Honeywell

FK-5-1-12 CLEAN AGENT FIRE EXTINGUISHING SYSTEM



HW-5112

Design, Installation, Operation Maintenance and Refilling Manual

Rev.01

PN: HSN-MNL-F1-R1
June 2025

UL FM APPROVED

A Foreword

This manual is written for those who own or are responsible for FK-5-1-12 Fire Extinguishing System. We assume no responsibility for the application of any systems other than those addressed in this manual. The technical data contained herein is limited strictly for information purposes only. We believe this data to be accurate, but it is published and presented without any guarantee or warranty whatsoever. We disclaim any liability for any use that may be made of the data and information contained herein by any and all other parties.
The FK-5-1-12 Fire Extinguishing System is to be designed, installed, inspected, maintained, tested and recharged by qualified, trained personnel in accordance with the following:

NFPA 2001, Standard for Clean Agent Fire Extinguishing Systems
NFPA 72, National Fire Code
NFPA 70, National Electrical Code
EN15004-1, Fixed firefighting systems - Gas extinguishing systems
ISO14520, Gaseous fire-extinguishing systems - Physical properties and system design

Storage, handling, transportation, service, maintenance, recharge and test of agent storage cylinders shall be per-formed only by qualified and trained personnel in accordance with the information in this manual and TPED Directive 2010/35/EU.

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

Honeywell Middle East FZE
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Phone: +971 4 450 5800
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B Attention Installer

This form must be signed by the system owner indicating that he/she has received a copy of this Owner's Manual Copy. Have the system installer fill-out this form.
Note: Retain a copy of this form for your records.

A System Installed:

_____

_____

_____

_____

B Listing of Major System Components:

_____

_____

_____

_____

C Description of Hazard Protected by System:

_____

_____

_____

_____

_____ _____

Owner or Authorized Representative Date

_____

Title

C History of Revisions

Table C.1 History of Revisions			
Version	**Revision Date**	**Revision Detail**	**Revised by**
R.0	28 / 10 / 2024	Document is created	Y.Koc
R.1	27 / 06 / 2025	Monitoring device type is changed	S.Baltacioglu

FK-5-1-12 Clean Agent Fire Extinguishing System

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0. General Introduction

This manual is a comprehensive guide the contains all the information needed to design, install and maintain the FK-5-1-12 Fire Extinguishing System. Users of this manual are assumed to be competent fire engineers with a basic knowledge of such systems. The contents are arranged in a logical order describing the various procedures in turn, alternatively specific sections can be referred to as required. Users who are not familiar with the equipment should first read the complete manual. FK-5-1-12 is a clean, safe firefighting agent for use in total flooding automatic extinguishing systems. It is intended as a long-term replacement for Halon 1301 and, whilst maintaining the excellent fire extinguishing properties of Halon, has none of the environmental problems. Storage and distribution requirements are like Halon and majority of system components are identical. However, FK-5-1-12 is not a direct replacement for existing Halon 1301 installations due to the difference in agent quantity and discharge characteristics.

Systems may be activated mechanically or electrically. Mechanical manual actuation is via a strike knob attached to the cylinder valve. Electrical actuation is via a removable side mounted solenoid. The solenoid can be energized automatically by a signal from a detection and alarm control panel. Users of this manual should find that sufficient information is provided to plan, design, purchase components, install, operate and maintain the system. However, if part of the document is not understood, or if there is any concern as to the suitability of the protection, do not hesitate to contact one of our specialist engineers for the matter to be quickly resolved. FK-5-1-12 Fire Extinguishing systems are employed to protect critical installations formerly protected by Halon 1301. These include:

- Data Processing Centers
- Telecommunication Switch Centers
- Process Control Rooms
- Art and Historical Collections
- MRI Room in Hospital
- Process Control Station of Oil Refinery
- Marine Engine Rooms and Drone Control Center of Military
- An ideal supplement for sprinkler systems to protect any type of assets that could be damaged by water.

1. Concept

1.1. Application

FK-5-1-12 fire extinguishing system is designed, installed, maintained and tested for total flooding in accordance with EPA, NFPA2001, ISO14520 and EN15004 standards. This is the time-tested agent available in the market. FK-5-1-12 fire extinguishing system are designed to extinguishes fires in specific hazards or equipment located where an electrically non-conductive agent is required, where agent cleanup creates a problem, where extinguishing capability with low weight is a factor and where the hazard is normally occupied by personnel.

Features of FK-5-1-12 Clean Agent:

- Ozone Depleting Potential (ODP) of Zero
- No post-fire residue or clean up
- No damage to protected equipment
- Is electrically non-conductive
- Safe for use in a wide range of normally occupied hazard areas
- Atmospheric lifetime of approximately 5 days
- Very low Global Warming Potential (GWP) of just 1

Typical Application:

- Telecommunication switch rooms
- Computer and electronic control rooms
- Banking Data Centre
- Marine Engine Rooms and Drone Control Center of Military
- Control Rooms in Power Generation Plants
- Control Rooms in Petrochemical Installations

1.2. System Description

1.2.1. General

FK-5-1-12 fire extinguishing system is a time-tested clean agent Halon alternative. It combines outstanding extinguishing performance with an excellent environmental profile. FK-5-1-12 has zero ozone depletion potential, a global warming potential of 5 days atmospheric lifetime, and a large margin of safety for occupied spaces. FK-5-1-12 clean agent extinguishes fire by a combination of chemical and physical action without affecting the available oxygen. It is also electrically non-conductive.

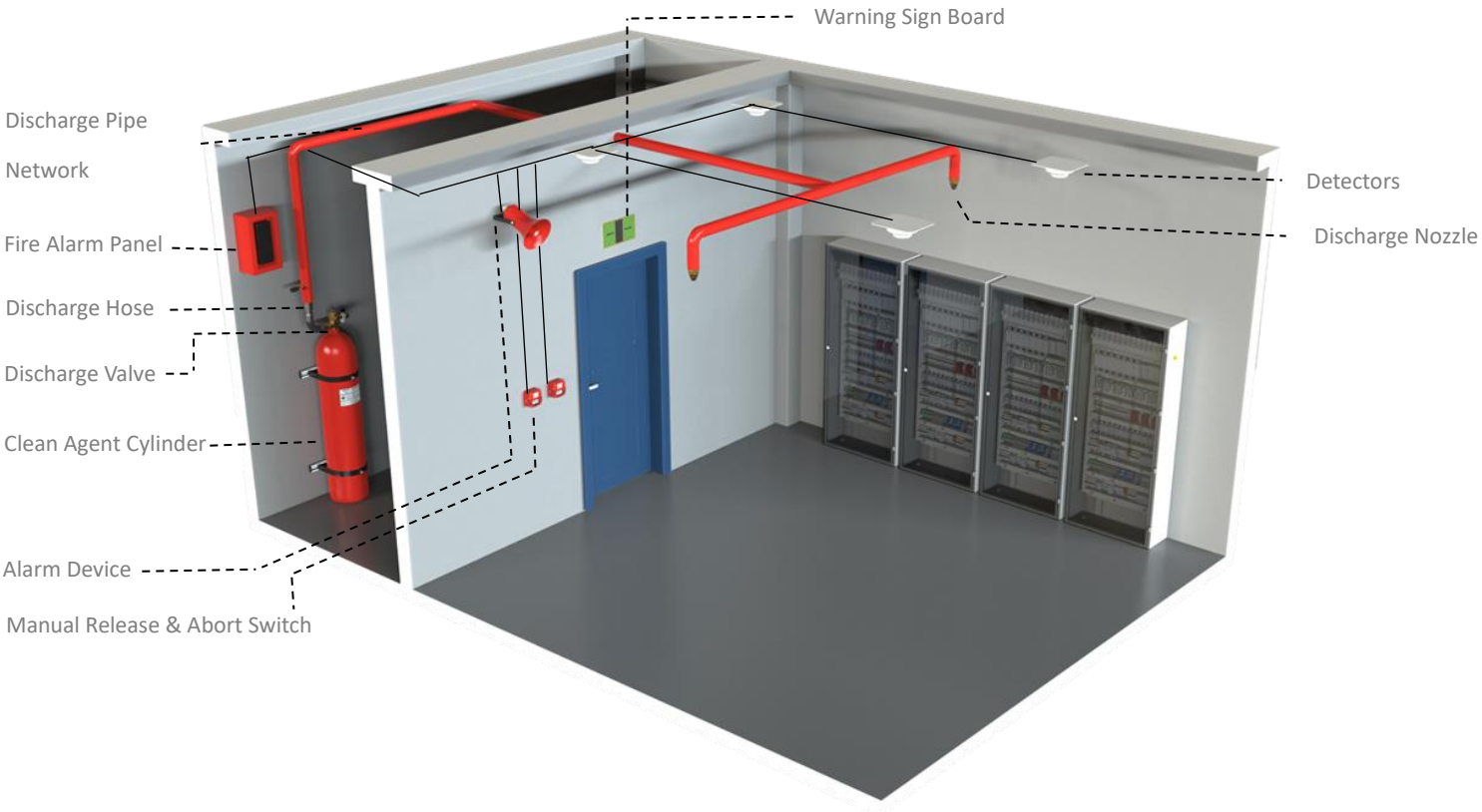


Figure 1.1.: Typical FK-5-1-12 Clean Agent Fire Extinguishing Systems

FK-5-1-12 Clean Agent Systems are designed for the following classes of fire:

- Class A; Surface Type Fires; Wood, cloth, rubber, paper and many plastics.
- Class B; A fire in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.
- Class C; A fire that involves energized electrical equipment.

1.2.2. Extinguishing Agent

FK-5-1-12 clean agent, referenced as FK-5-1-12 in EN15004 and NFPA2001 are a fluorinated ketone (or fluoroketone) with a chemical structure of $CF_3CF_2C(O)CF(CF_3)_2$. It is a clear, colorless, odorless, liquid that is super-pressurized with nitrogen and stored in high-pressure cylinders. This agent extinguishes fire by a combination of Chemical and physical mechanisms with minimal effect on the available oxygen. This allows people to see and breathe, permitting them to leave the fire area safely.

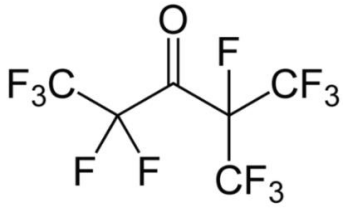


Figure 1.2.: FK-5-1-12 Molecule

1.2.2.1. Toxicity

Unnecessary exposure to clean agents is to be avoided in accordance with the requirements of NFPA2001. FK-5-1-12 use concentration is much lower than its No Observable Adverse Effects Level (NOAEL), FK-5-1-12 offers the largest margin of safety of any halon replacement available on the market today.

Table 1.1. Toxicity Information

Agent	LC50 or ALC (%)	NOAEL	LOAEL
FK-5-1-12	> 10	10.0 %	> 10.0
NOTE.1: LC50 is the concentration lethal to 50 % of a rat population during a 4 h exposure. The ALC is the approximate lethal concentration. NOTE.2: The cardiac sensitization levels are based on the observance or non-observance of serious heart arrhythmias in a dog. The usual protocol is a 5 min exposure followed by a challenge with epinephrine. NOTE.3: High concentration values are determined with the addition of oxygen to prevent asphyxiation.			
Reference: EN15004-1, Table G.1 — Toxicity information for halocarbon clean agents. NFPA2001 Table 1.5.1.2.1.(a) — Information for halocarbon clean agents.			

1.2.2.2. Environmentally Friendly

FK-5-1-12 has zero ozone depletion potential, 5 days atmospheric lifetime, FK-5-1-12 is the preferred clean agent halon replacement to offer a viable, long-term, sustainable technology for special hazards fire protection.

Table 1.2. Environmental Properties				
Description	**FK-5-1-12**	**Halon 1301**	**HFC-125**	**HFC-227ea**
Ozone Depletion Potential	0.0	12.0	0.0	0.0
Global Warming Potential	1	7140	3500	3220
Atmospheric Lifetime (Years)	0.014 (5 days)	65	29	34.2
SNAP (YES/NO)				
Reference: World Meteorological Organization (WMO) 1998, Model-Derived Method Intergovernmental Panel on Climate Change (IPCC) 2007 Method, 100-year ITH				

IMPORTANT NOTICE:

FK-5-1-12 is discharged through the nozzle orifices. Direct eye or skin contact with the liquid or cold gas can cause chilling or possibly frostbite on exposed tissues. Misuse or intentional inhalation abuse can cause suffocation or death. Do not stand directly in front of the discharge lines as the discharge pressure could cause injury. The nozzles are used to discharge the FK-5-1-12 in a horizontal direction. The flow of FK-5-1-12 should not be blocked by any obstructions. Please read and follow the precautions and the safety related information in the Material Safety Data Sheet (MSDS).

1.2.2.3. Storage

FK-5-1-12 Clean Agent has a low vapor pressure 0.404 bar (5.85 psi) @ 21 ºC (70 ºF). To displace the extinguishing clean agent out of the steel cylinders through the pipelines to the nozzles in protected hazard, nitrogen is added as a propellant to improve the discharge characteristics. FK-5-1-12 clean agent system is available for only 42bar system.

• 42 Bar system: FK-5-1-12 clean agent is stored in seamless cylinder as liquid, super pressurize with dry nitrogen to 42 Bar at 21°C (610 psi at 70 °F).

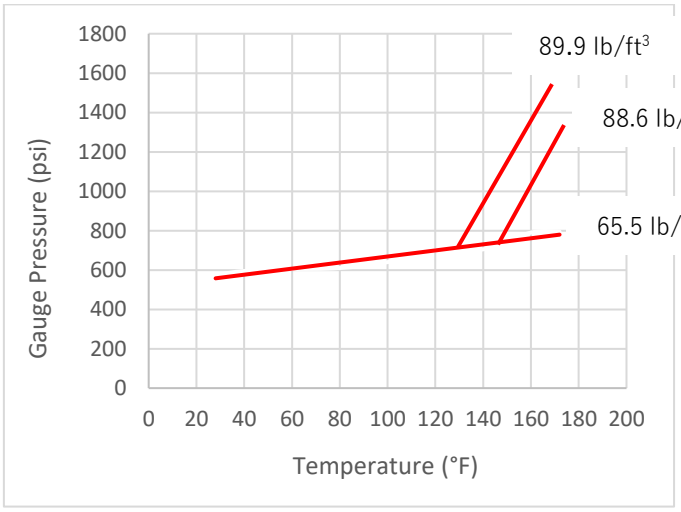


Figure 1.3.: Pressure vs. Temperature curve for FK-5-1-12 clean agent to 610 psi at 70 °F

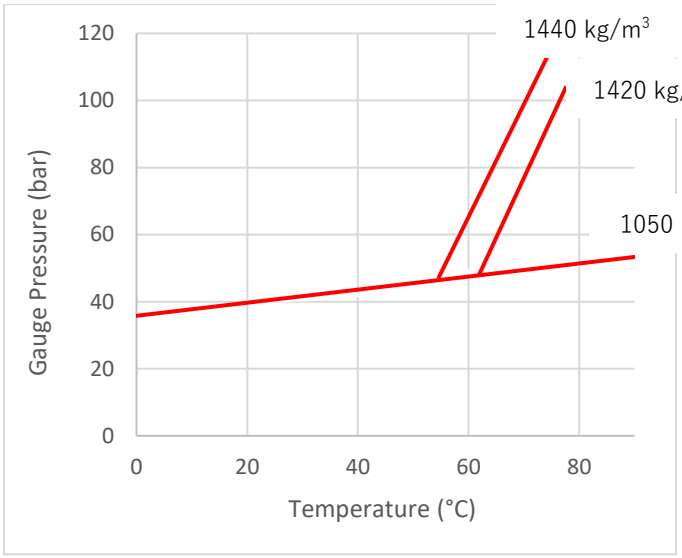


Figure 1.4.: Pressure vs. Temperature curves for FK-5-1-12 clean agent to 42 bar at 20 °C

Table 1.3. Physical Properties of FK-5-1-12

Properties	FK-5-1-12
Chemical Name	1,1,1,2,2,4,5,5,5- Nonafluoro-4-(Trifluoromethyl)-3-Pentanone
Chemical Formula	CF3CF2C(O)CF(CF3)2
Molecular Weight	316.04
Boiling Point @ 1 atm	49.2 ºC (120.6 ºF)
Freezing Point	-108.0 ºC (-162.4 ºF)
Critical Temperature	168.7 0C (335.6 ºF)
Critical Pressure	18.65 Bar (270.44 psi)
Liquid Density @ 1 atm	1.60 g/mL
Vapor Density @ 1 atm	11.6 g/mL
Vapor Pressure	0.3260 bar (4.73psi) @ 20 ºC (68 ºF)
Ozone Depletion Potential	0.0
Global Warming Potential, GWP (100yr ITH. for CO_2, GWP=1)	1
Atmospheric Lifetime	Approximate 5 days
Reference: FK-5-1-12 clean agent manufacturer's MSDS	

2. Component Descriptions

2.1. Introduction

This chapter provides a functional description of the components and assemblies of the FK-5-1-12 Fire Extinguishing System.

