cylinder valve.
- Loosen and disconnect the discharge pipe from the cylinder valve's outlet port.
- Install the safety cap onto the cylinder valve's outlet port.
- Loosen and remove the cylinder safety brackets.
- Check the pressure gauge reading on each cylinder. The nominal pressure should be approximately 200 Bar or 300 Bar @ 15ºC (2900 psi or 4351 psi @ 59ºF). However, the pressure will vary depend on temperature. If pressure loss exceeds 10% of the nominal pressure, check the cylinder for leaks, repair and refill as necessary.
- Inspect discharge pipes for loose fittings, damaged threads, cracks, rust, kinks, and distortion.
- Tighten loose fittings and replace pipe(s) show corrosion or mechanical damage.

6.2.4 Inspect all the hoses installed for physical damages.

6.2.5 Inspect discharge nozzle(s) for dirt, dust, debris, and physical damage. Replace damaged or clogged nozzle(s) and clean out where necessary.

6.2.6 Check the condition of manual / pneumatic and electrical actuators and do replacement where appropriate. Check all valve assemblies for damages and leaks. If leaking occurs, the contents of the cylinder must be transferred to another cylinder before reconditioning the valve.

WARNING

NEVER ATTEMPT TO RECONDITION THE VALVE UNTIL THE CONTENTS OF THE CYLINDER HAVE BEEN TRANSFERRED AND THE PRESSURE GAUGE READS 0 BAR.

6.3 EVERY TWO YEARS PREVENTIVE MAINTENANCE PROCEDURES

WARNING

DO NOT USE OXYGEN OR WATER TO BLOW OUT PIPE LINES. THE USE OF OXYGEN IS ESPECIALLY DANGEROUS AS THE POSSIBLE PRESENCE OF OIL MAY CAUSE AN EXPLOSION.

CAUTION

DISCONNECT ELECTRICAL POINT FROM SOLENOID DISHARGE VALVE TO PREVENT ACCIDENTAL SYSTEM DISCHARGE**. FOR SYSTEM SUPERVISION – DO NOT USE LOOPED WIRE UNDER TERMINALS, BREAK WIRE RUN TO PROVIDE SUPERVISION OF CONNECTIONS.**

6.3.1 Remove electrical actuator from the cylinder valve's actuation port.

6.3.2 Remove all cylinder(s) from the safety bracket including disconnecting its valve from the discharge pipes. Install safety cap onto the cylinder valve's outlet port.

6.3.3 Remove any nozzle(s) from the pipe network to allow any foreign matter to blow clear.

6.3.4 Blow out all distribution piping with dry nitrogen to ensure the pipe work is not blocked or clogged, verifying that dry nitrogen is discharging at the end of the pipe where the nozzle(s) is(are) supposed to be installed.

6.3.5 Reinstall the system according to the installation manual.

7.0 SYSTEM DISCHARGE - RECHARGING CYLINDER AFTER OPERATION

WARNING

DO NOT ENTER A HAZARD AREA WITH AN OPEN FLAME OR LIGHTED CIGARETTE. THE POSSIBLE PRESENCE OF FLAMMABLE VAPORS MAY CAUSE A SPARK, RE-IGNITION OR EXPLOSION.

WARNING

ENSURE FIRE IS COMPLETELY EXTINGUISHED BEFORE VENTILATING THE ENCLOSURE. PERSONNEL MUST USE A BREATHING APPARATUS OR VENTILATE THE ENCLOSURE THOROUGHLY BEFORE ENTERING THE HAZARD AREA.

After system discharge, ventilation of the enclosure must be allowed to ventilate the agent, smoke and harmful by-products from the room produced by post fire to the atmosphere. The hazard area must require an extract ventilation system. Apart from natural ventilation system, mechanical ventilation system is more effective on ventilation and exhaust. Control for ventilation system must be position outside of the enclosure and shall be key operated. In certain situation, ventilation can be provided by having an opened doors and windows.

After system discharge, a qualified fire suppression system maintenance personnel must perform post fire maintenance by checking the hazard area for sources of ignition. Observe all warnings and notices as a safety precaution before entering the hazard area. Inspect system components and nozzle(s) for its functionality and condition.

For cylinder refilling, contact local distributor to arrange for refilling at an authorized UL fill station. The following procedures to enable the refilling of a cylinder that has been discharged.

- Check that the cylinder is empty.
- Remove the electrical point of solenoid discharge valve.
- Recharging Cylinder(s)

WARNING

ONLY QUALIFIED (TRAINED) PERSONNEL SHOULD OPERATE CHARGING EQUIPMENT. EXERCISE EXTREME CARE WHEN WORKING WITH PRESSURE EQUIPMENT TO PREVENT INJURY TO PERSONNEL AND DAMAGE TO PROPERTY, RESULTING FROM CARELESS HANDLING OR POSSIBLE EQUIPMENT FAILURE. PERFORM ALL OPERATIONS IN AN ASSIGNED AREA CLEARED OF ALL UNAUTHORIZED PERSONNEL. MAKE SURE ALL EQUIPMENT IS PROPERLY SECURED AND ALL PERSONNEL SHOULD WEAR PERSONAL PROTECTIVE EQUIPMENT IN THE FILL STATIONS.