Table 2.1. Part List	
Description	**Part Number**
42 Bar Cylinder Sets	
8L Seamless TPED Cylinder Set (with DN12 solenoid integrated valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-008-1
13.4L Seamless TPED Cylinder Set (with DN12 solenoid integrated valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-013-1
26.8L Seamless TPED Cylinder Set (with DN33 valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-026-1
40L Seamless TPED/DOT Cylinder Set (with DN33 valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-040-1
67.5L Seamless TPED/DOT Cylinder Set (with DN33 valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-067-1
80L Seamless TPED/DOT Cylinder Set (with DN33 valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-080-1
120L Seamless TPED Cylinder Set (with DN33 valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-120-1
180L Seamless TPED Cylinder Set (with DN50 valve, siphon tube, label, protection cap, bracket)	HSN-FK-US-SM-180-1
Pressure Gauges	
Ø50mm Contacted pressure gauge 38bar NO, Range: 0-80Bar	HSN-PGV-NOC-3880
Ø50mm Contacted pressure gauge 38bar NC, Range: 0-80Bar	HSN-PGV-NCC-3880
Actuators	
Manual Actuator (release device) for DN33&50 valves	HSN-ACT-M01
Manual Actuator (release device) for DN12 valve on board solenoid	HSN-ACT-M02
Solenoid Actuator 24V DC (release device) for DN33&50 valve	HSN-ACT-S03
Pneumatic Actuator (release device)	HSN-ACT-P01
Discharge Line Hose & Adaptors	
Discharge Hose, DN12, L:400mm (13.4 to 26.8L)	HSN-DH-12-400
Discharge Hose, DN33, L:400mm, (40L to 120L)	HSN-DH-33-400
Discharge Hose, DN50, L:400mm, (180L)	HSN-DH-50-400
Discharge Hose Adaptor for DN33	HSN-DHA-33-001
Discharge Hose Adaptor for DN50	HSN-DHA-50-001
Outlet Adaptor for 33mm (Cylinder Discharge Line, 26.8L to 120L)	HSN-OA-33-FF
Outlet Adaptor for 50mm (Cylinder Discharge Line, 180L)	HSN-OA-50-FF
Check Valves	
Check Valve DN33	HSN-CHV-033
Check Valve DN50	HSN-CHV-050

Table 2.1. Part List (continued)	
Description	**Part Number**
Actuation Line Accessories	
Pilot Hose DN5 500 mm - 360bar	HSN-PLH-01-500
Pilot Line Nipple Adaptor (Screw-in fitting straight) G1/8” - M12x1,5	HSN-PNA-01
Bleed Valve G1/8"	HSN-BLD-01
Clean Agents	
FK-5-1-12 Clean Agent (Factory Filled in Kg)	HSN-FK5112-01
FK-5-1-12 Clean Agent in drums 250kg	HSN-FK5112-250
Discharge Nozzles	
Nozzle, Ø15mm, 1/2", 180D, 5xØ6.7	HSN-NOZ-01-15
Nozzle, Ø15mm, 1/2", 360D, 8xØ5.4	HSN-NOZ-02-15
Nozzle, Ø20mm, 3/4", 180D, 9xØ6.7	HSN-NOZ-01-20
Nozzle, Ø20mm, 3/4", 360D, 16xØ5	HSN-NOZ-02-20
Nozzle, Ø25mm, 1", 180D, 9xØ8.4	HSN-NOZ-01-25
Nozzle, Ø25mm, 1", 360D, 16xØ6.3	HSN-NOZ-02-25
Nozzle, Ø32mm, 11/4", 180D, 9xØ10.7	HSN-NOZ-01-32
Nozzle, Ø32mm, 11/4", 360D, 16xØ8	HSN-NOZ-02-32
Nozzle, Ø40mm, 11/2", 180D, 14xØ10.7	HSN-NOZ-01-40
Nozzle, Ø40mm, 11/2", 360D, 24xØ8.2	HSN-NOZ-02-40
Nozzle, Ø50mm, 2", 180D, 14xØ13.4	HSN-NOZ-01-50
Nozzle, Ø50mm, 2", 360D, 24xØ10.2	HSN-NOZ-02-50
Switches	
Discharge Pressure Switch	HSN-DPS-01
Monitoring Device for DN33&DN50 Valves	HSN-MDS-01
Label	
FK-5-1-12 Label	HSN-LBL-F1
Caution Signs	
FK-5-1-12 Protected Room Caution Sign	HSN-CS-FK-01
Manual Release Point Caution Sign	HSN-CS-MRP-01
Filling Parts	
DN12 Valve Filling Adaptor Set	HSN-FLA-12-01
DN33 Valve Filling Adaptor Set	HSN-FLA-33-01
DN50 Valve Filling Adaptor Set	HSN-FLA-50-01
Calculation Software	
FK-5-1-12 Flow Calculation 7.8.4 Software	HSN-FK-SW-02

2.2. Component Descriptions

2.2.1. Seamless Cylinder

In 42 Bar FK-5-1-12 System, clean agent is stored as liquid in seamless cylinder designed specifically for the application and charged to a fill density of between 0.50 kg/ltr. (31.2lb/ft3) and

1.20 kg/ltr. (74.9 lb/ft3). To ensure optimal performance, each cylinder is super pressurized with dry nitrogen to 42 bar at 21°C (610 psi at 70 °F).

An identification label is affixed to the cylinder body indicating the fill quantity of FK-5-1-12, charging pressure and date of fill. Many variations in cylinder capacities (Refer Table 2.2.) to select the best as per project requirement. Fire extinguishing systems utilizing FK-5-1-12 clean agent is designed to be discharged within 6-10 seconds into a room or an enclosure with the structural integrity to retain the agent.

The FK-5-1-12 clean agent uniformly mixes throughout the protected area achieving a minimum concentration level in accordance with NFPA2001.

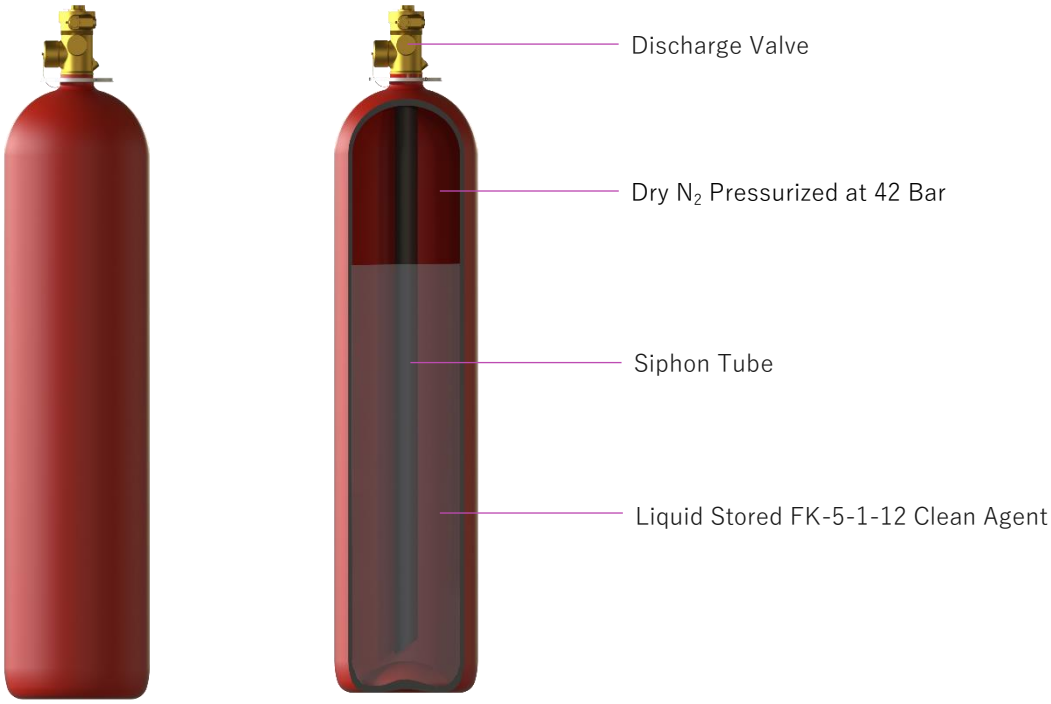


Figure 2.1.: Typical seamless cylinder & valve assembly

Table 2.2. 42 Bar FK-5-1-12 Clean Agent Seamless Cylinders

Part Number	Valve Size mm	Cylinder Volume liter	Cylinder Diameter mm**	Empty Weight kg***	System Pressure bar	Filling Range kg
HSN-FK-US-SM-008-1	12	8	140	10.4	42	4.0-9.6*
HSN-FK-US-SM-013-1		13.4	140	16.0		6.7-16.08
HSN-FK-US-SM-026-1	33	26.8	219	35.0		14.3-32.16
HSN-FK-US-SM-040-1		40	219	48.0		20.0-48.0
HSN-FK-US-SM-067-1		67.5	267	68.0		33.5-80.4
HSN-FK-US-SM-080-1		80	267	77.5		40.0-96.0
HSN-FK-US-SM-120-1		120	356	115.0		60.0-144.0
HSN-FK-US-SM-180-1	50	180	406	176.0		90.0-216.0

** According to UL system approval, the minimum filling quantity for 8L cylinder starts from 6.4kg.*

*** Cylinder diameters have tolerance +/- 5 % according to cylinder manufacturer.*

**** Cylinder weights are approximately.*

IMPORTANT NOTICE: FK-5-1-12 clean agent fire extinguishing system equipment's are designed for an operating temperature range of 5°C to 50°C (41°F to 122°F).

2.2.2. Valve Assembly

The automatic release of FK-5-1-12 clean agent is controlled by a forged brass, differential pressure operated cylinder valve connected to the neck of the cylinder. Each cylinder and valve assembly are provided with a safety cap and a protection cap which is a safety feature to prevent uncontrolled, accidental discharge. Discharge valve assembly is available in three sizes DN12, DN33 and DN50.

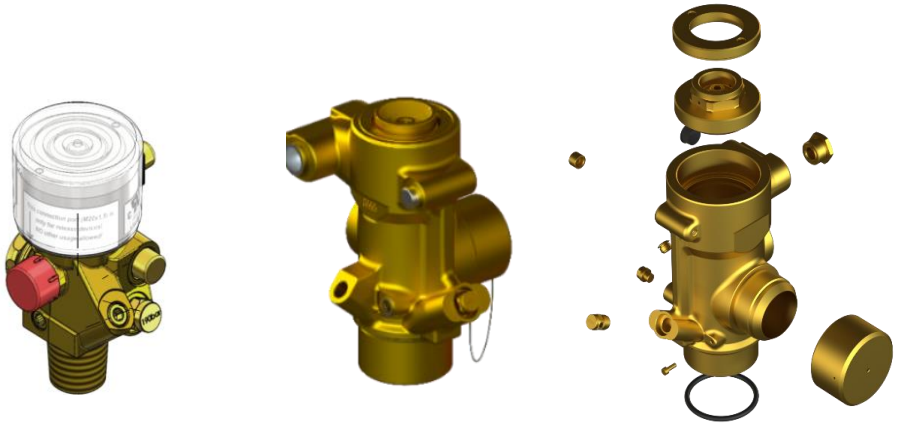


Figure 2.2.: General Arrangement of Discharge Valves

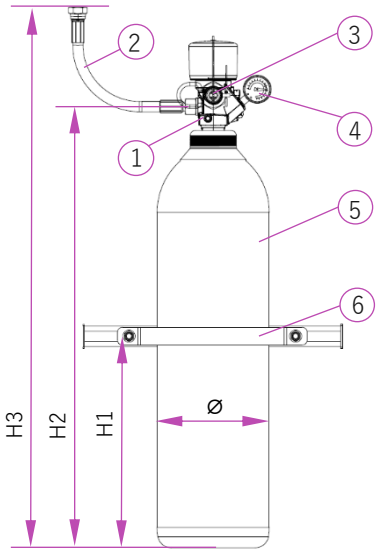


Table 2.3. Hardware for 8L & 13.4L Cylinders

No.	Description	Part Number
1	DN12 Solenoid (Integrated) Discharge Valve	HSN-VLV-HS-2-12
2	Discharge Hose, L:400mm, 16mm	HSN-DH-12-400
3	Manual Actuator for DN12 Valve	HSN-ACT-M02
4.1	Ø50mm contacted pressure gauge 38bar NO	HSN-PGV-NOC-3880
4.2	Ø50mm contacted pressure gauge 38bar NC	HSN-PGV-NCC-3880
5.1	8L Seamless TPED Cylinder Set	HSN-FK-US-SM-008-1
5.2	13.4L Seamless TPED Cylinder Set	HSN-FK-US-SM-013-1
6.1	8L Seamless Cylinder Bracket	HSN-BRC-140
6.2	13.4L Seamless Cylinder Bracket	

Figure 2.3.: General Arrangement of Assembly of 8L & 13.4L System

Table 2.4. Dimensions for 8L & 13.4L Cylinders				
Type	**H1 (mm)**	**H2 (mm)**	**H3 (mm)**	**Ø (mm)**
8L	400-500	700	900	140
13.4L	700-800	1100	1300	140

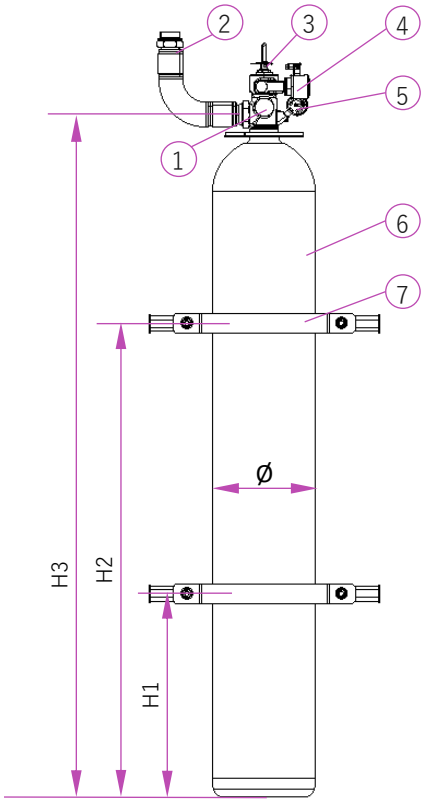


Table 2.5. Hardware for 26.8, 40, 67.5, 80, 120L Cylinders		
No.	**Description**	**Part Number**
1	DN33 Discharge Valve	HSN-VLV-H-2-33
2	Discharge Hose DN33, L:400mm	HSN-DH-33-400
3	Manual Actuator	HSN-ACT-M01
4	Solenoid Actuator, 24V DC	HSN-ACT-S03
5.1	Ø50mm contacted pressure gauge 38bar NO	HSN-PGV-NOC-3880
5.2	Ø50mm contacted pressure gauge 38bar NC	HSN-PGV-NCC-3880
5.3	26.8L Seamless TPED Cylinder Set	HSN-FK-US-SM-026-1
6.1	40L Seamless TPED Cylinder Set	HSN-FK-US-SM-040-1
6.2	67.5L Seamless TPED Cylinder Set	HSN-FK-US-SM-067-1
6.3	80L Seamless TPED Cylinder Set	HSN-FK-US-SM-080-1
6.4	120L Seamless TPED Cylinder Set	HSN-FK-US-SM-120-1
7.1	26.8L Seamless Cylinder Bracket	HSN-BRC-219
7.2	40L Seamless Cylinder Bracket	
7.3	67.5L Seamless Cylinder Bracket	HSN-BRC-267
7.4	80L Seamless Cylinder Bracket	
7.5	120L Seamless Cylinder Bracket	HSN-BRC-356

Figure 2.4.: General Arrangement of Assembly of 26.8L, 40L, 67.5L, 80L, 120L System

Table 2.6. Dimensions for 26.8, 40, 67.5, 80, 120L Cylinders				
Type	**H1 (mm)**	**H2 (mm)**	**H3 (mm)**	**Ø (mm)**
26.8L	N/A	650	970	219
40L	N/A	865	1345	219
67.5L	400	1140	1510	267
80L	400	1390	1745	267
120L	400	1170	1510	356

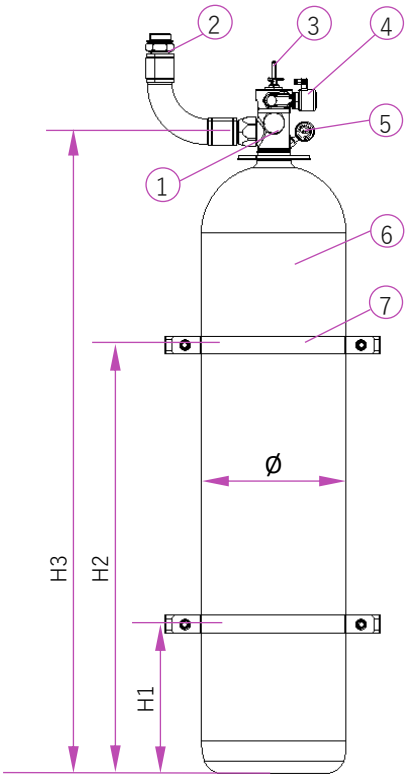


Table 2.7. Hardware for 180L Cylinder		
No.	**Description**	**Part Number**
1	DN50 Discharge Valve	HSN-VLV-H-2-50
2	Discharge Hose DN50, L:400mm	HSN-DH-50-400
3	Manual Actuator	HSN-ACT-M01
4	Solenoid Actuator, 24V DC	HSN-ACT-S03
5.1	Ø50mm contacted pressure gauge 38bar NO	HSN-PGV-NOC-3880
5.2	Ø50mm contacted pressure gauge 38bar NC	HSN-PGV-NCC-3880
6	180L Seamless TPED Cylinder Set	HSN-FK-US-SM-180-1
7	180L Seamless Cylinder Bracket	HSN-BRC-406

Figure 2.5.: General Arrangement of Assembly of 180L System

Table 2.8. Dimensions for 180L Cylinders				
Type	**H1 (mm)**	**H2 (mm)**	**H3 (mm)**	**Ø (mm)**
180L	500	1350	1730	406

2.2.3. Solenoid Actuator (P/N: HSN-ACT-S03)

The Solenoid Actuator attaches to the primary cylinder at the valve actuation connection and is utilized to automatically open the cylinder valve upon receipt of a signal from the control panel or other source.

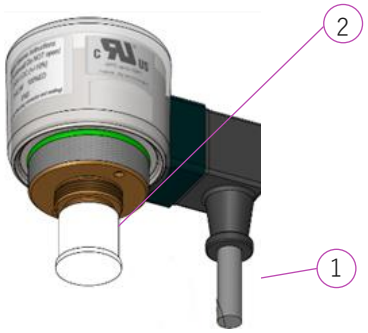


Table 2.9. Solenoid Actuator	
No.	**Description**
1	Connector plug for wiring
2	Connection to cylinder valve

Figure 2.6.: Solenoid actuator

Materials:

Body, screws, cap nuts, seals: Brass, stainless steel, nickel-plated steel, elastomeric seals, plastic

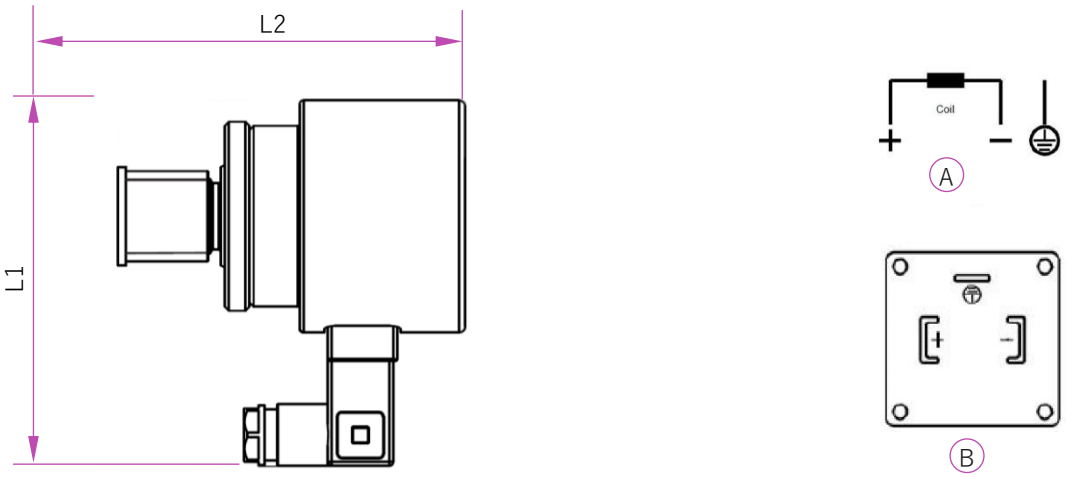


Figure 2.7.: Solenoid actuator features

Table 2.10. Solenoid Actuator Features	
L1	89mm
L2	85mm
A	Solenoid circuit
B	Male connector plug socket DIN EN 175301-803 Form A

IMPORTANT NOTICE:

The solenoid actuator shall be installed during the commissioning phase only so to avoid incorrect manipulation and possible accidental activation of the system, which would discharge the agent. This type of solenoid actuator does not need to be reset by a special tool. The solenoid actuator will be automatic reset when 24V DC energy is off.

Table 2.11. Electrical Data of Solenoid Actuator	
Voltage	24 VDC (+/-10%)
Temperature range	-20 ºC to +50 ºC
Max. current at union and RT	0.4 A
Power consumption at union and RT	9.5 W
Duty cycle	100% ED
Class of insulation	F
Protection class (DIN 40050)	IP 65 (With assembled cable connector and attached sealing)

IMPORTANT NOTICE:

Be sure that the threaded ring is screwed into the end stop, before assembling the actuator.

Hand-tight, without any additional tool. While tightening the solenoid actuator to valve, don't use the nickel-plated surface, only use brass knurled surface. (refer to Figure 2.9.)

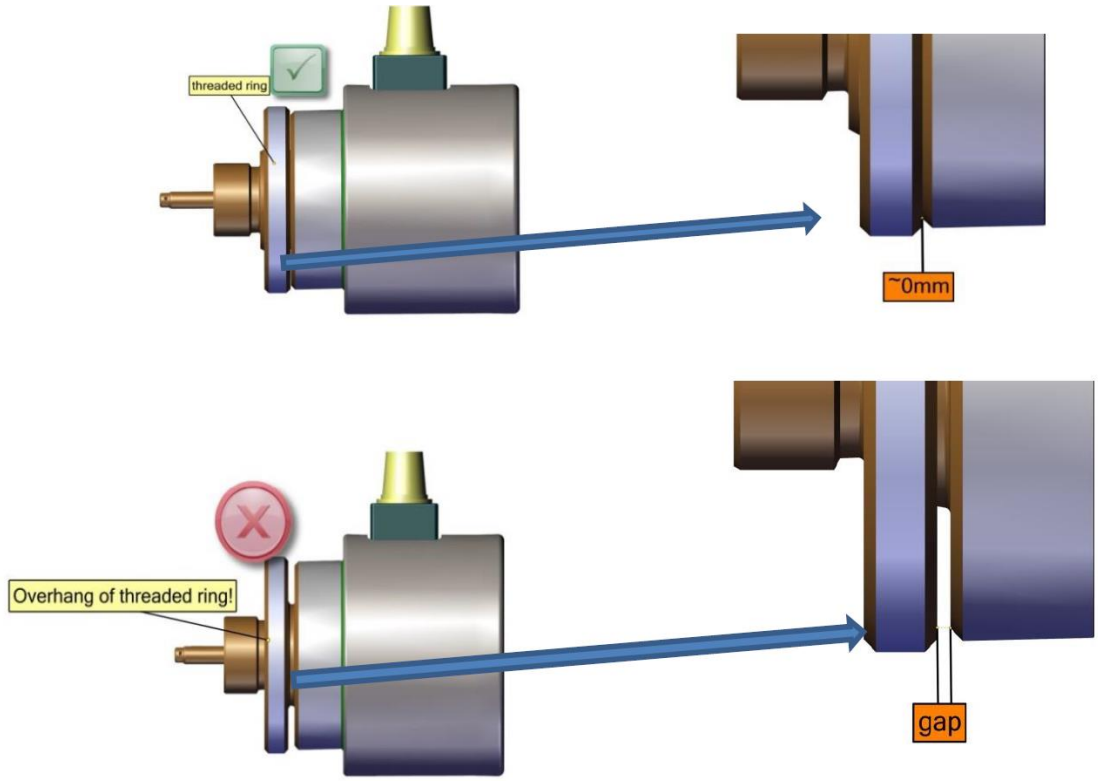


Figure 2.8.: Solenoid actuator assembling

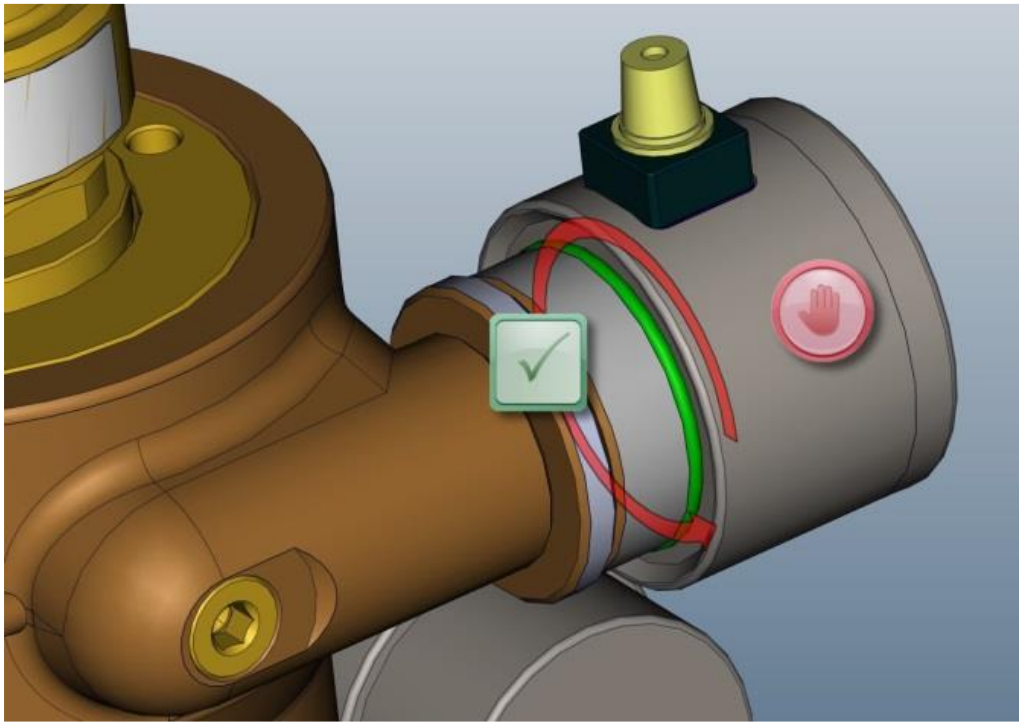


Figure 2.9.: Solenoid actuator tightening

2.2.4. Manual Actuator for DN33&DN50 Valves (P/N: HSN-ACT-M01)

The manual actuator allows manual activation of the cylinder valve. It is compulsory to always include such an actuator. Located on top of the cylinder valve or solenoid valve, the lever is manually operated to open the valve and activate the system. It includes a safety pin to prevent accidental activation, and this safety pin incorporates a safety seal to avoid incorrect manipulation.

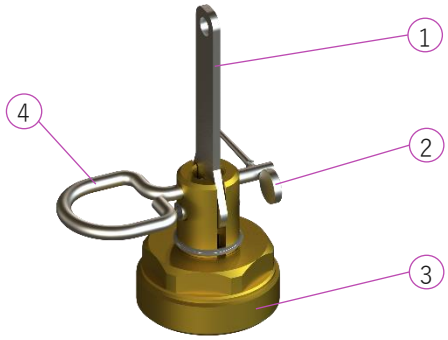


Table 2.12. Manual Actuator for DN33&DN50 Valves	
No.	**Description**
1	Lever
2	Safety lock
3	Connection to cylinder valve or solenoid actuator
4	Safety pin

Figure 2.10.: Manual actuator for DN33 & DN50 valves

2.2.5. Manual Actuator for DN12 Solenoid Valve (P/N: HSN-ACT-M02)

The manual actuator allows manual activation of the cylinder solenoid valve. It is compulsory to always include such an actuator. Located on the cylinder solenoid valve, the lever is manually operated to open the valve and activate the system. It includes a safety pin to prevent accidental activation, and this safety pin incorporates a safety seal to avoid incorrect manipulation.

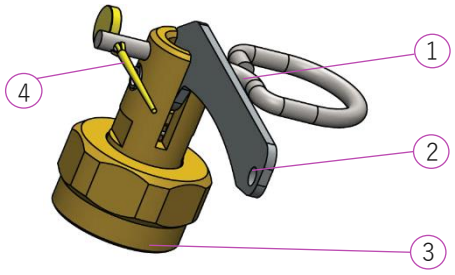


Table 2.13. Manual Actuator for DN12 Solenoid Valve	
No.	**Description**
1	Safety pin
2	Lever
3	Connection to cylinder solenoid valve
4	Safety lock

Figure 2.11.: Manual actuator for DN12 solenoid valve

IMPORTANT NOTICE:

This manual actuator (HSN-ACT-M02) is only suitable with DN12 solenoid (integrated) discharge valve.

2.2.6. Pneumatic Actuator (P/N: HSN-ACT-P01)

On multiple cylinder systems, the Solenoid Actuator will actuate the master (primary) cylinder and then, in a rapidly occurring sequence, the pneumatic actuator will actuate all other slave cylinders valve, using pressure of the master (primary) cylinder.

A pneumatic actuator attaches to the valve actuation connection of each slave cylinder. It receives pressure from the actuation port of the master (primary) cylinder through the pilot actuation hose.

The body of the pneumatic actuator is made from brass and an internal mechanism consists of brass piston and pin.

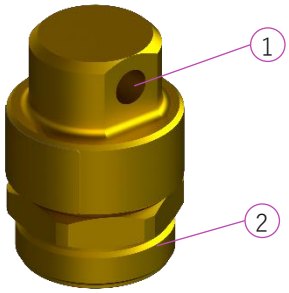
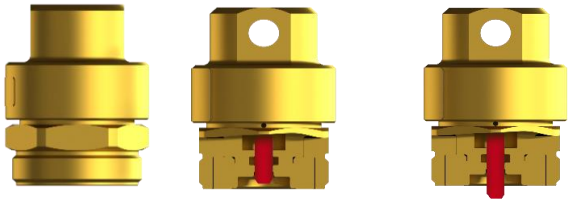


Figure 2.12.: Pneumatic actuator

Table 2.14. Pneumatic Actuator	
No.	**Description**
1	Pilot actuation hose connection
2	Connection to cylinder valve



IMPORTANT NOTICE:

After the pneumatic actuator is activated, the pin will fall downwards. The falling pin must be reset by pushing up as before activation. Otherwise, if the pneumatic actuator assembly to top on valve with falling pin, the system will discharge incorrectly.

Figure 2.13.: Pneumatic actuator activation before vs after

2.2.7. Discharge Hoses and Adaptors

The discharge hose is used to connect the cylinder valve to the manifold so to direct the agent flow to the pipe network. It is installed between the cylinder valve and the check valve. In the case of a modular cylinder, it is installed directly to the discharge pipe.

IMPORTANT NOTICE:

It is recommended to replace the discharge hoses after a maximum period of use of 8 years.
The minimum permissible bending radius must not be undercut.
Minimum bending radius R 100mm.

2.2.7.1. Discharge hose for DN12 valve (P/N: HSN-DH-12-400)

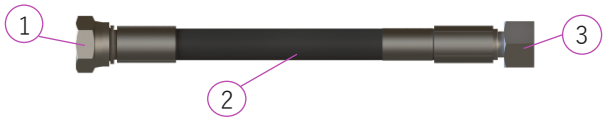


Figure 2.14.: Discharge hose for DN12 valve

Table 2.15. Discharge Hose for DN12 Valve	
No.	**Description**
1	Swivel female W21,8 x 1/14”
2	Flexible hose, DN12, L: 400mm
3	Swivel female G3/4”

Table 2.16. Features of Discharge Hose for DN12 Valve	
Working pressure PS	Max. 360 bar inlet pressure
Inlet thread	W21,8 x 1/14”
Outlet thread	BSP 3/4"
Length	400 mm
Temperature range	-20°C up to +50°C
Material hose	Synthetic rubber
Screwing materials	Coated steel

2.2.7.2. Discharge hose for DN33 valve (P/N: HSN-DH-33-400)

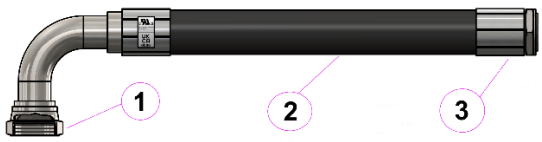


Figure 2.15.: Discharge hose for DN33 valve

Table 2.17. Discharge Hose for DN33 Valve	
No.	**Description**
1	Outlet G 1 1/2" male thread (rigid)
2	Flexible hose, DN38, L: 400mm
3	Inlet 1 7/8" 12UN swivel female

Table 2.18. Features of Discharge Hose for DN33 Valve	
Working pressure PS	Max. 70bar inlet pressure
Inlet thread	1 7/8” – 12UN
Outlet thread	Male thread BSP – G 1 ½”
Length	400 mm
Temperature range	-20°C up to +50°C
Material hose	Synthetic rubber
Screwing materials	Coated steel

2.2.7.3. Discharge hose adaptor for DN33 valve (P/N: HSN-DHA-33-001)

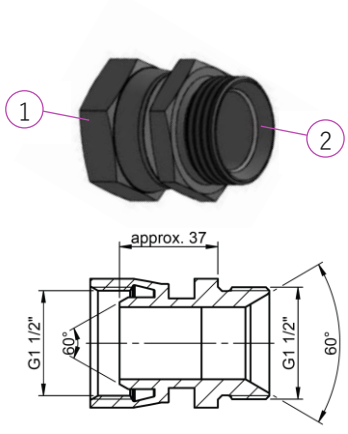


Figure 2.16.: Discharge hose adaptor for DN33 valve

Table 2.19. Hose Adaptor for DN33 Valve	
No.	**Description**
1	Inlet G 1 1/2" swivel female
2	Outlet G1 1/2" male thread (rigid)

2.2.7.4. Discharge line outlet adaptor for DN33 valve (P/N: HSN-OA-33-FF)

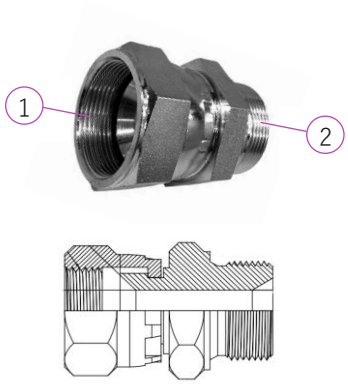


Table 2.20. Outlet Adaptor for DN33 Valve	
No.	**Description**
1	Inlet 1 7/8" 12UN swivel female
2	Outlet G1 1/2" male thread (rigid)

Figure 2.17.: Discharge line outlet adaptor for DN33 valve

2.2.7.5. Discharge hose for DN50 valve (P/N: HSN-DH-50-400)

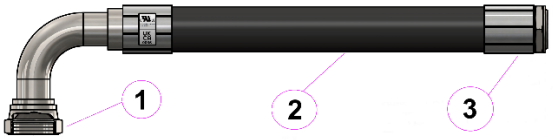


Table 2.21. Discharge Hose for DN50 Valve	
No.	**Description**
1	Outlet G 2" male thread (rigid)
2	Flexible hose, DN50, L: 400mm
3	Inlet 21/2" 12UN swivel female