7.1 FILLING INERT GAS AGENT

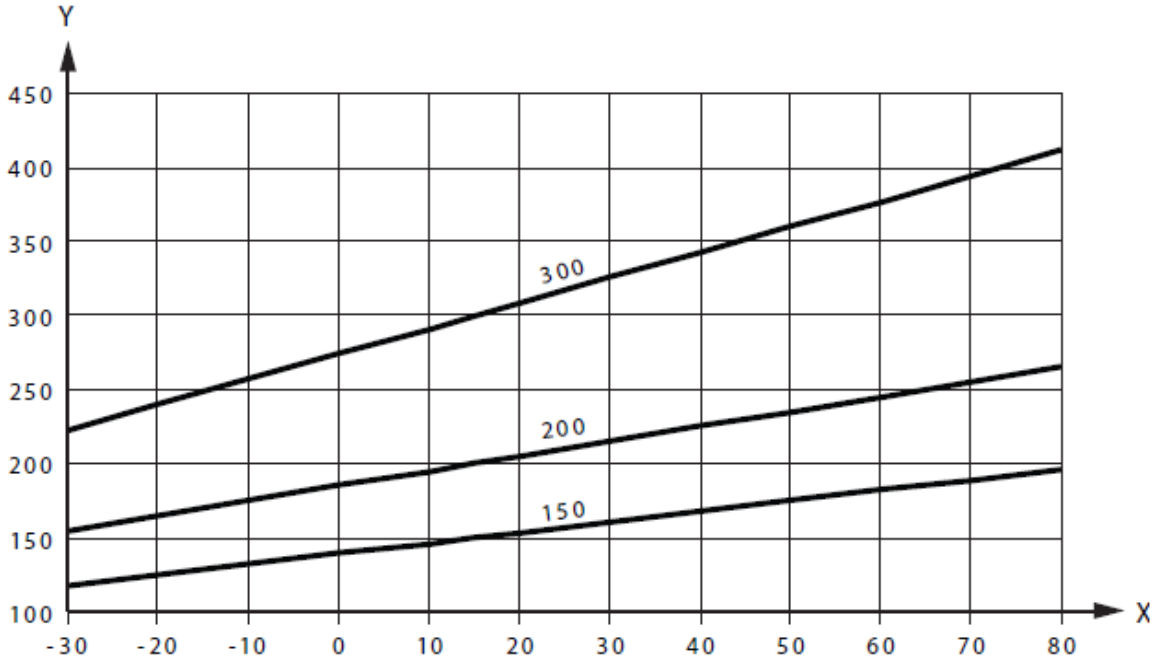
- Cylinders shall be new and have been hydraulic pressure tested.
- The cylinders are factory painted in Red color and fitted with discharge valve prior to filling.
- Filled cylinders to be provided with a cylinder label to indicate the cylinder part number, filled weight and etc.

Note: The cylinder is filled through the valve discharge outlet. Once the filling is completed, Refit the valve outlet with safety cap for safety purpose.

7.2 FILLING INFORMATION

The filling station for LIFECO-541 systems is used to transfer the compressed gas Nitrogen, Argon and Carbon Dioxide into system cylinders. Filling process can only be carried out by trained and authorized person. The filling procedure are as below:

- Issue work order to production person in-charged.
- Relocate the required cylinder to the fill station.
- Visual Inspection shall be done to ensure cylinder is in good condition.
- Attach appropriate filling adaptor to cylinder discharge outlet.
- Key in all the required detailed of the cylinder serial no, filled weight, cylinder size, purchase order, work order, bulk tank serial number, empty cylinder weight into computer.
- Verify agent temperature by measuring cylinder temperature.
- Press start button to start the filling process.
- Disconnect the filling adaptor and refit with valve outlet safety cap.
- Secure cylinder(s) on transport cage or pallets.
- Ship to customer or site as per order.



Key

X temperature, °C

Y pressure, bar

Figure 7.2.1: IG-541 Pressurized to 200 Bar, 300 Bar at 15˚C

8.0 WARRANTY

LIFECO warrants all of the system hardware which is supplies to the customers shall be free from defects in materials and workmanship for a period of one (1) year from the date of installation.

The limited warranty is based upon the customer satisfying the following conditions:

- The system hardware must be supplied, designed, installed and commissioned by LIFECO and its authorized distributor, in accordance with the instructions contained in this manual or other data sheet / information supplied with LIFECO hardware.
- The LIFECO hardware have not been altered or modified.
- Within thirty (30) days after the customer's finding of what the customer believes is a manufacturing defect, the customer must notify LIFECO in writing and ship the hardware to LIFECO or its authorized distributor.
- LIFECO at its option and within 45 days of receipt, will repair, replace or refund the purchase price of that hardware or system found to be defective. Failure of customer to give such written notice and ship the hardware within thirty (30) days shall be deemed absolute and unconditional waiver of any and all claims of the customer arising out of such defect.

The warranty shall not apply in the following circumstances such as:

- The system cylinders filled or refilled by other parties than LIFECO or its authorized distributor approved by LIFECO.
- Any system hardware is found to be non-genuine or supplied other than LIFECO and its distributor.
- System hardware have been modified, serviced, or maintained by other parties than LIFECO and its qualified / certified distributor's technicians.

Limitation of Damages such as:

- LIFECO shall not be liable for incidental consequential, lost profit or other losses arising out of or alleged caused by the use of any LIFECO system hardware.
- LIFECO shall not be liable for, all personal injury and property damage in connected with handling, transportation, possession, or other use or resale of system hardware, whether used alone or in combination with any other products or materials.

9.0 DISCLAIMERS

The contents herein are reasonably believed to be correct at the time of issue but that may not have been independently verified and are subject to change. The information in this manual LFIGMAL-0541 is subject to change without notice. Neither does this manual purport to contain all the information that a qualified clean agent installer or the system user may require. All issues are uncontrolled copies.

10.0 APPENDICES

Appendix A – LIFECO-541 Hydraulic Flow Calculation Program

LIFECO Flow Calculation Software v4.10

File Name: Sample Calculation .FC4

Consolidated Report

Enclosure Report

Elevation: 0 m (relative to sea level)
Atmospheric Correction Factor: 1 (NFPA 2001)

Enclosure 1 Sample Calculation

Enclosure Temperature:		Number of Nozzles:	4
Minimum:	20.0 C	Width:	1.00 m
Maximum:	35.0 C	Length:	94.56 m
Max. Concentration:	41.69% (At 35.0 C)	Height:	3.40 m
Design Concentration:		Volume:	321.50 m³
Adjusted:	40.15 %	Non-permeable:	0.00 m³
Minimum:	38.21 %	Total Volume:	321.50 m³
Min. Agent Required:	154.78 m³		
Adjusted Agent Required:	165.04 m³		

Calculation Date/Time: Tuesday, June 13, 2023, 2:12:59 PM
Copyright (c) Jensen Hughes, Inc.
Key ID: 2049470579

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LIFECO

Agent Source Report

Consolidated Report

Agent:	IG-541
Cylinder Name:	140 L Cylinder - 300 bar
Cylinder Part Number:	LF-IG541140300
Agent Per Cylinder:	41.26 m^3
Number of Main Cylinders:	4
Number of Reserve Cylinders:	0
Cylinder Empty Weight:	144.00 kg
Weight, All Cylinders + Agent:	809.44 kg
Floor Area Per Cylinder:	0.08 m^2
Floor Loading Per Cylinder:	2363 kg /m^2

Calculation Date/Time: Tuesday, June 13, 2023, 2:12:59 PM

Key ID: 2049470579

LIFECO

Consolidated Report
Parts Report

Total Agent Required: 165.04 m ³

Cylinder Name: 140 L Cylinder - 300 bar (Part: LF-IG541140300)