Figure 2.18.: Discharge hose for DN50 valve

Table 2.22. Features of Discharge Hose for DN50 Valve	
Working pressure PS	Max. 70bar inlet pressure
Inlet thread	2,5" – 12UN
Outlet thread	Male thread BSP – G2 "
Length	400 mm
Temperature range	-20°C up to +50°C
Material hose	Synthetic rubber
Screwing materials	Coated steel

2.2.7.6. Discharge hose adaptor for DN50 valve (P/N: HSN-DHA-50-001)

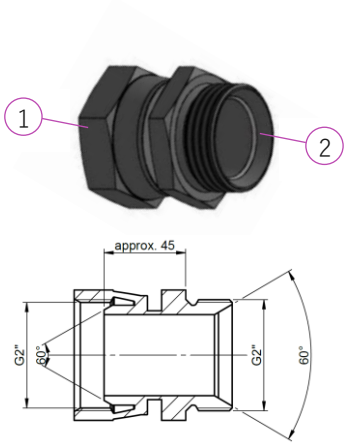


Table 2.23. Hose Adaptor for DN50 Valve	
No.	**Description**
1	Inlet G 2" swivel female
2	Outlet G2" male thread (rigid)

Figure 2.19.: Discharge hose adaptor for DN50 valve

2.2.7.7. Discharge line outlet adaptor for DN50 valve (P/N: HSN-OA-50-FF)

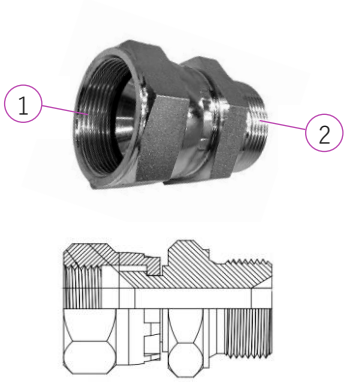


Table 2.24. Outlet Adaptor for DN50 Valve	
No.	**Description**
1	Inlet 21/2" 12UN swivel female
2	Outlet G2" male thread (rigid)

Figure 2.20.: Discharge line outlet adaptor for DN50 valve

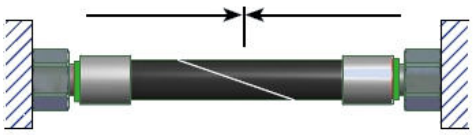
IMPORTANT NOTICE:

When using discharge hoses, discharge hose adaptors HSN-DHA-33-001 and HSN-DHA-50-001 must be used to ensure the possibility of orientation of the hose while connecting to check valves. This is requirement for only multiple cylinder arrangements which are including check valves. This is not necessary for single cylinder arrangements.

Example of installation for Discharge Hoses

Inccorrect application

Pressure and torsion load



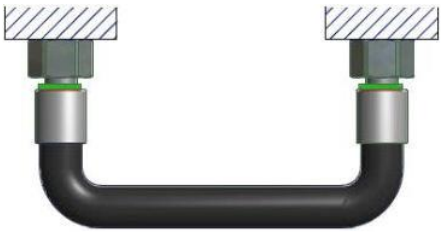
Correct application

Tensile stress



Inccorrect application

Bent installation



Correct application

Bent installation



Figure 2.21.: Discharge line hose example of installation

2.2.8. Pilot Line Hose (P/N: HSN-PLH-01-500)

The Pilot Line Hose is a flexible connection in the release circuit to activate the valves pneumatically. It is installed between the pilot line connection from the Master cylinder valve to the pneumatic actuators and/or pneumatic-manual actuator on the slave cylinders.



Figure 2.22.: Pilot line hose

Table 2.25. Pilot Line Hose	
No.	**Description**
1	Swivel female M12x1.5
2	Flexible hose, DN5, L: 500mm
3	Swivel female M12x1.5

IMPORTANT NOTICE:

It is recommended to replace the pilot lines after a maximum period of use of 8 years.

The minimum permissible bending radius must not be undercut.

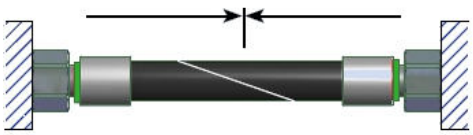
Minimum bending radius R 30mm.

Table 2.26. Features of Pilot Hose	
Nominal width	DN5
Connection type	Connection type
Temperature range TS	-20°C to +50°C
Working pressure PS	Max. 360 bar inlet pressure
Materials	Polyurethan, polyester, plastic, steel galvanized or zinc-nickel coated Type: SAE100 R1 TP1 Pressure absorber: Braiding of brass-coated, high strength steel wires Inner liner: Seamless extruded polyester-tube (PEL) Outer liner: Polyurethane, black
Mounting torque at the outlet thread	The reference value for the mounting torque is max. 8Nm The correct torque can differ from the reference value and is subjected to the responsibility of the operator.

Example of installation for Pilot Hose

Inccorrect application

Pressure and torsion load



Correct application

Tensile stress



Inccorrect application

Bent installation



Correct application

Bent installation



Figure 2.23.: Pilot line hose example of installation

2.2.9. Pilot Line Nipple Adaptor (P/N: HSN-PNA-01)

The Pilot Line Nipple Adaptor is a flexible connection in the release circuit to activate the valves pneumatically. It is installed between the pilot line connection from the Master cylinder valve to the pneumatic actuators and/or pneumatic-manual actuator on the slave cylinders. The Pilot Line Nipple Adaptor available working pressure is 360bar.

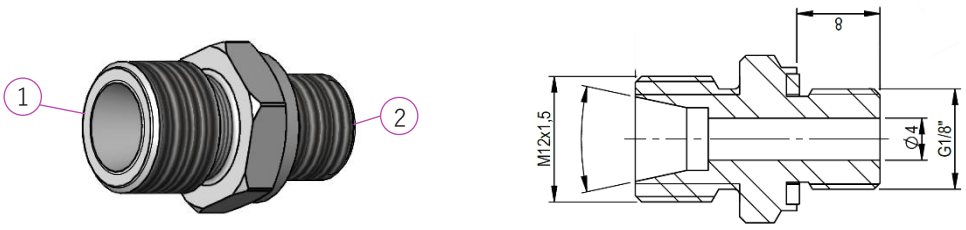


Figure 2.24.: Pilot line nipple adaptor

Table 2.27. Pilot Line Nipple Adaptor	
No.	**Description**
1	M12 x 1.5 male threaded connection (connect to pilot hose)
2	G1/8" male threaded connection (connect to release device)

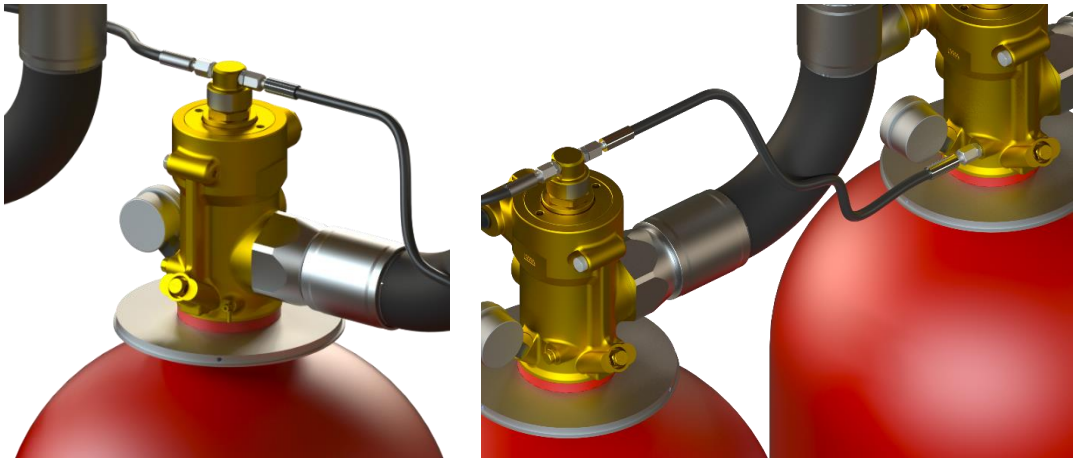


Figure 2.25.: Pilot line nipple adaptor connection

2.2.10. Bleed Valve (P/N: HSN-BLD-01)

The Bleed Valve vents pressure or releases small leaking gas from pilot line to protect the system from fault actuation when one or more cylinder leak gas into the pilot actuation line.

Pw max 360bar and Reseating Volume Flow ~30l/min.

Reseating Pressure 0,5bar (Static) / ~ 0,7bar (Dynamic)



Figure 2.26.: Bleed Valve

Table 2.28. Bleed Valve	
No.	**Description**
1	G1/8" male threaded connection

The bleed valve is a venting valve, which is in the "open" position in the unpressurized state and allows creeping gas to escape into the atmosphere. If the fire extinguishing system is switched off, the bleed valve will close to the atmosphere. If the control line is deaerated and thus pressure less, the bleed valve opens independently.

It is visually visible whether the bleed valve is open or closed. If the bleed valve is closed, the pin is visible in the recess.

IMPORTANT NOTICE:

When assembling the bleed valve into the control circuit of a fire extinguishing system, it is important to ensure that the recess is free, that means the bleed valve is open. Otherwise, the pressure in case of any leaks occurring at the bottle valve of the pilot bottle cannot be adequately dissipated and the function of the bleed valve is thus not present.

If the bleed valve is open, the recess is free. (See Figure 2.22.: Position of Bleed Valve)

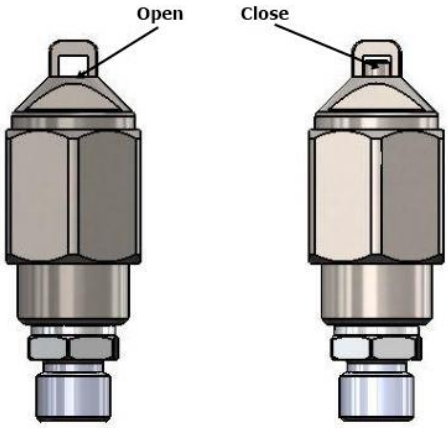
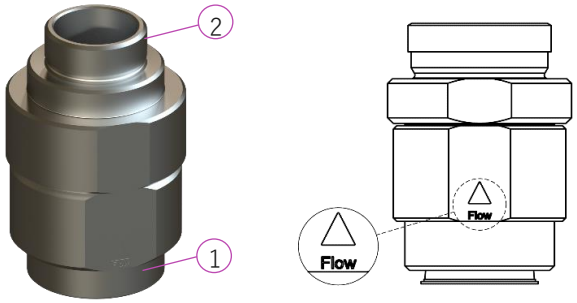


Figure 2.27.: Position of Bleed Valve

2.2.11. Check Valves

Check Valves are installed at the discharge manifold in a multiple cylinder arrangement to allow removal of any FK-5-1-12 cylinder from the manifold while still retaining a closed system. Check valves are used only in banks of cylinders. It prevents the gas backflowing from the manifold pipe into the cylinders, thus ensuring a complete discharge of all the cylinders. It also acts as a safety element during maintenance operations, in case cylinders are disconnected from the manifold and an accidental discharge is produced it prevents the gas from being released and injuring personnel.



IMPORTANT NOTICE:

Make sure that check valve flow direction is showing right position. To be sure about that, follow the flow direction arrow; it must be assembled while arrow showed the flow direction from downward to upward.

Figure 2.28.: Check valves

Table 2.29. Check Valves			
Description	**Part Number**	**1**	**2**
DN33 Check Valve	HSN-CHV-033	G11/2" BSP Female Inlet	G2" BSP Male Outlet
DN50 Check Valve	HSN-CHV-050	G2" BSP Female Inlet	G2" BSP Male Outlet

2.2.12. Discharge Pressure Switch (P/N: HSN-DPS-01)

Discharge Pressure Switch closes or opens an electric circuit when a discharge from the manifold takes place. Notifying gas flow has occurred. The electric signal may be monitored by a control panel to operate and/or shut down other electrical devices. Once activated it is rearmed manually by pulling the rearming button which incorporates the latching mechanism. This switch can be mounted in any position though the preferred installation is upright. Wiring diagram for connection of switch is shown in below figure.

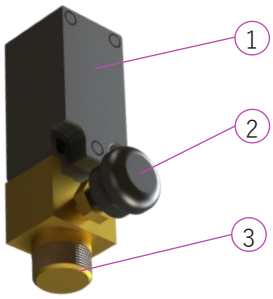


Table 2.30. Discharge Pressure Switch	
No.	**Description**
1	Electrical switch body
2	Reset button
3	Connection to manifold, G1/2" male thread

Figure 2.29.: Discharge pressure switch

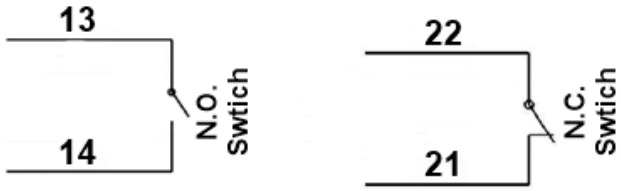


Figure 2.30.: Wiring diagram for discharge pressure switch

Table 2.31. Electrical Data of Discharge Pressure Switch	
Max voltage	400V AC/DC
Temperature range	-20 ºC to +60 ºC
Thermal current	10 A
Conditional short circuit current	100 A acc. to EN 60947-5-1
Protection against short circuits	Type aM fuse 10 A 500 V
Protection degree	IP 67 acc. to EN 60529 (With cable gland presenting same or higher protection degree)

IMPORTANT NOTICE:

While installation of the Discharge Pressure Switch, gas leakage must be prevented from the connection point. Discharge Pressure Switch maximum working pressure is 360 bar. Discharge Pressure Switch body material are brass, nickel-plated steel, elastomeric seals and plastic.

2.2.13. Monitoring device for DN33&DN50 valves (P/N: HSN-MDS-01)

The monitoring device is an optional accessory product for use with DN33 & DN50 cylinder valves. It can be mounted to the cylinder valve prior to the attachment of the release device. The integrated switch includes a plunger which sticks out over the connection port for the electrical release device. When attaching a release device to the container valve, the front face of the release device's threaded locking ring presses this plunger and thus engages the switch (refer to Figure 2.30.)

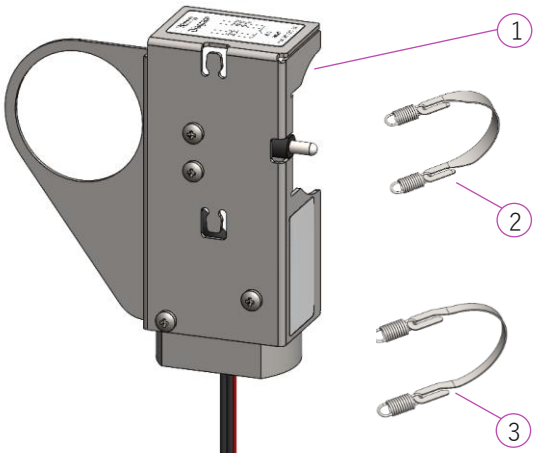


Table 2.32. Monitoring Device	
No.	**Description**
1	Monitoring device
2	Mounting clamp for use with DN33 valve
3	Mounting clamp for use with DN50 valve

Figure 2.31.: Monitoring device for solenoid actuator

Monitoring device should be connected with discharge valve according to below instructions step by step.

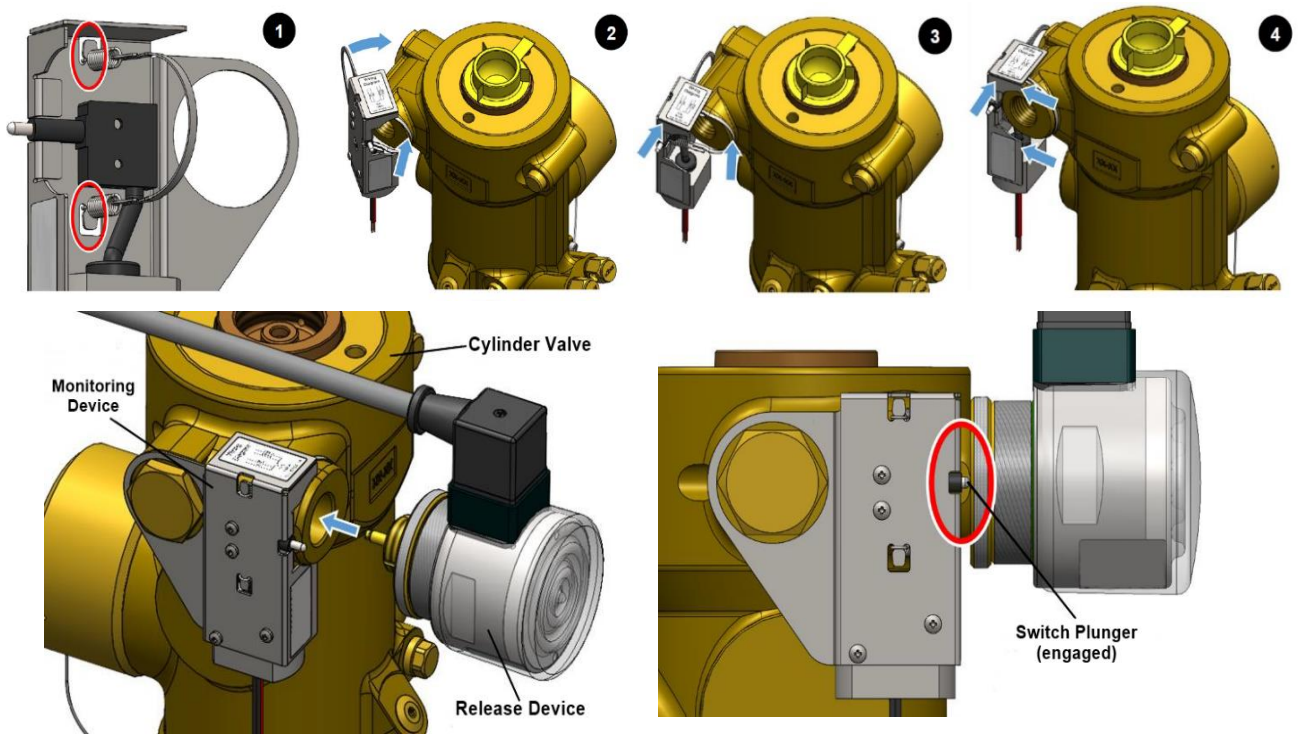


Figure 2.32.: Monitoring device assembly instructions



Figure 2.33.: Wiring diagram for monitoring device

Table 2.33. Electrical Data of Monitoring Device	
Voltage	24 VDC (+/-10%)
Max. current at union and RT	3A
Temperature range	-20 ºC to +50 ºC
Conduit hub	1/2" NPT female thread
Switch	Normally open configuration
Sealing	IP67
Wiring	4 x AGW 22 (dual leads), Length: approx. 950mm
Materials	Housing parts: Stainless steel Switch housing and strain relief bushing: plastic

IMPORTANT NOTICE:

The connection for the supervisory circuit has 4 wires: 2 yellow and 2 gray. The 2 yellow wires are for connection to the supervisory circuit. The 2 gray wires are for connection to additional supervisory devices or the EOLR for the supervisory zone.

2.2.14. Pressure Gauges

A pressure gauge is provided with each cylinder valve to indicate the pressure inside the cylinder. Its electrical contact allows real time monitoring notifying in case of leaks.

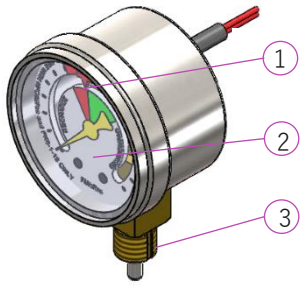


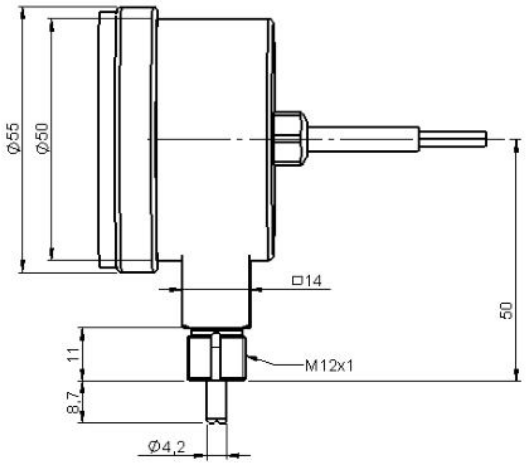
Figure 2.34.: Pressure gauge

Table 2.34. Pressure Gauges	
No.	**Description**
1	Contacted point indicator
2	Gauge display screen
3	Connection to cylinder valve

IMPORTANT NOTICE:

- Use only pressure gauges supplied by Honeywell.
- The pressure gauges can be assembled and disassembled under pressure.
- Before mounting the pressure gauge, the plug screw at the pressure gauge connection on the valve shall be unscrewed. When dismounting the pressure gauge the plug screw shall be screwed back in place.

Table 2.35. Available Types of Pressure Gauges		
Description	**Part Number**	**Contacted Switch**
0-80 Bar Pressure gauge with low pressure switch *Available for 42bar storage system	HSN-PGV-NOC-3880	Gives NO contact at 38bar
0-80 Bar Pressure gauge with low pressure switch *Available for 42bar storage system	HSN-PGV-NCC-3880	Gives NC contact at 38bar



IMPORTANT NOTICE:

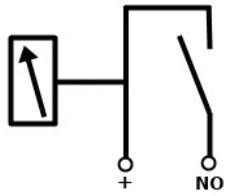
- Switch point tolerances: 2,5% (full scale value)
- Accuracy class: 1,6
- Nominal size: 50mm
- Operating temperature range: -20°C to +55°C

Figure 2.35.: Dimensions of pressure gauge

Table 2.36. Features of Pressure Gauges	
Connection	M12x1 thread, brass, radial
Case	Stainless steel
Pressure element	Copper alloy
Movement	Copper alloy
Dial	Aluminum white
Pointer	Yellow plastic
Window	Polycarbonate

The contact type shown on the pressure gauge have to be regarded;

status of switch at minimum scale value:

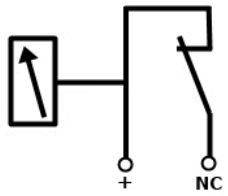


Pressure below switching point = contact is **open**

Pressure above switching point = contact is **closed**

Normally Opened

status of switch at minimum scale value:



Pressure below switching point = contact is **closed**

Pressure above switching point = contact is **open**

Normally Closed

Figure 2.36.: Wiring diagram for pressure gauge

Table 2.37. Electrical Data of Pressure Gauges	
Switching voltage	4.5 ... 24 V DC/AC
Switching current	5 ... 100 mA
Contact load	max. 2.4 W
Permissible temperature	-20 ºC to +60 ºC
Cable	2-core (red/black) 1m length; PVC coated
Ingress protection	Indoor, dry environment

IMPORTANT NOTICE:

- Pressure gauges must be included to the potential equalization of the whole plant
- Pressure gauges must be protected against strong electromagnetic fields

2.2.15. Discharge Nozzles

Discharge nozzles are used to uniformly distribute the FK-5-1-12 clean agent. They are performance tested to ensure that the agent is discharged within 6-10 seconds and properly dispersed throughout the protected area.

FK-5-1-12 clean agent is distributed within the protected area by the discharge nozzle which is sized to ensure the correct flow of agent for the risk. Nozzles are available with 180° and 360° discharge patterns. The 180° nozzle is engineered to provide 180° discharge pattern for sidewall applications. The 360° nozzle offers a full 360° discharge pattern for installations where nozzles are located in the center of the hazard. Nozzles are supplied as standard in brass with BSPT female thread. The agent flow is controlled by a calibrated diaphragm disc inside the nozzle body, determined by the results from The Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software. It guarantees a homogenous gas distribution throughout the volume.

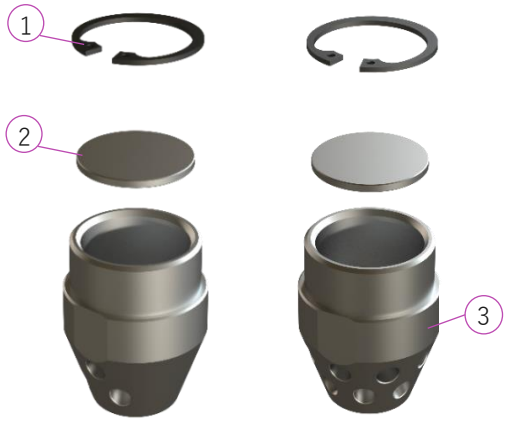


Figure 2.37.: Discharge nozzles 180 degree & 360 degree

Table 2.38. Discharge Nozzle Parts

No.	Description
1	Circlip for Diaphragm Disc Assembly
2	Diaphragm Disc
3	180/360 Degree Nozzle

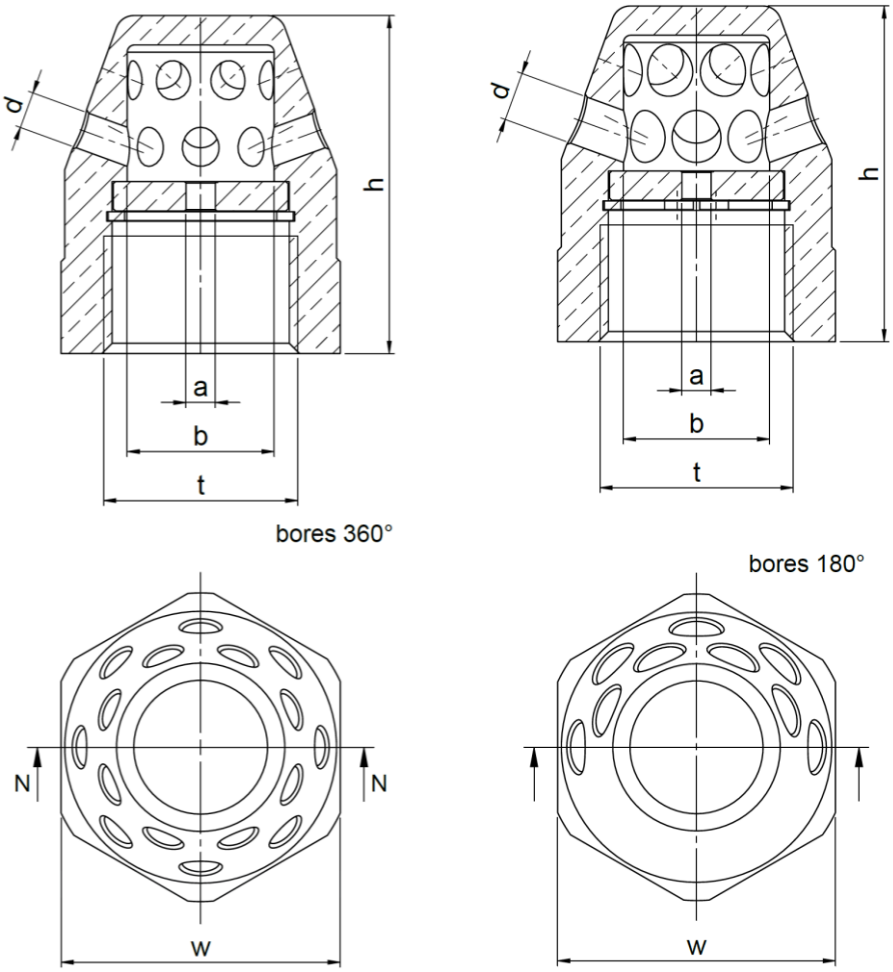


Figure 2.38.: Discharge nozzles dimensions for 180 & 360 degree

Table 2.39. Discharge Nozzles

Part Number	Nozzle Size		Type	Orifice Diameters (a)		Nozzle Orifice Area to Pipe Area Ratio (%)		Dimensions	
	mm (b)	in. (t)		Min. ø (mm)	Max. ø (mm)	Min.	Max.	h (mm)	W (mm)
HSN-NOZ-01-15	15	1/2"	180°	5.5	10.5	12	45	36	30
HSN-NOZ-01-20	20	3/4"		9.5	14.0			46	38
HSN-NOZ-01-25	25	1"		12.0	17.5			55	45
HSN-NOZ-01-32	32	1 1/4"		15.5	23.5			64	50
HSN-NOZ-01-40	40	1 1/2"		18.5	27.5			77	60
HSN-NOZ-01-50	50	2"		23.5	35.0			94	80
HSN-NOZ-02-15	15	1/2"	360°	5.5	10.5			36	30
HSN-NOZ-02-20	20	3/4"		9.5	14.0			46	38
HSN-NOZ-02-25	25	1"		12.0	17.5			55	45
HSN-NOZ-02-32	32	1 1/4"		15.5	23.5			64	50
HSN-NOZ-02-40	40	1 1/2"		18.5	27.5			77	60
HSN-NOZ-02-50	50	2"		23.5	35.0			94	80

The required orifice diameter must be determined by Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software and drilled out to the calculated orifice size.

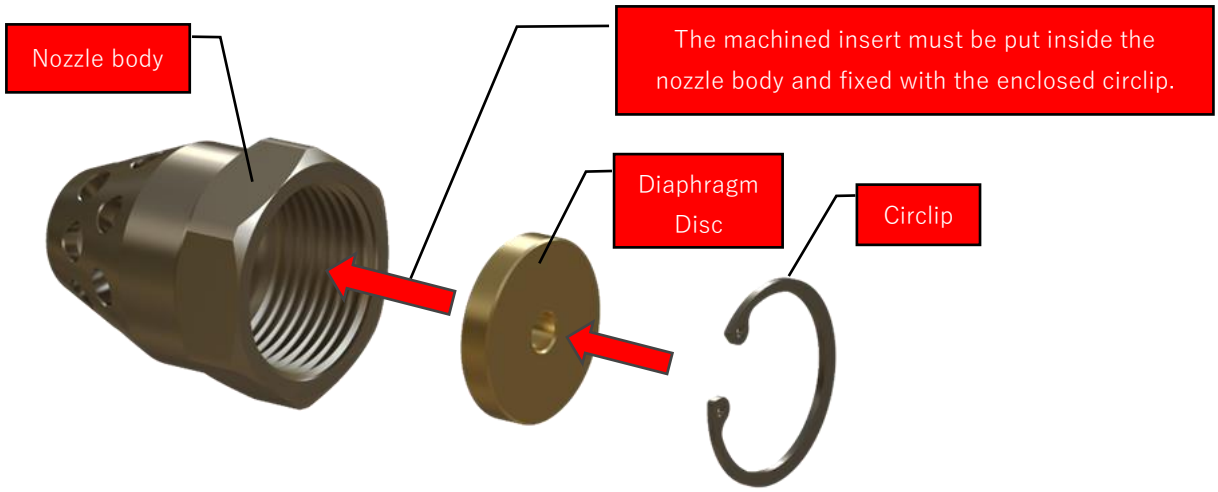


Figure 2.39.: Parts of the nozzle

The Diaphragm Disc must be drilled out to the required cross-section (as described above). Afterwards the drilling must be deburred (consider the specifications below).



Figure 2.40.: Nozzle drilling details

Nozzles are consisting below materials;