Number of Cylinders: 4

Nozzle	Type	Nozzle Diameter	Nozzle Area	Part Number
E1-N1	360	25 mm	95.03 mm ²	LF-360IG-25
E1-N2	360	25 mm	95.03 mm ²	LF-360IG-25
E1-N3	360	25 mm	95.03 mm ²	LF-360IG-25
E1-N4	360	25 mm	95.03 mm ²	LF-360IG-25

Nozzle	Drill Diameter	Drill Size
E1-N1	11.0 mm	11.0 mm
E1-N2	11.0 mm	11.0 mm
E1-N3	11.0 mm	11.0 mm
E1-N4	11.0 mm	11.0 mm

Pipe & Fittings	Type	Diameter	Length	Elbows (90)	Elbows (45)	Tees	Unions
	40T	25 mm	8.70 m	9	0	0	0
	40T	32 mm	6.30 m	0	0	3	0
	40T	40 mm	0.30 m	0	0	1	0
	40T	50 mm	25.30 m	3	0	2	0

Other Objects	Name	Quantity	Part Number
	12mm Check Valve	4	LF-CV

System Acceptance Report

System Discharge Time: 83.9 seconds

Calculation Date/Time: Tuesday, June 13, 2023, 2:12:59 PM

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LIFECO

Consolidated Report

Percent Agent In Pipe: 11.9%
Percent Agent Before First Tee: 10.0%

Enclosure Number: 1
Enclosure Name: Sample Calculation
Minimum Design Concentration: 38.21%
Adjusted Design Concentration: 40.15%
Maximum Design Concentration: 41.80%
Minimum Predicted Concentration: 40.15% (At 20.0 C)
Maximum Predicted Concentration: 41.69% (At 35.0 C)

Maximum Allowed Enclosure Pressure: 500.00 Pa
Estimated Free Vent Area Required: 0.14 m^2
Installed Vent Area: 0.00 m^2
Predicted Enclosure Pressure: N/A
Maximum Enclosure Flow Rate: 139.3 m^3/min

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	38.70 m^3	41.26 m^3	41.26 m^3	24.855 bar
E1-N2	38.70 m^3	41.26 m^3	41.26 m^3	24.855 bar
E1-N3	38.70 m^3	41.26 m^3	41.26 m^3	24.855 bar
E1-N4	38.70 m^3	41.26 m^3	41.26 m^3	24.855 bar

Calculation Date/Time: Tuesday, June 13, 2023, 2:12:59 PM

Key ID: 2049470579

LIFECO

Consolidated Report

Pipe Network Report

Description	Pipe Section	Start Node	End Node	Pipe Type	Pipe Diameter	Pipe Length	Union	Total Elevation Change	Total Equivalent Length	Nozzle Name	Nozzle Size	Nozzle Type	Nozzle Area
Cylinder - On	Man.	0	17		15 mm	0.03 m	0	0.03 m	3.66 m				
Pipe	Man.	17	18	40T	25 mm	0.10 m	0	------	0.10 m				
Elbow (90)	Man.	18	19	40T	25 mm	------	0	------	0.85 m				
Check Valve ->	Man.	19	20			0.07 m	0	0.07 m	0.59 m				
Elbow (90)	Man.	20	21	40T	25 mm	------	0	------	0.85 m				
Pipe	Man.	21	22	40T	25 mm	0.30 m	0	------	0.30 m				
Tee	Man.	22	23	40T	32 mm	------	0	------	0.70 m				
Pipe	Man.	23	24	40T	32 mm	0.30 m	0	------	0.30 m				
Tee	Man.	24	25	40T	40 mm	------	0	------	0.82 m				
Pipe	Man.	25	26	40T	40 mm	0.30 m	0	------	0.30 m				
Tee	Man.	26	27	40T	50 mm	------	0	------	1.06 m				
Pipe	Man./End	27	28	40T	50 mm	0.30 m	0	------	0.30 m				
Elbow (90)	System	28	29	40T	50 mm	------	0	------	1.68 m				
Pipe	System	29	30	40T	50 mm	1.30 m	0	1.30 m	1.30 m				
Elbow (90)	System	30	31	40T	50 mm	------	0	------	1.68 m				
Pipe	System	31	32	40T	50 mm	19.50 m	0	------	19.50 m				
Elbow (90)	System	32	33	40T	50 mm	------	0	------	1.68 m				
Pipe	System	33	34	40T	50 mm	4.20 m	0	------	4.20 m				
Tee	System	34	35	40T	32 mm	------	0	------	2.29 m				
Pipe	System	35	36	40T	32 mm	3.00 m	0	------	3.00 m				
Tee	System	36	37	40T	25 mm	------	0	------	1.74 m				
Pipe	System	37	38	40T	25 mm	1.80 m	0	------	1.80 m				
Elbow (90)	System	38	39	40T	25 mm	------	0	------	0.85 m				
Pipe&Nozzle	System	39	40	40T	25 mm	0.20 m	0	-0.20 m	0.20 m	E1-N1	25 mm	360	95.03 mm ²
Tee	System	36	41	40T	25 mm	------	0	------	1.74 m				
Pipe	System	41	42	40T	25 mm	1.80 m	0	------	1.80 m				
Elbow (90)	System	42	43	40T	25 mm	------	0	------	0.85 m				
Pipe&Nozzle	System	43	44	40T	25 mm	0.20 m	0	-0.20 m	0.20 m	E1-N2	25 mm	360	95.03 mm ²
Tee	System	34	45	40T	32 mm	------	0	------	2.29 m				
Pipe	System	45	46	40T	32 mm	3.00 m	0	------	3.00 m				
Tee	System	46	47	40T	25 mm	------	0	------	1.74 m				
Pipe	System	47	48	40T	25 mm	1.80 m	0	------	1.80 m				