Nozzle body: Nickel-plated brass

Diaphragm disc: Brass

Circlip: Stainless steel

2.2.16. Label (P/N: HSN-LBL-F1)

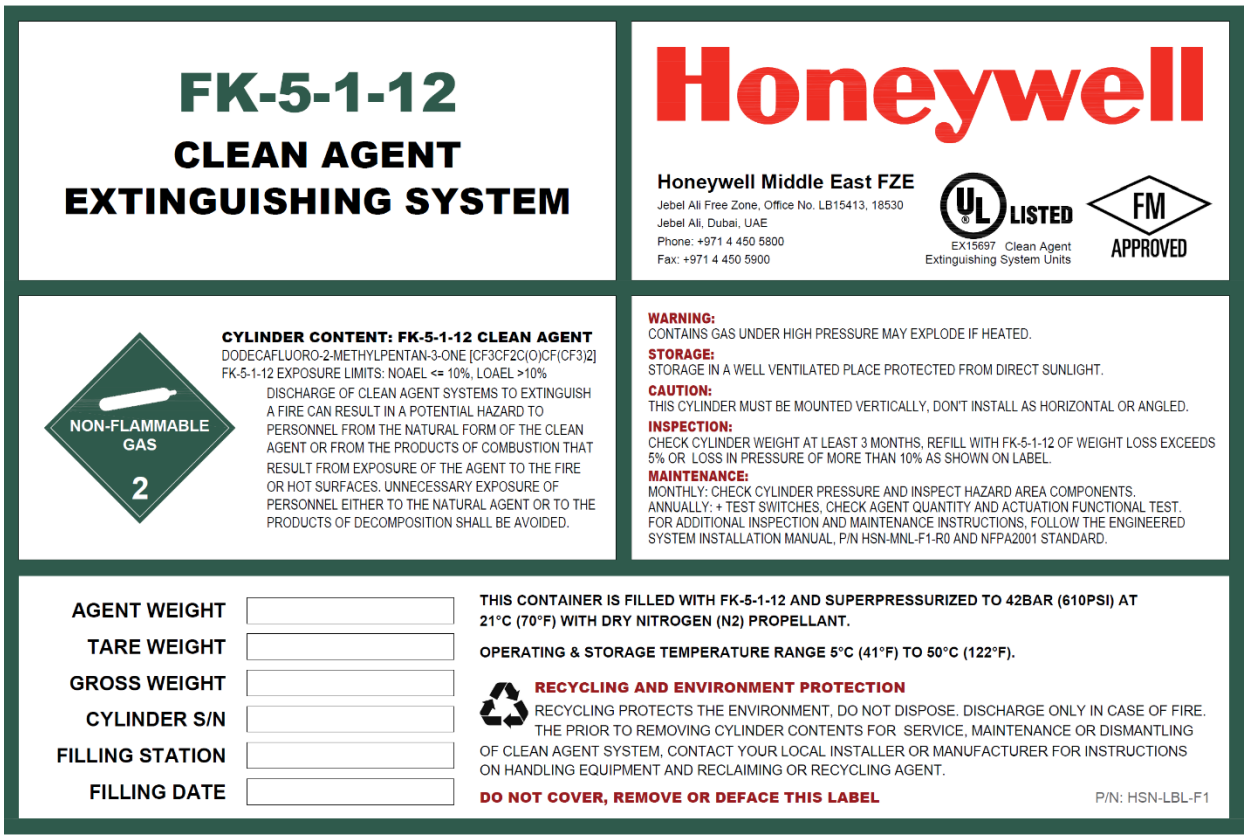


Figure 2.41.: Label for FK-5-1-12

2.2.17. Caution Signs

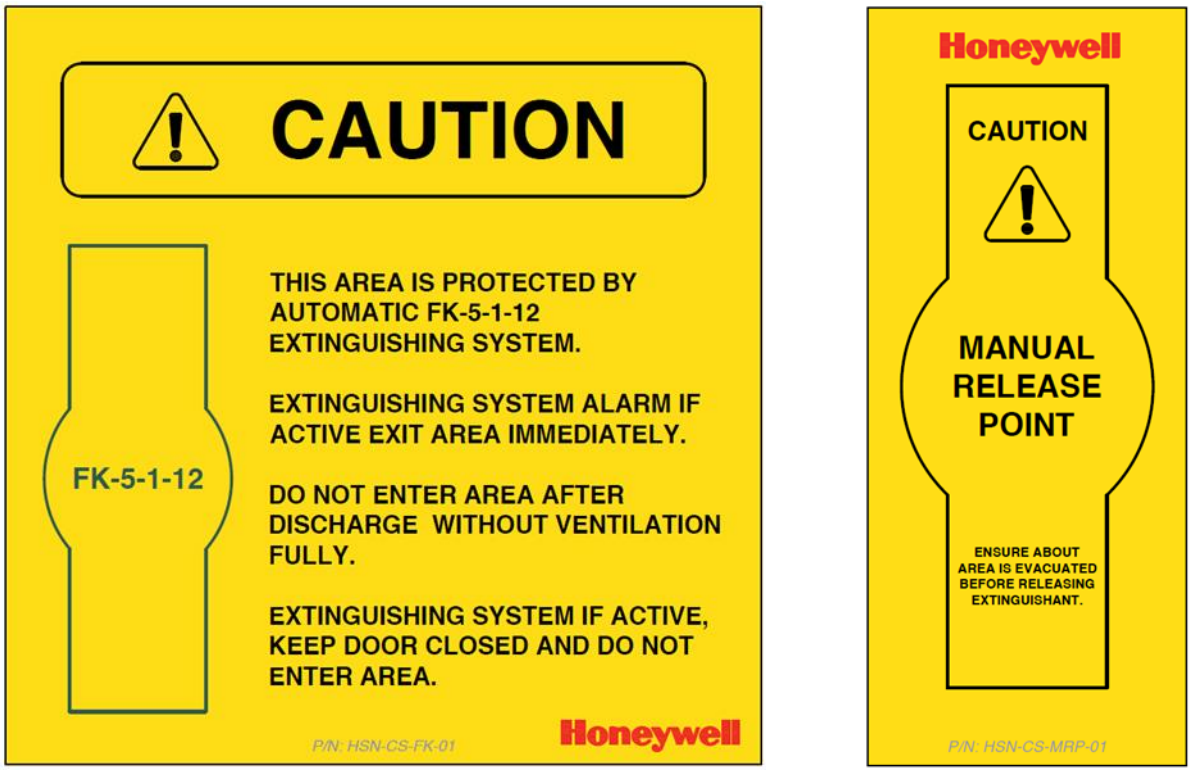


Figure 2.42.: Caution Signs

Table 2.40 Caution Signs	
Description	**Part Number**
FK-5-1-12 Protected Room Caution Sign	HSN-CS-FK-01
Manual Release Point Caution Sign	HSN-CS-MRP-01

2.2.18. Filling Adaptor Set

Filling adapters are specially manufactured equipment according to the dimensions and features of the valves to be filled. These products must be used during the initial filling or refilling. Filling adapters with different features for different valves are listed as follows. Each filling adaptor set has 60bar maximum working pressure.

IMPORTANT NOTICE:

Filling adapters are equipment that includes special connections according to the valve types they will be used on and are factory hydrostatically tested after production. Alternative filling adapters not supplied by Honeywell should never be used; this may cause serious damage to the products or the filling personnel!

2.2.18.1. Filling adaptor set for DN12 valve (P/N: HSN-FLA-12-01)

Adapters will be used to fill the valves located on the cylinders with capacity of 13.4L.

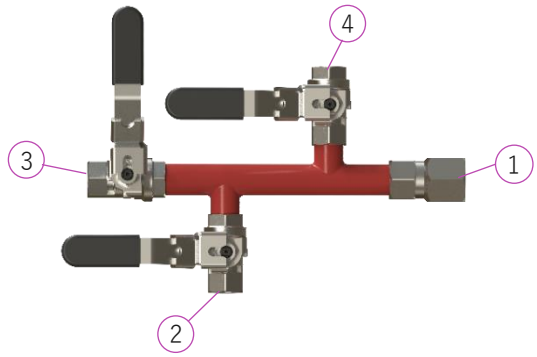


Figure 2.43.: Filling adaptor set for DN12 valve

Table 2.41. Filling Adaptor Set for DN12 Valve	
No.	**Description**
1	Connection to cylinder filling line
2	Connection to nitrogen source
3	Connection to clean agent source
4	Venting to the atmosphere

2.2.18.2. Filling adaptor set for DN33 valve (P/N: HSN-FLA-33-01)

Adapters will be used to fill the valves located on the cylinders with capacities of 26.8L, 40L, 67.5L, 80L and 120L.

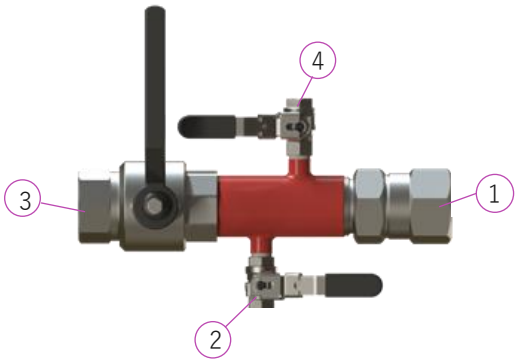


Figure 2.44.: Filling adaptor set for DN33 valve

Table 2.42. Filling Adaptor Set for DN33 Valve	
No.	**Description**
1	Connection to cylinder filling line
2	Connection to nitrogen source
3	Connection to clean agent source
4	Venting to the atmosphere

2.2.18.3. Filling adaptor set for DN50 valve (P/N: HSN-FLA-50-01)

Adapters will be used to fill the valves located on the cylinders with capacities of 180L.

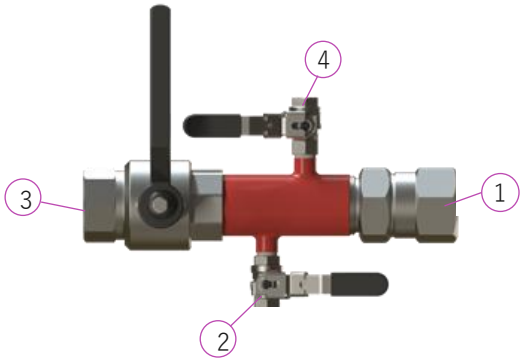


Figure 2.45.: Filling adaptor set for DN50 valve

Table 2.43. Filling Adaptor Set for DN33 Valve	
No.	**Description**
1	Connection to cylinder filling line
2	Connection to nitrogen source
3	Connection to clean agent source
4	Venting to the atmosphere

3. System Design

3.1. Introduction

There are two main elements of system design. The first is risk assessment, determining the type of protection required, considerations such as ventilation, openings and restrictions, equipment location etc. The second is calculating the quantity of FK-5-1-12 clean agent required, including floor and / or ceiling voids, positioning of nozzles, electrical requirements, etc.

The system design is based on the requirements of NFPA2001, ISO14520 and EN15004-1 & EN15004-2 (current editions).

3.1.1. Hazard Analysis

The following steps must be taken to design FK-5-1-12 clean agent system.

1. Perform a hazard analysis of protected areas.
2. Determine the class of fire hazards.
3. Determine the minimum and maximum ambient temperature for the hazard.
4. Calculate FK-5-1-12 agent quantity to provide required design concentration at minimum expected ambient temperature in protected area. Calculate the quantity of FK-5-1-12 clean agent required to provide the proper design concentration at the minimum expected hazard temperature.

All system design calculations are calculated at minimum design concentration to determine FK-5-1-12 agent quantity. Agent quantity shall be adjusted if the system is installed at altitudes > 1000m. If hazard altitude is not listed in the table, find the altitude next lower than the hazard altitude and determine the correction factor. See the altitude correction factor.

Table 3.1. Altitude Correction Factors – NFPA2001

Altitude (m)	Sea Level	300	610	910	1220	1520	1830	2130	2450	2740	3050
Correction Factor	1.000	0.960	0.930	0.890	0.860	0.820	0.780	0750	0.720	0.690	0.660

Table 3.2. Altitude Correction Factors - ISO 14520 / EN 15004

Altitude (m)	Sea Level	1000	1500	2000	2500	3000	3500	4000	4500	-	-
Correction Factor	1.000	0.885	0.830	0.785	0.735	0.690	0.650	0.610	0.565		

Maximum design concentration should be at the maximum anticipated enclosure temperature, for comparison see NOAEL / LOAEL values. (Refer to Table 1.1.)

FK-5-1-12 clean agent fire extinguishing system is suitable for use with the following materials.

Class A: Surface Type Fires: Fires involving solid materials usually of an organic nature, in which combustion normally takes place with the formation of glowing embers.

Class B: Fires involving flammable liquids or liquefiable solids and flammable gases.

Class C: Fires involving energized electrical equipment where the electrical no conductivity of the extinguishing media is of importance.

Table 3.3. Design Concentrations - NFPA2001		
Class	**Minimum Design Concentrations**	
	UL	**FM**
Class A	4.5	4.5
Class B* (n-Heptane)	5.9	5.9
Class C	4.5	4.5
*: For other Class B fuels, contact with Honeywell Technical Team		
Reference: NFPA2001 Table A.5.4.2.1		

Table 3.4. Design Concentrations – ISO 14520 / EN 15004	
Class	**Minimum design** % by volume
Class B Heptane (cup burner) Heptane (room test)	5.9
Surface Class A Wood crib PMMA PP ABS	5.3
Higher Hazard Class A	5.6
a: The minimum design concentration for Higher Hazard Class A fuels shall be the higher of Surface Class A or 95 % of the Class B minimum design concentration	
Reference: EN15004-2, Table 4 — FK-5-1-12 reference extinguishing and design concentrations	

3.1.2. Determine Which Components Are Required

Cylinder volume, quantity and fill requirements. Refer to Table 2.2

Cylinder framing, mounting brackets, etc.

Detection and control equipment required.

Other system requirements, such as reserve supply, pressure switches, etc.

3.1.3. Positioning of Nozzles

Locate nozzles based on the following:

• Ceiling height [Maximum Height 4.4m (14.31ft), Minimum Height 0.3m (0.98ft)]

• Nozzle area coverage [10.1m (33.14ft) x 10.1m (33.14ft)]

• Special hazard area layout considerations

3.1.4. Positioning of Cylinders

• Locate cylinders based on the following: Number of cylinders required.

• Storage temperature/environmental considerations, such as weather, area classification and corrosive environment.

• Floor loading.

3.1.5. Positioning of Piping

• Nozzle location.

• Structural members for bracing the pipe.

3.1.6. Pipe Size and Layout

• Draw piping isometric.

• Dimensions of all pipe sections.

• Locate all fittings.

• Note all elevation changes. The preceding information will be entered into the computer program.

3.1.7. Manifolds

It may be necessary to manifold agent cylinders to provide the required amount of agent for a hazard, or to make available the proper increments of agent weight for the protection of multiple hazards. Whenever cylinders are manifolded, the following rules must be observed.

1. All cylinders connected to the same manifold or pipe must be the same size and filled with the same agent weight, pressure and filling density.

2. Agent cylinders must be in a single row and spaced according to section.

3. A connected reserve may be employed in some circumstances providing a secondary supply of agent.

4. Flexible discharge hoses and check valves must be used at each inlet.



Figure 3.1.: General arrangements of manifold

IMPORTANT NOTICE:

Class 150 and cast-iron fittings must not be used. Manifold available working pressure must be at least 100 bar (1450 psi). Manifolds must be tested at 1.5 times of available working pressure. Check Valves are required for each cylinder being connected to a manifold.

Table 3.5. Technical Information for Manifolds	
Material	ASTM A53 or ASTM A106 Grade B
Maximum working pressure	100bar (or higher)
Test pressure	150bar (or higher)
Inlet-Outlet Size	50, 65, 80, 100 and 150mm
Surface	Black smooth or equivalent surface ready to paint

Cylinders are assembled together on manifold for three main reasons;

• To reduce the amount of piping required by connection to one feeder pipe.

• For systems that require main and reserve system configuration.

• Combining the correct cylinders to obtain the required quantity of agent within a specific hazard area.

1. Fix the back channels of the mounting brackets to the wall at the appropriate heights using suitable anchor type bolts.

2. Position the cylinders against the back channels with the valve outlets pointing left at the required spacing for the manifold ports.

3. Insert the cylinders straps at top and bottom and secure with the nut bolts.

4. Remove the safety cap from one cylinder outlet port and connect the flexible discharge hose to the cylinder outlet port.

5. Remove the protection caps from the cylinder actuation ports.

The manifolds that may be recommended for Honeywell FK-5-1-12 gas extinguishing system are listed in the table below. The design of the manifolds should be made in accordance with the limitations specified.

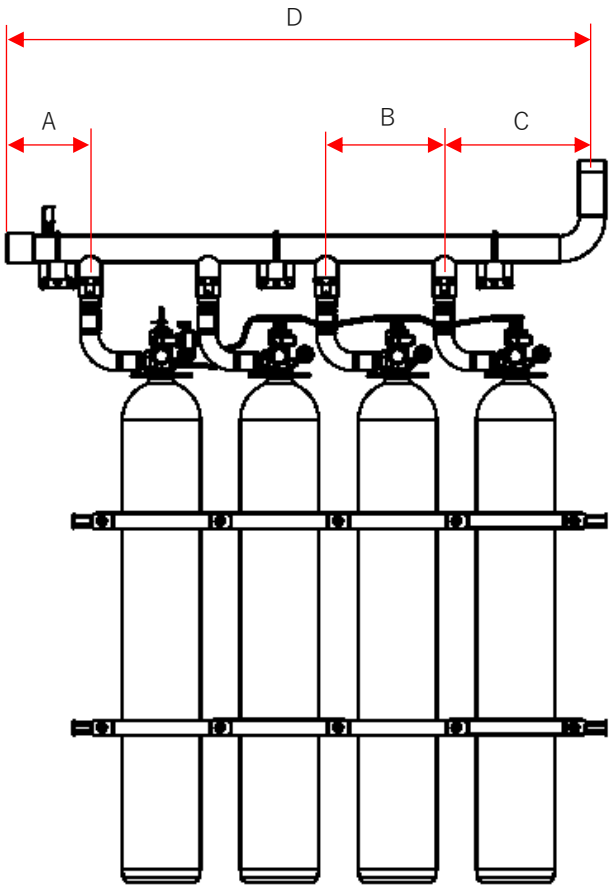


Figure 3.2.: Manifold details

Table 3.6. Recommended Manifold Configurations

Number of Inlets (pcs)	Inlet to End Cap Distance (A)	Inlet to Inlet Distance (B)	Last Inlet to End Distance (C)	Overall Length (D)
2	250mm	500 mm	300-400mm	1050-1100mm
3	250mm	500 mm	300-400mm	1550-1600mm
4	250mm	500 mm	300-400mm	2050-2100mm
5	250mm	500 mm	300-400mm	2550-2600mm
6	250mm	500 mm	300-400mm	3050-3100mm
7	250mm	500 mm	300-400mm	3550-3600mm
8	250mm	500 mm	300-400mm	4050-4100mm
9	250mm	500 mm	300-400mm	4550-4600mm

3.1.8. Mounting Bracket

The brackets are used to secure cylinders to a wall or other suitable mounting surface. The cylinders shall be mounted only on the floor.

IMPORTANT NOTICE:

The Bolts and nuts are not part of the cylinder mounting assembly. Honeywell will not be supplying these parts to customers. The bolts or fixing components must be corrosion resistant stainless steel 316.



Figure 3.3.: Bracket

Table 3.7. Brackets and cylinder sizes

Part Number	Cylinder Size (L)	Length (A) (mm)	Width (B) (mm)
HSN-BRC-140	8	350	150
	13.4		
HSN-BRC-219	26.8	400	230
	40	600	
HSN-BRC-267	67.5		280
	80		
HSN-BRC-356	120		370
HSN-BRC-406	180		420

** All diameters have tolerance +/- 5% according to manufacturers.*

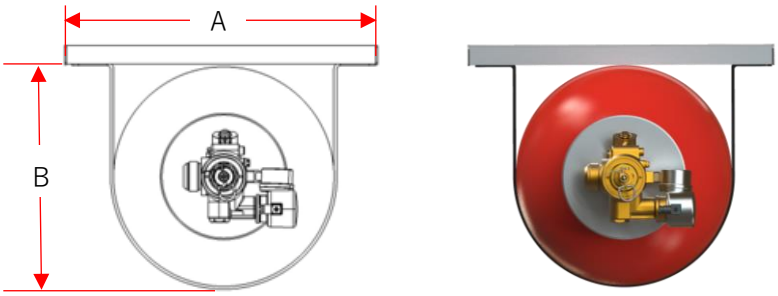


Figure 3.4.: Dimension of the bracket

3.1.9. Nitrogen Super-Pressurization

Nitrogen is added to the FK-5-1-12 clean agent cylinders. This addition of nitrogen, known as super-pressurization, will cause a portion of the nitrogen to mix with the FK-5-1-12, the remaining portion of the nitrogen will remain in the vapor space above the liquid providing the increased propulsion necessary to discharge the FK-5-1-12 clean agent from the cylinder.

3.1.10. Flow in Pipe

In a properly designed distribution piping network, the flow of FK-5-1-12 clean agent will consist of a two-phase mixture of liquid and vapor. The properties of this mixture will vary with its composition; therefore, when the mixture contacts the pipeline walls, the friction decreases the density of the mixture resulting in a non-linear pressure drop and an increase in flow velocity. Another consequence of two- phase flow is the potential for separation of liquid and vapor. In a properly designed pipe network, the velocity of the mixture will be high enough to maintain highly turbulent flow. However, if the pipeline diameter is too large for the design flow rate, the two phases may separate, leading to alternate discharges of liquid and vapor (slugging) or layering of the two phases. Therefore, the pipeline must be properly sized to keep the FK-5-1-12 clean agent flows turbulent enough to prevent phase separation.

3.1.11. Design Criteria

The complexity of two-phase flow formulas does not allow for any simple method of manual calculation. For this reason, the flow calculations and design criteria described in this manual have been programmed into computer software. To determine the proper procedures for applying the input parameters to the FK-5-1-12 clean agent computer software. There are several limitations to these input parameters which must be observed if accurate results are to be obtained. Most of these limitations are in the program. However, there are certain restrictions that must be addressed by the system designer before applying the input data.

3.1.12. Design Example and Calculations

Minimum agent quantity is based on the hazard volume at the minimum anticipated temperature and concentration required. To determine the minimum agent quantity the following equation is used: $\mathbf{W = (V/S) \times [C/(100-C)] \times C_{Alt}}$

W = Weight of Agent required (kg)

V = Hazard Volume (m^3)

S = Specific Vapor Volume (m^3/kg)

S = 0,0664 + 0,000274t

t = Design Temperature in Hazard Area (ºC)

C = Required FK-5-1-12 concentration. (% by volume)

Calculation for two rooms and floor void with the following dimensions:
Switch Room: 7,0m x 7,0m x 3,5m = 171.5m^3
Computer Room: 16,0m x 12,0m x 3,0m = 576,0m^3
Floor Void: 16,0m x 12,0m x 0,35m = 67,2m^3
T = 21ºC (70ºF) for calculation example, where S = 0,072154 (m^3/kg)
The altitude correction factor of sea level is 1.00. (see Table 3.1 or Table 3.2)

Switch Room: (4,5 % required design concentration example only)
W: (171,5 / 0,072154) x [4,5 / (100-4,5)] = 112 kg

Computer Room: (4.5 % required design concentration example only)
W: (576,0 / 0,072154) x [4,5 / (100-4,5)] = 376,2 kg

Floor Void: (4.5 % required design concentration example only)
W: (67,2 / 0,072154) x [4,5 / (100-4,5)] = 43,9 kg

It is determined from the above that both the Switch Room and the Computer Room can be fed by one manifolded system using 5 x 120L cylinders, each filled with 97,7 kg of agent. The Floor Void would use 1 x 67,5L cylinder filled with 43,9 kg. (From Table 2.2.)

Example using the flooding factors:
Minimum Design Temperature = 21ºC (70ºF)
Minimum Design Concentration = 4,5 %
Flooding Factor=0,6534 kg/L (refer to Table 3.8)

Switch Room:
W: 171,5 x 0,6534 = 112 kg

Computer Room:
W: 576,0 x 0,6534 = 376,2 kg

Floor Void:
W: 67,2 x 0,6925 = 43,9 kg
The altitude correction factor of sea level is 1.00. (see Table 3.1)

It is determined from the above that both the Switch Room and the Computer Room can be fed by one manifolded system using 5 x 120L cylinders, each filled with 97,7 kg of agent. The Floor Void would use 1 x 67,5L cylinder filled with 43,9 kg. (From Table 2.2.)

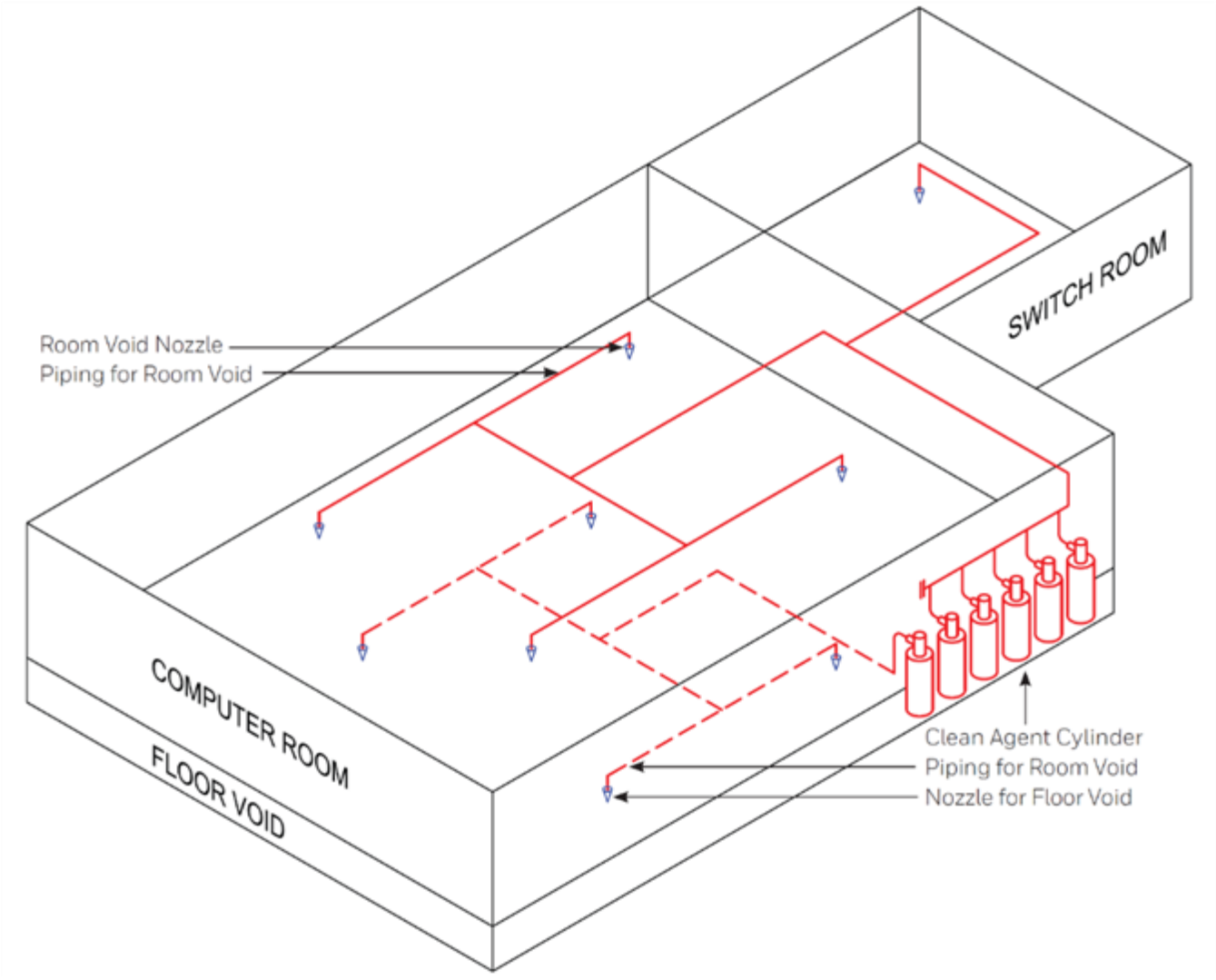


Figure 3.5.: Example of system

Table 3.8. FK-5-1-12 Total Flooding Quantity												
Temp. T °C	**Specific Vapor Volume** S, (m^3/kg)	**FK-5-1-12 mass requirements per unit volume of protected space, m/V (kg/m^3)** This information refers only FK-5-1-12 and may not represent any other products containing Dodecafluoromethylpentan-3-one as a component.										
		Design Concentrations (% - by volume)										
		4,0	**4,5**	**5,0**	**5,3**	**5,6**	**5,9**	**6,0**	**7,0**	**8,0**	**9,0**	**10,0**
-20	0,0609	0,6840	0,7740	0,8640	0,9190	0,9740	1,0300	1,0407	1,2357	1,4275	1,6236	1,8241
-15	0,0623	0,6690	0,7570	0,8450	0,8990	0,9530	1,0070	1,0248	1,2084	1,3961	1,5879	1,7839
-10	0,0637	0,6545	0,7407	0,8268	0,8800	0,9320	0,9850	1,0027	1,1824	1,3660	1,5537	1,7455
-5	0,0650	0,6407	0,7251	0,8094	0,8610	0,9130	0,9650	0,9816	1,1575	1,3372	1,5209	1,7087
0	0,0664	0,6275	0,7101	0,7926	0,8430	0,8940	0,9450	0,9613	1,1336	1,3096	1,4895	1,6734
5	0,0678	0,6148	0,6957	0,7766	0,8260	0,8760	0,9260	0,9418	1,1106	1,2831	1,4593	1,6395
10	0,0691	0,6026	0,6819	0,7612	0,8100	0,8580	0,9070	0,9232	1,0886	1,2576	1,4304	1,6070
15	0,0705	0,5909	0,6687	0,7464	0,7940	0,8420	0,8900	0,9052	1,0674	1,2332	1,4026	1,5757
20	0,0719	0,5796	0,6559	0,7322	0,7790	0,8260	0,8730	0,8879	1,0471	1,2096	1,3758	1,5457
21	0,0722	0,5774	**0,6534**	0,7294	**0,7762**	**0,8228**	**0,8696**	0,8846	1,0432	1,2051	1,3706	1,5399
25	0,0733	0,5688	0,6436	0,7184	0,7650	0,8100	0,8560	0,8713	1,0275	1,1870	1,3500	1,5167
30	0,0746	0,5583	0,6318	0,7052	0,7510	0,7950	0,8410	0,8553	1,0086	1,1652	1,3252	1,4888
35	0,0760	0,5482	0,6204	0,6925	0,7370	0,7810	0,8260	0,8399	0,9904	1,1442	1,3013	1,4620
40	0,0774	0,5385	0,6094	0,6802	0,7240	0,7670	0,8110	0,8250	0,9728	1,1239	1,2783	1,4361
45	0,0787	0,5291	0,5988	0,6684	0,7110	0,7540	0,7970	0,8106	0,9559	1,1043	1,2560	1,4111
50	0,0801	0,5201	0,5886	0,6570	0,6990	0,7410	0,7830	0,7967	0,9395	1,0854	1,2345	1,3869
55	0,0815	0,5113	0,5786	0,6459	0,6870	0,7290	0,7700	0,7833	0,9237	1,0671	1,2137	1,3636
60	0,0829	0,5029	0,5691	0,6352	0,6760	0,7170	0,7570	0,7704	0,9084	1,0495	1,1936	1,3410

m/V is the agent mass requirement (in kilograms per cubic meter); i.e. mass, m, in kilograms of agent required per cubic meter of protected volume V to produce the indicated concentration at the temperature specified.

V is the net volume of hazard (in cubic meters); i.e. the enclosed volume minus the fixed structures impervious to extinguishant.

m = (c/(100-c). V/S

T is the temperature (in degrees Celsius); i.e. the design temperature in the hazard area.

S is the specific volume (in cubic meters per kilogram); the specific volume of superheated FK-5-1-12 vapor at a pressure of 1,013 bar may be approximated by the formula: S = k1 + k2 ·T

where; k1 = 0,0664; k2 = 0,000274.

c is the concentration (in percent); i.e. the volumetric concentration of FK-5-1-12 in air at the temperature indicated, and a pressure of 1,013 bar absolute.

3.1.13. Duration of Discharge

Per NFPA2001, the liquid agent discharge shall be completed in a nominal ten seconds or less. Discharge times shorter than 10 seconds are desirable to minimize production of breakdown products. Discharge times are as short as 6 seconds are permitted.

3.2. System Limitations

The information presented below details the steps necessary to design a Honeywell Clean Agent Fire Suppression System with FK-5-1-12 agent within the limitations set by UL & FM and NFPA 2001.

3.2.1. Hazard Classification

Table 3.9. Minimum and maximum design concentrations

Hazard Classification	Minimum Design Concentrations % by Volume			Maximum Design Concentrations % by Volume	
	UL	FM	ISO14520/EN15004	Occupied	Non-Occupied
Class A	4.5	4.5	5.3	10,0	Unlimited
Class B	5.9	5.9	5.9		
Class C*	4.5	4.5	5.6		

**Class C is equal to Higher Hazard Class A in EN 15004*

IMPORTANT NOTICE:

Maximum human exposure time shall not exceed 5 minutes for FK-5-1-12 systems utilized in any occupiable spaces.

3.2.2. Concentration at Maximum Temperature

The expected concentration at maximum temperature can be determined by the following formula:

C = 100 x W x S / (W x S + V)

W = Weight of Agent required (kg)

V = Hazard Volume (m^3)

C = Required FK-5-1-12 concentration (% by volume).

S = Specific Vapor Volume (m^3/kg) (Refer to Flooding Factor Table 3.8. to determine the S value)

IMPORTANT NOTICE:

The Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software will automatically calculate concentration at the max. temperature entered.

3.2.3. Temperature Limitation

Table 3.10. Limitation of temperature		
Minimum	**Maximum**	**Notes**
5°C (41°F)	50°C (122°F)	At temperatures outside of this range, the system may not supply the desired quantity of agent or discharge due to over-pressure.

3.2.4. System Discharge Time

Per NFPA2001, the liquid agent discharge shall be completed in a nominal 10 seconds or less.

Table 3.11. System Discharge Time	
Minimum	**Maximum**
6 seconds	10 seconds

3.2.5. Nozzle Location and Limitation

The number of nozzles required is connected to the hazard volume, configuration and the coverage provided by the nozzle. Nozzles are installed on the pipe the same way as the pipe fitting. Nozzles must be placed in the correct location in accordance with the installation drawings to supply the correct amount of FK-5-1-12 to the designated area.

The required orifice diameter must be determined by Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software and drilled out to the calculated orifice size.

Table 3.12. Minimum & Maximum Nozzle Orifice Sizes (for Schedule 40 pipe)								
Part Number	**Nozzle Size**		**Orifice Holes**	**Type**	**Orifice Diameters**		**Min. Nozzle Orifice Area to Pipe Area Ratio**	**Max. Nozzle Orifice Area to Pipe Area Ratio**
	mm	**in.**			**Min. ø (mm)**	**Max. ø (mm)**		
HSN-NOZ-01-15	15	1/2"	5 x ø 6,7	**180°**	5.5	10.5	12%	45%
HSN-NOZ-01-20	20	3/4"	9 x ø 6,7		9.5	14.0		
HSN-NOZ-01-25	25	1″	9 x ø 8,4		12.0	17.5		
HSN-NOZ-01-32	32	1 1/4"	9 x ø 10,7		15.5	23.5		
HSN-NOZ-01-40	40	1 1/2"	14 x ø 10,7		18.5	27.5		
HSN-NOZ-01-50	50	2″	14 x ø 13,4		23.5	35.0		
HSN-NOZ-02-15	15	1/2"	8 x ø 5,4	**360°**	5.5	10.5		
HSN-NOZ-02-20	20	3/4"	16 x ø 5,0		9.5	14.0		
HSN-NOZ-02-25	25	1″	16 x ø 6,3		12.0	17.5		
HSN-NOZ-02-32	32	1 1/4"	16 x ø 8,0		15.5	23.5		
HSN-NOZ-02-40	40	1 1/2"	24 x ø 8,2		18.5	27.5		
HSN-NOZ-02-50	50	2″	24 x ø 10,2		23.5	35.0		

IMPORTANT NOTICE:

The specified flow rates are estimated values. For actual flow rates, please refer to The Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software.

3.2.6. Nozzle Coverage Area

Designers may desire to increase the nozzle quantity to provide a more even distribution agent while the protected room is oddly shaped.

If the nozzle velocity is an issue, the designer may desire to add additional nozzles to lower the individual nozzle velocity to an acceptable limit.

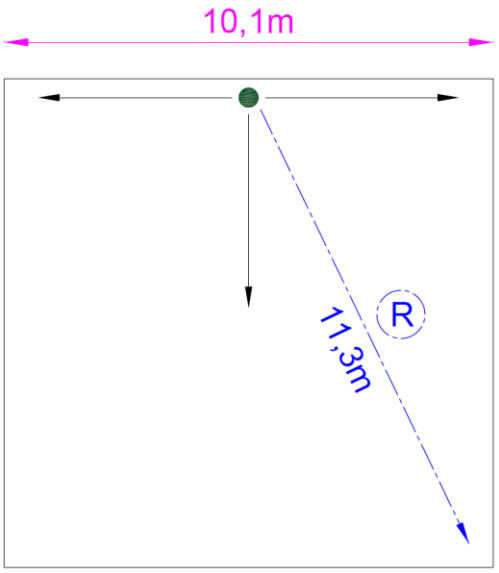


Figure 3.6.: 180° nozzles located

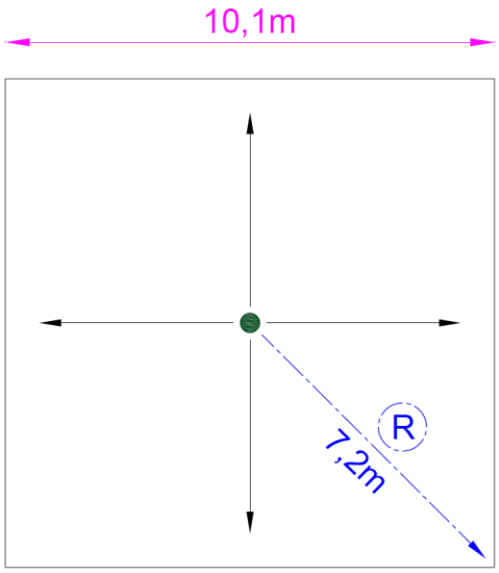


Figure 3.7.: 360° nozzles located

Table 3.13. Nozzle Coverage Area

Part Number	Type	Radius		Ceiling Height Range	
		m	ft.	m	ft.
HSN-NOZ-01-15	180°	11.3	37,1	0.3 to 4.4	1.0 to 14.4
HSN-NOZ-01-20					
HSN-NOZ-01-25					
HSN-NOZ-01-32					
HSN-NOZ-01-40					
HSN-NOZ-01-50					
HSN-NOZ-02-15	360°	7.2	23.6		
HSN-NOZ-02-20					
HSN-NOZ-02-25					
HSN-NOZ-02-32					
HSN-NOZ-02-40					
HSN-NOZ-02-50					

IMPORTANT NOTICE:

• The maximum coverage area is 102 m2 (1098 ft2) for each type of nozzle.
• The shape of the hazard area affects the nozzle location.
• Nozzles must not be placed where their discharge performance may be effected by objects.
• If nozzle velocity is a concern, additional nozzles may be added to lower the individual nozzle velocity.
• Nozzles can be installed up to a maximum of 300 mm (12 in.) below the ceiling.
• Maximum nozzle height above floor level for a single row of nozzles is 4.4 m (14.4 ft). For ceiling heights above 4.4 m (14.4 ft) additional rows of nozzles may be added.
• 180-degree nozzles must be mounted within 300 mm (12 in.) of the wall and point at the center of the hazard.
• The minimum ceiling height, for subfloors, false ceilings, for example, is 300 mm (12 in.).
• Nozzles are positioned vertically, either up or down.
• The maximum elevation difference between the cylinder outlet and the furthest horizontal pipe run or discharge nozzle shall not exceed 15,8 m (51,8 ft), see Figure 3.13.
• The maximum elevation difference between the furthest horizontal pipe runs or discharge nozzles shall not exceed 15,8 m (51,8 ft), see Figure 3.14.
• If the room is an odd shape, the designer may increase the nozzle quantity to provide a more even agent distribution.