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LIFECO

Consolidated Report

Description	Pipe Section	Start Node	End Node	Pipe Type	Pipe Diameter	Pipe Length	Union	Total Elevation Change	Total Equivalent Length	Nozzle Name	Nozzle Size	Nozzle Type	Nozzle Area
Elbow (90)	System	48	49	40T	25 mm	------	0	------	0.85 m				
Pipe&Nozzle	System	49	50	40T	25 mm	0.20 m	0	-0.20 m	0.20 m	E1-N3	25 mm	360	95.03 mm ²
Tee	System	46	51	40T	25 mm	------	0	------	1.74 m				
Pipe	System	51	52	40T	25 mm	1.80 m	0	------	1.80 m				
Elbow (90)	System	52	53	40T	25 mm	------	0	------	0.85 m				
Pipe&Nozzle	System	53	54	40T	25 mm	0.20 m	0	-0.20 m	0.20 m	E1-N4	25 mm	360	95.03 mm ²
Tee	Man.	5	27	40T	50 mm	------	0	------	3.41 m				
Check Valve ->	Man.	4	5			0.07 m	0	0.07 m	0.59 m				
Elbow (90)	Man.	3	4	40T	25 mm	------	0	------	0.85 m				
Pipe	Man.	2	3	40T	25 mm	0.10 m	0	------	0.10 m				
Cylinder - On	Man.	0	2		15 mm	0.03 m	0	0.03 m	3.66 m				
Tee	Man.	10	25	40T	40 mm	------	0	------	2.65 m				
Check Valve ->	Man.	9	10			0.07 m	0	0.07 m	0.59 m				
Elbow (90)	Man.	8	9	40T	25 mm	------	0	------	0.85 m				
Pipe	Man.	7	8	40T	25 mm	0.10 m	0	------	0.10 m				
Cylinder - On	Man.	0	7		15 mm	0.03 m	0	0.03 m	3.66 m				
Tee	Man.	15	23	40T	32 mm	------	0	------	2.29 m				
Check Valve ->	Man.	14	15			0.07 m	0	0.07 m	0.59 m				
Elbow (90)	Man.	13	14	40T	25 mm	------	0	------	0.85 m				
Pipe	Man.	12	13	40T	25 mm	0.10 m	0	------	0.10 m				
Cylinder - On	Man.	0	12		15 mm	0.03 m	0	0.03 m	3.66 m				

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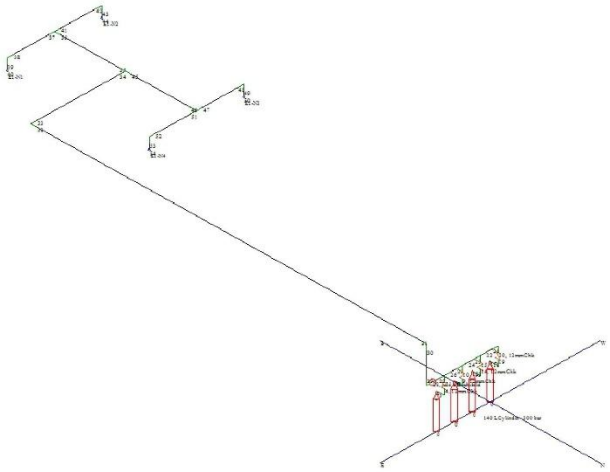
LIFECO

Consolidated Report



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Appendix B – SAFETY DATA SHEET

Safety Data Sheet

Section 1 – Chemical Product and Company Identification	
Product Name	IG-541 Gas Suppression System
Agent	Nitrogen, Argon, Carbon Dioxide, Compressed Gas
Chemical Name	Nitrogen, Argon, Carbon Dioxide
Product Use	Fire extinguishing agent
Supplier	Lichfield Fire & Safety Equipment CO LTD
Supplier Address	Edmund House 12-22 Newhall Street, Birmingham, B3 3AS United Kingdom
Email	sales@lifeco-uk.com
Telephone	+44 (0) 1902 798 706
Fax	+44 (0) 1902 798 679

Section 2 –Hazard Identification	
OSHA/HCS status	This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200)
Classification of the substance or mixture	H280 – Compressed Gas
Hazard pictograms	
Signal word	Warning
Hazard statements	H280: Contains gas under pressure; may explode if heated. May displace oxygen and cause rapid suffocation Simple Asphyxiant.
Prevention	Use only outdoors or in a well-ventilated area. Avoid breathing dust/fume/gas/mist/vapors/spray.
Response	IF INHALED: Remove person to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor if you feel unwell.
Disposal	Dispose of contents/container in accordance with local/regional/ national/international regulations.
Precautionary statements	Store in a well ventilated place. Protect from sunlight. The rapid release of compressed gas may cause frost bite

MSDS No: LF-MSDS-IG541 Revision date: 14.06.2023 Version 0.0
- 1 -

Safety Data Sheet

Section 3 – Composition/Information on Ingredients

Ingredient name	CAS No.	%(weight)
Nitrogen	7727-37-9	0-100
Carbon Dioxide	124-38-9	<20
Argon	7440-37-1	0-100

Section 4 – First Aid Measures

Inhalation
Remove to fresh air. If breathing has stopped or is labored, give assisted respirations. Supplemental oxygen may be indicated. If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately. In case of shortness of breath, give oxygen.

Skin
If frostbite or freezing occur, immediately flush with plenty of lukewarm water (105-115°F; 41-46°C). DO NOT USE HOT WATER. If warm water is not available, gently wrap affected parts in blankets. Get immediate medical attention.

Eyes
Flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical attention.

Most important symptoms and effects, both acute and delayed

Acute: Suffocation, frostbite

Section 5 – Fire Fighting Measures

Extinguishing media
All known extinguishing media can be used. .

Special hazards
Upon exposure to intense heat or flame, cylinder will vent rapidly and or rupture violently. Product is non-flammable and does not support combustion. Move away from container and cool with water from a protected position.
Keep containers and surroundings cool with water spray.

Special protective equipment for firefighters
Wear self-contained breathing apparatus for fire fighting if necessary.

Section 6 – Accidental Release Measures

Personal precautions, protective equipment and emergency procedures
Evacuate personnel to safe areas. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Monitor oxygen level. Ventilate the area.

Environmental precautions
Do not discharge into any place where its accumulation could be dangerous. Prevent further leakage or spillage if safe to do so.

Safety Data Sheet

Methods and material for containment and cleaning up	Stop leak if possible without personal risk. Keep unnecessary people away, isolate hazard area and deny entry. Stay upwind and keep out of low areas. Ventilate closed spaces before entering. Damaged cylinders should be handled only

Section 7 – Handling and Storage

Handling	Avoid breathing dust/fume/gas/mist/vapors/spray. Use only with adequate ventilation
Storage	Protect from sunlight. Store in a well-ventilated place. Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.101. Keep separated from incompatible substances.
Incompatible Materials	Combustible materials, oxidizing materials, metal salts, reducing agents, metal carbide, metals, bases, halocarbons, amines

Section 8 –Exposure Controls/Personal Production

Appropriate engineering controls	Provide natural or mechanical ventilation to prevent oxygen deficient engineering atmospheres below 19.5% oxygen. controls

Personal protective equipment

Respiratory Protection	Self-contained breathing apparatus (SCBA) or positive pressure airline with mask are to be used in oxygen-deficient atmosphere. Air purifying respirators will not provide protection. Users of breathing apparatus must be trained.
Skin Protection	Wear working gloves when handling gas containers. Chemical resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. For the gas: Protective clothing is not required. For the liquid: Wear appropriate protective, cold insulating clothing.
Eye Protection	For the gas: Eye protection not required, but recommended. For the liquid: Wear splash resistant safety glasses. Contact lenses should not be worn. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.
Other	Ensure adequate ventilation, especially in confined areas.

Safety Data Sheet

Carbon Dioxide	**124-38-9**
ACGIH	5000 ppm TWA 30000 ppm STEL
NIOSH	5000 ppm TWA ; 9000 mg/m3 TWA 30000 ppm STEL ; 54000 mg/m3 STEL 40000 ppm IDLH
Europe	5000 ppm TWA ; 9000 mg/m3 TWA
OSHA (US)	5000 ppm TWA ; 9000 mg/m3 TWA
Mexico	5000 ppm TWA [VLE-PPT] 5000 ppm TWA [VLE-PPT]
Nitrogen	**7727-37-9**
ACGIH	(See Appendix F: Minimal Oxygen Content)
Argon	**7440-37-1**
ACGIH	(See Appendix F: Minimal Oxygen Content)

ACGIH - Threshold Limit Values - Biological Exposure Indices (BEI) There are no biological limit values for any of this product's components.

Section 9 – Physical and Chemical Properties

Physical state	:	Gas
Colour	:	Colourless.
Odour	:	Odourless
Melting point	:	N/A
Boiling point	:	N/A
Flammability (solid, gas)	:	Non-flammable
Vapor pressure	:	N/A
Viscosity	:	N/Acp
Solubility in Water	:	N/A
Relative vapour density	:	N/A
Molecular weight	:	34 g/mole
Density	:	N/A
Specific Volume	:	N/A
Volatility	:	N/A
Solvent solubility	:	Soluble – liquid ammonia Slightly soluble – alcohol

Section 10 – Stability and Reactivity

Chemical stability	Stable under normal conditions.
Possibility of hazardous reactions	Will not polymerize
Conditions to avoid	Protect from physical damage and heat. Containers may rupture or explode if exposed to heat
Hazardous decomposition products	oxides of nitrogen

Safety Data Sheet

Section 11 – Toxicological Information

Inhalation Effects	:	Sensitivity to light, changes in blood pressure, nausea, irregular heartbeat, headache, dizziness, Disorientation, sleep disturbances, emotional disturbances, tingling sensation, tremors, muscle cramps, visual disturbances, suffocation, convulsions, Unconsciousness, coma, vomiting, difficulty breathing, loss of coordination, changes in body temperature, hallucinations, pain in extremities, lung congestion
Skin contact	:	blisters, frostbite
Eye Contact	:	frostbite, blurred vision
Ingestion Effects : Product Toxicity Data		Ingestion is not considered a potential route of exposure.
Immediate effects	:	Suffocation, frostbite
Specific Target Organ Toxicity - Single Exposure	:	Simple Asphyxiant

Section 12 – Ecological Information

No known ecological damage caused by this product.

Section 13 –Disposal Considerations

Waste from residues / : Contact supplier if guidance is required. Return unused product in unused products original cylinder to supplier.

Contaminated packaging: Return cylinder to supplier.

Section 14—Transport Information

UN Number : UN1956

UN Proper Shipping Name : COMPRESSED GAS, N.O.S. , (Contains: Nitrogen, Argon)

Hazard label (DOT) : 2.2 (Non-flammable gas)

Section 15—Regulatory Information

- Occupational Safety and Health Act 1994 and Regulations.
- Use and Standards of Exposure of Chemical Hazardous to Health Regulation 2000.
- Occupational Safety and Health (Classification, Labeling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013.

Safety Data Sheet

Country	Regulatory list	Notification
USA	TSCA	Included on Inventory.
EU	EINECS	Included on Inventory.
Canada	DSL	Included on Inventory.
Australia	AICS	Included on Inventory.
South Korea	ECL	Included on Inventory.
China	SEPA	Included on Inventory.
Philippines	PICCS	Included on Inventory.
Japan	ENCS	Included on Inventory.

Section 16 – Other Information

NFPA Ratings Health: 3 Fire: 0 Instability: 0 Other: SA
Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

Training information : Users of breathing apparatus must be trained. The hazard of asphyxiation is often overlooked and must be stressed during operator training. Ensure operators understand the hazards.

Other information : Before using this product in any new process or experiment, a thorough material compatibility and safety study should be carried out. Ensure adequate air ventilation. Ensure all national/local regulations are observed. Whilst proper care has been taken in the preparation of this document, no liability for injury or damage resulting from its use can be accepted.

Disclaimer

In accordance with good practices of personal cleanliness and hygiene handle with the care and avoid unnecessary contact with this product. This information is being supplied to you under OSHA Hazard Communication Standard 29 CFR 1910.1200 and is offered in good faith as typical values and not as a product specification. The information contained herein is based on the data available to us and is believed to be true and accurate. No warranty expressed or implied regarding the accuracy of this data. The hazards connected with the use of the material or the results to be obtained from the use thereof are made. LIFECO assumes no responsibility for damage or injury from the use of the product described herein

Appendix C – Safety Bulletins

LIFECO-541 Engineered fire suppression system uses pressurized cylinders, therefore, personnel responsible for fire suppression systems must be aware of the dangers associated with the improper handling, installation and maintenance of the system equipment.

Fire suppression system service personnel must be thoroughly trained in the proper handling, installation and maintenance of LIFECO-541 equipment and follow the instructions of this manual. Warnings, cautions and important notes written in this manual are to be adhered to at all times. Failure to do so may result in serious injury to personnel.

Important safety memos before handling a cylinder.

- PRESSURIZED CYLINDERS ARE EXTREMELY HAZARDOUS AND IF NOT HANDLED PROPERLY ARE CAPABLE OF VIOLENT DISCHARGE. THIS MAY RESULT IN SERIOUS BODILY INJURY, DEATH AND PROPERTY DAMAGE.
- Before handling LIFECO-541 cylinder(s), all personnel must be thoroughly trained in the safe handling of the cylinder(s) as well as in the proper procedures for installation, removal, filling and connection of other components, such as an electrical actuator(s) to ensure **fault light doesn't show up** and connecting the discharge pipe to the valve outlet.
- READ, UNDERSTAND and ALWAYS FOLLOW this operation and maintenance manual.