The nozzle should be placed as close to the center of the hazard as possible. On the multiple nozzle system, the nozzle should be as equally spaces as possible.

The 180º nozzle is engineered to provide an 180º discharge pattern for sidewall applications. The 360º nozzle offers a full 360º discharge pattern for installations where nozzles are located in the center of the hazard.

180º nozzles should be located in a symmetrical, or near symmetrical, pattern within the protected area. 180º nozzles should be located along the perimeter of the area – discharging along the perimeter and toward the opposite side. These nozzles can be located a maximum of 1’-0” (0.3 m) out from the wall.

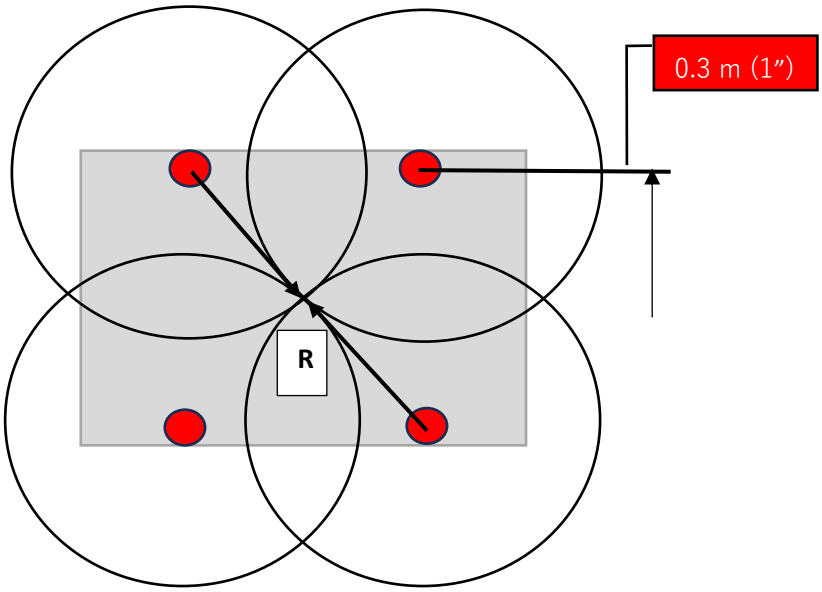


Figure 3.8.: 180º Nozzles

360º Nozzles should be located in a symmetrical, or near symmetrical, pattern within the protected area. Nozzle patterns need to overlap, to adequately cover the area without any “blind spots” due to nozzle locations. Apply to all Nozzle types.

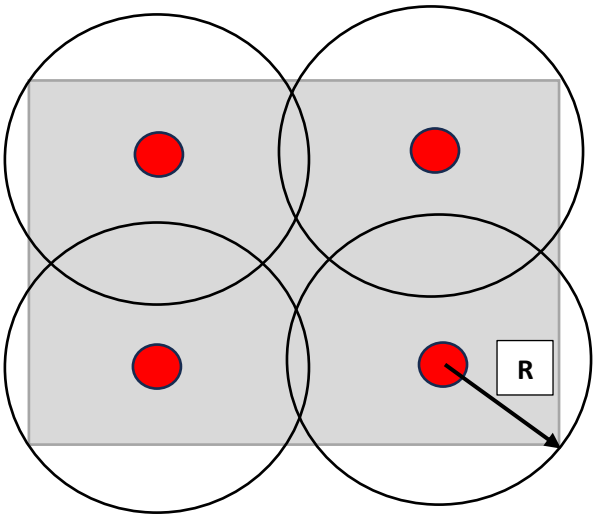


Figure 3.9.: 360º Nozzles

Back-to-back application:

180°Nozzles can be installed in a back-to-back arrangement within the following limitations:

- Maximum distance between nozzles = 1.0’ (0.3 m)
- Agent supplied and flow rate from both nozzles are the same.
- Pipe size from tee to both nozzles are the same.

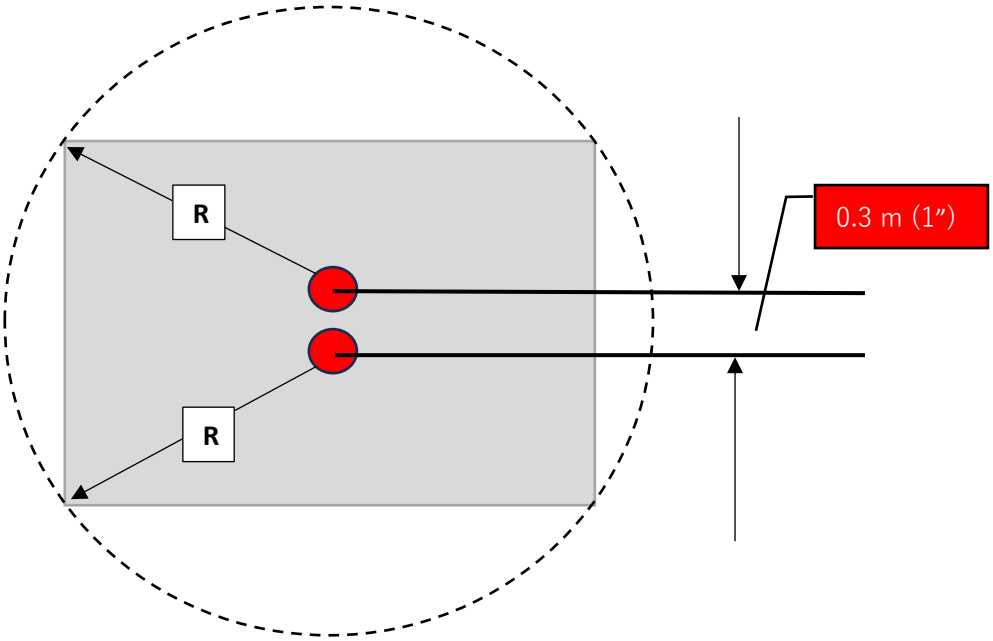


Figure 3.10.: Back-to-back nozzles application

3.2.7. Ceiling Height and Levels of Nozzles

The maximum nozzle height above floor level for a single row of nozzles is 4.4m. For ceiling heights above 4.4m additional rows of nozzles may be added. The minimum ceiling height is 0,3m. For instance, for false ceilings, sub-floors and plenum spaces.

Table 3.14. Nozzle Levels	
Ceiling Height	**Levels of Nozzles Required**
1.0′ (0.3 m) to 14.4′ (4.4 m)	1
Over 14.4′ (4.4 m) to 28.8′ (8.8 m)	2 (See Maximum Elevation Differences in Pipe Runs Limitation)

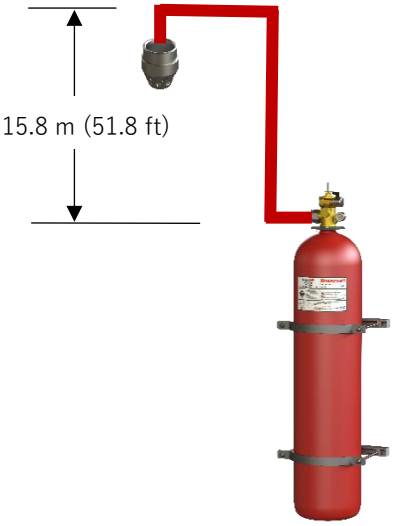


Figure 3.11.: Maximum elevation between between nozzles and cylinder outlet

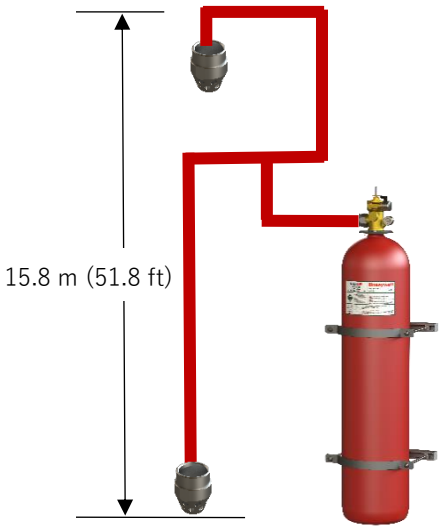


Figure 3.12.: Maximum elevation horizontal pipe runs and nozzles

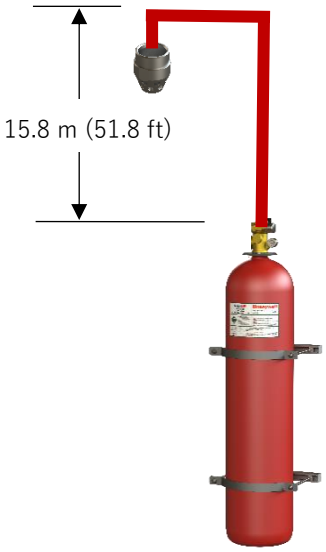


Figure 3.13.: Example 1
System with a single row of nozzle/s above cylinder outlet

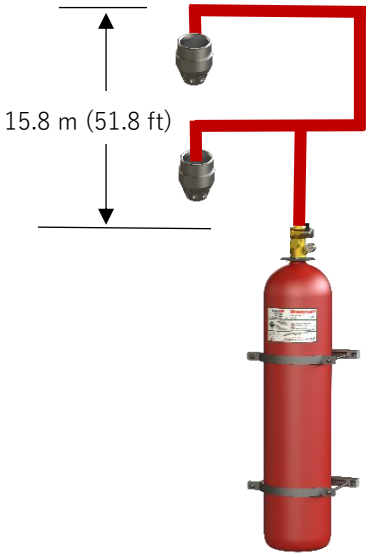


Figure 3.14.: Example 2
System with a multiple row of nozzle/s above outlet

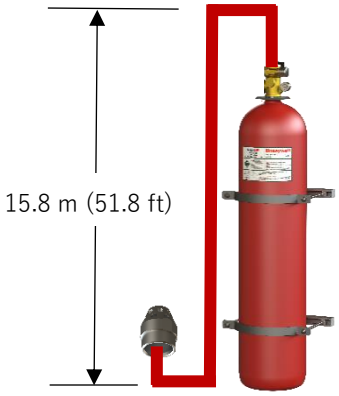


Figure 3.15.: Example 3
System with a single row of nozzle/s below cylinder outlet

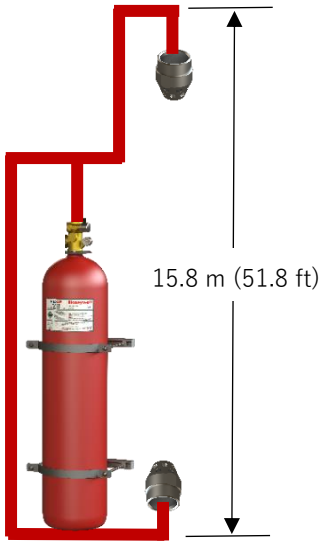


Figure 3.16.: Example 4
System with a multiple row of nozzle/s below outlet

3.2.8. Tee Split Ratios

Table 3.15. Tee Split Ratios					
Type of Tee	**Major-Flow Outlet**		**Minor-Flow Outlet**		
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Orientation**
Bull Tee	%50	%50	%32	%68	Standard
Side-Thru	%28	%72	%11	%89	Standard

IMPORTANT NOTICE:

Designs will be made only in the given split ratios. Other percentages such as 41% & 59% etc. are not correct. And it is also not correct to change the 90% and 10% splits in the pipeline.

Every outlet of each tee must be oriented in the horizontal plane.

Table 3.16. Type of Fittings		
Type of Fitting	**Type of Tee**	**Range**
Equal Tee	Bull Tee	Starting from 1/2" up to 6"
	Side Tee	Starting from 1/2" up to 6"
45° Elbow	Standard	Starting from 1/2" up to 6"
90° Elbow	Standard	Starting from 1/2" up to 6"

3.2.9. Tee Configurations

Bull Tee

Where the two-outlet branches change direction from the incoming piping inlet.

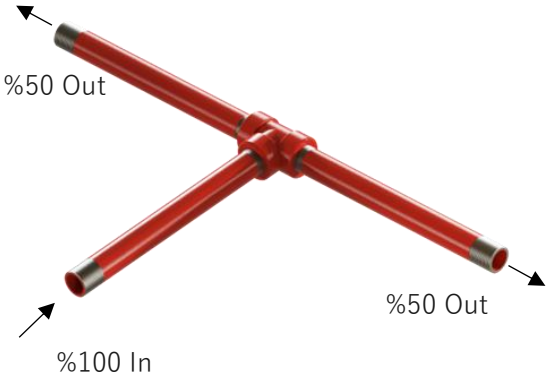


Figure 3.17.: Bull Tee %50-%50



Figure 3.18.: Bull Tee %68-%32

Side Tee

Where one outlet branch changes direction from the inlet and the other continues straight through in the same direction as the inlet.



Figure 3.19.: Side-Thru Tee %89-%11



Figure 3.20.: Side-Thru Tee %72-%28

Correct & In-correct designs:

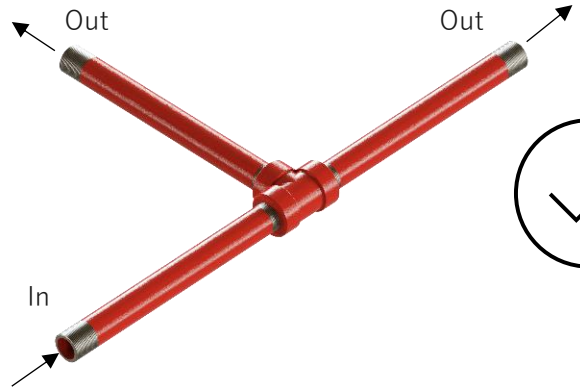


Figure 3.21.: Correct configuration-1



Figure 3.22.: Correct configuration-2

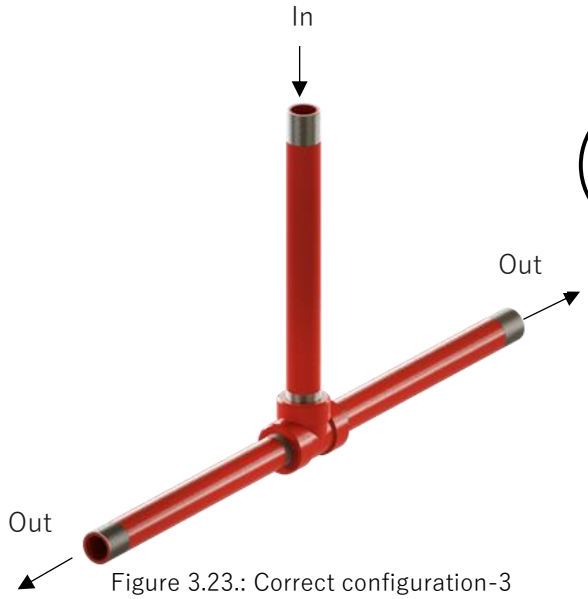


Figure 3.23.: Correct configuration-3

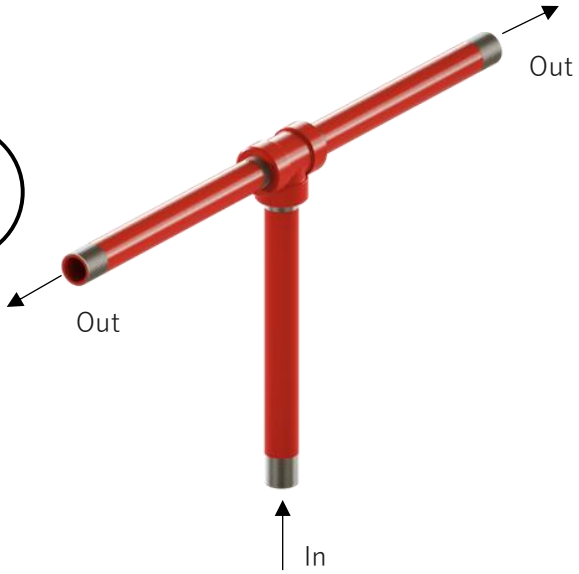


Figure 3.24.: Correct configuration-4