Safe cylinder handling procedures

- Cylinder(s) must be shipped compactly in the upright/horizontal position and must be properly secured in place. Cylinder(s) must neither be rolled, dragged/slid, nor allowed to be slid from tailgates of moving vehicles. A suitable hand truck, forklift truck, roll platform or a similar transport equipment or vehicle must be used.
- Cylinder(s) must not be dropped or permitted to strike violently against each other or other surfaces.
- Cylinder(s) must be stored in a standing upright position where they are not likely to be knocked over and they must be secured. Cylinder(s) should not be positioned in direct sunlight, area exceeding 55^{o}C (131^{o}F) or below -20^{o}C (-4 ^{o}F).

Appendix D – LIFECO-541 System Components and their Part Numbers

Components Description	Part Number
LIFECO-UK IG541 80L 200bar Assembly c/w Solenoid valve	LF-IG54180200S
LIFECO-UK IG541 80L 300bar Assembly c/w Solenoid valve	LF-IG54180300S
LIFECO-UK IG541 140L 200bar Assembly c/w Solenoid valve	LF-IG541140200S
LIFECO-UK IG541 140L 300bar Assembly c/w Solenoid valve	LF-IG541140300S
LIFECO-UK IG541 80L 200bar Assembly c/w Discharge valve	LF-IG54180200
LIFECO-UK IG541 80L 300bar Assembly c/w Discharge valve	LF-IG54180300
LIFECO-UK IG541 140L 200bar Assembly c/w Discharge valve	LF-IG541140200
LIFECO-UK IG541 140L 300bar Assembly c/w Discharge valve	LF-IG541140300
IG 4L Pilot cylinder 200bar Assembly	LF-IGPC4
IG 10L Pilot Cylinder 200bar Assembly	LF-IGPC10
IG Discharge Valve (W21.8-14TPI) 200bar	LF-IGDV200
IG Discharge Valve (W21.8-14TPI) 300bar	LF-IGDV300
IG Solenoid discharge valve (W21.8-14TPI) 200bar	LF-IGEASV200
IG Solenoid discharge valve (W21.8-14TPI) 300bar	LF-IGEASV300
IG Manual actuator for Solenoid valve	LF-COMA
IG Pneumatic Manual actuator	LF-COMPA
IG Pneumatic Manual actuator for Solenoid valve	LF-COMPA/1
IG Pneumatic actuator 20bar	LF-COPA
IG Discharge Hose W21.8-14TPI x 20mm BSP 250mm Straight	LF-DH250S
IG Discharge Hose W21.8-14TPI x 20mm BSP 300mm Straight	LF-DH300S
IG Discharge Hose W21.8-14TPI x 20mm BSP 350mm Straight	LF-DH350S
IG Discharge Hose W21.8-14TPI x 20mm BSP 400mm Straight	LF-DH400S
IG Discharge Hose W21.8-14TPI x 20mm BSP 450mm Straight	LF-DH450S
IG Discharge Hose W21.8-14TPI x 20mm BSP 500mm Straight	LF-DH500S
IG Discharge Hose W21.8-14TPI x 20mm BSP 550mm Straight	LF-DH550S
IG Discharge Hose W21.8-14TPI x 20mm BSP 600mm Straight	LF-DH600S
IG Discharge Hose W21.8-14TPI x 20mm BSP 650mm Straight	LF-DH650S
IG Discharge Hose W21.8-14TPI x 20mm BSP 700mm Straight	LF-DH700S
IG Discharge Hose W21.8-14TPI x 20mm BSP 750mm Straight	LF-DH750S
IG Discharge Hose W21.8-14TPI x 20mm BSP 800mm Straight	LF-DH800S
IG Discharge Hose W21.8-14TPI x 20mm BSP 850mm Straight	LF-DH850S

IG Discharge Hose W21.8-14TPI x 20mm BSP 900mm Straight	LF-DH900S
IG Discharge Hose W21.8-14TPI x 20mm BSP 950mm Straight	LF-DH950S
IG Discharge Hose W21.8-14TPI x 20mm BSP 1000mm Straight	LF-DH1000S
IG Discharge Hose W21.8-14TPI x 20mm BSP 1100mm Straight	LF-DH1100S
IG Discharge Hose W21.8-14TPI x 20mm BSP 1200mm Straight	LF-DH1200S
IG Discharge Hose W21.8-14TPI x 20mm BSP 250mm 90˚Elbow	LF-DH250E
IG Discharge Hose W21.8-14TPI x 20mm BSP 300mm 90˚Elbow	LF-DH300E
IG Discharge Hose W21.8-14TPI x 20mm BSP 350mm 90˚Elbow	LF-DH350E
IG Discharge Hose W21.8-14TPI x 20mm BSP 400mm 90˚Elbow	LF-DH400E
IG Discharge Hose W21.8-14TPI x 20mm BSP 450mm 90˚Elbow	LF-DH450E
IG Discharge Hose W21.8-14TPI x 20mm BSP 500mm 90˚Elbow	LF-DH500E
IG Discharge Hose W21.8-14TPI x 20mm BSP 550mm 90˚Elbow	LF-DH550E
IG Discharge Hose W21.8-14TPI x 20mm BSP 600mm 90˚Elbow	LF-DH600E
IG Discharge Hose W21.8-14TPI x 20mm BSP 650mm 90˚Elbow	LF-DH650E
IG Discharge Hose W21.8-14TPI x 20mm BSP 700mm 90˚Elbow	LF-DH700E
IG Discharge Hose W21.8-14TPI x 20mm BSP 750mm 90˚Elbow	LF-DH750E
IG Discharge Hose W21.8-14TPI x 20mm BSP 800mm 90˚Elbow	LF-DH800E
IG Discharge Hose W21.8-14TPI x 20mm BSP 850mm 90˚Elbow	LF-DH850E
IG Discharge Hose W21.8-14TPI x 20mm BSP 900mm 90˚Elbow	LF-DH900E
IG Discharge Hose W21.8-14TPI x 20mm BSP 950mm 90˚Elbow	LF-DH950E
IG Discharge Hose W21.8-14TPI x 20mm BSP 1000mm 90˚Elbow	LF-DH1000E
IG Discharge Hose W21.8-14TPI x 20mm BSP 1100mm 90˚Elbow	LF-DH1100E
IG Discharge Hose W21.8-14TPI x 20mm BSP 1200mm 90˚Elbow	LF-DH1200E
IG Pilot Hose M12-1.5 x 350mm	LF-PH350
IG Pilot Hose M12-1.5 x 450mm	LF-PH450
IG Pilot Hose adaptor	LF-PHA
IG Pilot Hose Tee connector (swivel on side)	LF-SORS
IG Pilot Hose Elbow	LF-PVE
IG Pilot Hose Tee connector (swivel on run)	LF-SORT
IG Pilot Valve adaptor	LF-PVA
IG bleed valve	LF-BVPL
IG Check valve	LF-CV
IG Constant pressure regulator	LF-PR

IG Pilot Line Check Valve	LF-CVPL
IG Nozzle 10mm 360deg BSP	LF-360IG-10
IG Nozzle 15mm 360deg BSP	LF-360IG-15
IG Nozzle 20mm 360deg BSP	LF-360IG-20
IG Nozzle 25mm 360deg BSP	LF-360IG-25
IG Nozzle 32mm 360deg BSP	LF-360IG-32
IG Nozzle 40mm 360deg BSP	LF-360IG-40
IG Nozzle 50mm 360deg BSP	LF-360IG-50
IG Nozzle 10mm 180deg BSP	LF-180IG-10
IG Nozzle 15mm 180deg BSP	LF-180IG-15
IG Nozzle 20mm 180deg BSP	LF-180IG-20
IG Nozzle 25mm 180deg BSP	LF-180IG-25
IG Nozzle 32mm 180deg BSP	LF-180IG-32
IG Nozzle 40mm 180deg BSP	LF-180IG-40
IG Nozzle 50mm 180deg BSP	LF-180IG-50
IG Pressure gauge 0-450bar NO	LF-PGLPS3
IG Pressure gauge 0-300bar NO	LF-PGLPS4
IG Pressure gauge 0-450bar NC	LF-PGLPS5
IG Pressure gauge 0-300bar NC	LF-PGLPS6
IG 80L Bracket (Dia:360mm)	LF- CB-80
IG 140L Bracket (Dia:474mm)	LF- CB-140
IG 4L/10L Pilot Bracket (Dia:148mm)	LF- CBP
80L Manifold 20mm 2 Port	LF-2COM20-80
80L Manifold 20mm 3 Port	LF-3COM20-80
80L Manifold 25mm 2 Port	LF-2COM25-80
80L Manifold 25mm 3 Port	LF-3COM25-80
80L Manifold 25mm 4 Port	LF-4COM25-80
80L Manifold 25mm 5 Port	LF-5COM25-80
80L Manifold 32mm 2 Port	LF-2COM32-80
80L Manifold 32mm 3 Port	LF-3COM32-80
80L Manifold 32mm 4 Port	LF-4COM32-80
80L Manifold 32mm 5 Port	LF-5COM32-80
80L Manifold 32mm 6 Port	LF-6COM32-80
80L Manifold 32mm 7 Port	LF-7COM32-80

80L Manifold 40mm 2 Port	LF-2COM40-80
80L Manifold 40mm 3 Port	LF-3COM40-80
80L Manifold 40mm 4 Port	LF-4COM40-80
80L Manifold 40mm 5 Port	LF-5COM40-80
80L Manifold 40mm 6 Port	LF-6COM40-80
80L Manifold 40mm 7 Port	LF-7COM40-80
80L Manifold 40mm 8 Port	LF-8COM40-80
80L Manifold 50mm 2 Port	LF-2COM50-80
80L Manifold 50mm 3 Port	LF-3COM50-80
80L Manifold 50mm 4 Port	LF-4COM50-80
80L Manifold 50mm 5 Port	LF-5COM50-80
80L Manifold 50mm 6 Port	LF-6COM50-80
80L Manifold 50mm 7 Port	LF-7COM50-80
80L Manifold 50mm 8 Port	LF-8COM50-80
80L Manifold 65mm 3 Port	LF-3COM65-80
80L Manifold 65mm 4 Port	LF-4COM65-80
80L Manifold 65mm 5 Port	LF-5COM65-80
80L Manifold 65mm 6 Port	LF-6COM65-80
80L Manifold 65mm 7 Port	LF-7COM65-80
80L Manifold 65mm 8 Port	LF-8COM65-80
80L Manifold 80mm 3 Port	LF-3COM80-80
80L Manifold 80mm 4 Port	LF-4COM80-80
80L Manifold 80mm 5 Port	LF-5COM80-80
80L Manifold 80mm 6 Port	LF-6COM80-80
80L Manifold 80mm 7 Port	LF-7COM80-80
80L Manifold 80mm 8 Port	LF-8COM80-80
80L Manifold 100mm 5 Port	LF-5COM100-80
80L Manifold 100mm 6 Port	LF-6COM100-80
80L Manifold 100mm 7 Port	LF-7COM100-80
80L Manifold 100mm 8 Port	LF-8COM100-80
140L Manifold 25mm 2 Port	LF-2COM25-140
140L Manifold 25mm 3 Port	LF-3COM25-140
140L Manifold 32mm 2 Port	LF-2COM32-140
140L Manifold 32mm 3 Port	LF-3COM32-140

140L Manifold 32mm 4 Port	LF-4COM32-140
140L Manifold 32mm 5 Port	LF-5COM32-140
140L Manifold 40mm 2 Port	LF-2COM40-140
140L Manifold 40mm 3 Port	LF-3COM40-140
140L Manifold 40mm 4 Port	LF-4COM40-140
140L Manifold 40mm 5 Port	LF-5COM40-140
140L Manifold 40mm 6 Port	LF-6COM40-140
140L Manifold 50mm 2 Port	LF-2COM50-140
140L Manifold 50mm 3 Port	LF-3COM50-140
140L Manifold 50mm 4 Port	LF-4COM50-140
140L Manifold 50mm 5 Port	LF-5COM50-140
140L Manifold 50mm 6 Port	LF-6COM50-140
140L Manifold 50mm 7 Port	LF-7COM50-140
140L Manifold 50mm 8 Port	LF-8COM50-140
140L Manifold 65mm 3 Port	LF-3COM65-140
140L Manifold 65mm 4 Port	LF-4COM65-140
140L Manifold 65mm 5 Port	LF-5COM65-140
140L Manifold 65mm 6 Port	LF-6COM65-140
140L Manifold 65mm 7 Port	LF-7COM65-140
140L Manifold 65mm 8 Port	LF-8COM65-140
140L Manifold 80mm 3 Port	LF-3COM80-140
140L Manifold 80mm 4 Port	LF-4COM80-140
140L Manifold 80mm 5 Port	LF-5COM80-140
140L Manifold 80mm 6 Port	LF-6COM80-140
140L Manifold 80mm 7 Port	LF-7COM80-140
140L Manifold 80mm 8 Port	LF-8COM80-140
140L Manifold 100mm 7 Port	LF-7COM100-140
140L Manifold 100mm 8 Port	LF-8COM100-140
80L Manifold 50mm 6 port - Double Row	LF-DR6COM50-80
80L Manifold 65mm 6 port - Double Row	LF-DR6COM65-80
80L Manifold 80mm 6 port - Double Row	LF-DR6COM80-80
80L Manifold 100mm 6 port - Double Row	LF-DR6COM100-80
140L Manifold 50mm 6 port - Double Row	LF-DR6COM50-140
140L Manifold 65mm 6 port - Double Row	LF-DR6COM65-140

140L Manifold 80mm 6 port - Double Row	LF-DR6COM80-140
140L Manifold 100mm 6 port - Double Row	LF-DR6COM100-140
IG Selector valve 20mm BSP	LF-DIV20-BSP
IG Selector valve 20mm NPT	LF-DIV20-NPT
IG Selector valve 25mm BSP	LF-DIV25-BSP
IG Selector valve 25mm NPT	LF-DIV25-NPT
IG Selector valve 32mm BSP	LF-DIV32-BSP
IG Selector valve 32mm NPT	LF-DIV32-NPT
IG Selector valve 40mm BSP	LF-DIV40-BSP
IG Selector valve 40mm NPT	LF-DIV40-NPT
IG Selector valve 50mm BSP	LF-DIV50-BSP
IG Selector valve 50mm NPT	LF-DIV50-NPT
IG Selector valve ISO Flange 65mm	LF-DIV65-ISO
IG Selector valve ISO Flange 80mm	LF-DIV80-ISO
IG Selector valve ISO Flange 100mm	LF-DIV100-ISO
IG Selector valve DIN Flange 65mm	LF-DIV65-DIN
IG Selector valve DIN Flange 80mm	LF-DIV80-DIN
IG Selector valve DIN Flange 100mm	LF-DIV100-DIN
Pilot Cylinder label	LF-CL3
LIFECO-541 Cylinder label (252.8mm x 190mm)	LF-CL8
Discharge Pressure Switch	LF-DPS

Appendix E – Maintenance Program

Inspection File - Maintenance of Fire Suppression Systems

System Service Provider

Service Provide: _____ Project No: _____

Address: _____ Purchase Order: _____

_____ Installation Date: _____

City: _____ Inspection Date: _____

Postcode: _____ Clean Agent Systems: _____

Telephone: _____

Fax: _____

Installation Location

Installation Site Address: _____

_____

_____

City: _____

Postcode: _____

Telephone: _____

Fax: _____

Site Official Representative: _____

Period of Service (* Please circle where appropriate)**

Monthly	Semi-Annual	Annual

1. Protected Enclosure:

Inspect the project details / data of the protected enclosure to ensure the system suitability for the fire protection, no alterations or modifications with respect to the previous service report.

Property owner / contractor shall provide the required details prior to inspection.

*** *Every NO answer shall be explained in detail and indicate so under observations.*

No	Description	Findings		
		YES	N/A	NO
1.1	Dimension of protected enclosure.			
1.2	Area occupied by persons.			
1.3	Modification on protected enclosure.			
1.4	Protected enclosure equipped with automatic disconnection during system discharge.			
1.5	Any previously noted deficiencies / past defects have been corrected.			

Observations:

Inspection File - Maintenance of Fire Suppression Systems

2. Agent Storage Area

Inspect and check if there are any changes to the approved installation and general condition of hardware installed. Ensure the system is isolated electrically and mechanically, remove manual actuator, electrical actuator, manifold (if applicable) discharge hose and piping away from cylinder valves. Immediately fit the safety cap onto the cylinder valves outlet to prevent accidental discharge.

*** *Every NO answer shall be explained in detail and indicate so under observations.*

No	Description	Findings		
		YES	N/A	NO
2.1	All actuation hardware deactivated to prevent accidental system discharge during maintenance.			
2.2	Releasing control panel is powered and is free of supervisory, trouble or false alarm conditions.			
2.3	Cylinder safe from mechanical damage corrosion or unauthorised interference.			
2.4	Cylinder paint in good condition.			
2.5	Cylinder label in good condition and its description still visible.			
2.6	Cylinder brackets are fitted and all bolts tightened.			
2.7	Cylinder locate at area prevented from direct sunlight.			
2.8	Pressure gauges in the operable range.			
2.9	Storage area clean and not to expose to adverse weather condition.			
2.10	Cylinder, valve, pressure gauge and all manual controls for actuation located for easily accessible.			
2.11	Manual actuator has their safety cable tie in good condition to prevent accidental discharge.			
2.12	Warning signage fixed, legible and resistant to environment conditions.			
2.13	Flexible hoses are not kinked.			
2.14	Are the flexible hoses connected appropriately?			
2.15	Is the external monitoring switch proper mounted onto the electrical actuator?			
2.16	Are the wires proper connected to the terminal block inside the nylon housing?			
2.17	All actuators are in non-fire position prior to reconnection to the cylinder valves.			
2.18	Record cylinder details as below:			

No.	Protected Enclosure / Room Name	Cylinder Size	Cylinder Serial no.	Filled Weight	Pressure (Bar)	Temperature (°C)	Corrections Required		
							YES	N/A	NO

Observations:

Inspection File - Maintenance of Fire Suppression Systems

3. Distribution / Piping System

Pipe system carrying agent from cylinders to distribution nozzles inside the hazard area. Inspect and check if the distribution / piping system has undergone any changes / modification since previous inspection. The piping used shall be schedule 40 pipes.

**** Every NO answer shall be explained in detail and indicate so under observations.*

No	Description	Findings		
		YES	N/A	NO
3.1	Pipe length and diameter have not undergone changes from previous project inspection.			
3.2	Are pipes free from mechanical damages along its length?			
3.3	Piping layout as per initial approved system design.			
3.4	PTFE tape is used to apply on the pipe male thread.			
3.5	Is dirt trap install to the end of each pipe runs?			
3.6	Are the threaded pipes used for the distribution system?			
3.7	Supports used are those specified in the project.			
3.8	Any previous record of deficiencies have been corrected.			

Observations:

4. Discharge Nozzles

Visualize inspect and check the condition of discharge nozzles or if they have been undergone modification.

**** Every NO answer shall be explained in detail and indicate so under observations.*

No	Description	Findings		
		YES	N/A	NO
4.1	Quantity of discharge nozzles installed in accordance with the system design approved for earlier design and installation.			
4.2	Discharge nozzles installed conform with model of those specified in system design approved for earlier design and installation.			
4.3	Discharge nozzle condition clean (no foreign material), no debris and physical damages.			
4.4	Discharge nozzle orientation as per earlier design.			
4.5	Discharge nozzle is free from obstacles and any projecting parts.			
4.6	Discharge nozzle has not undergone any modifications.			

Observations: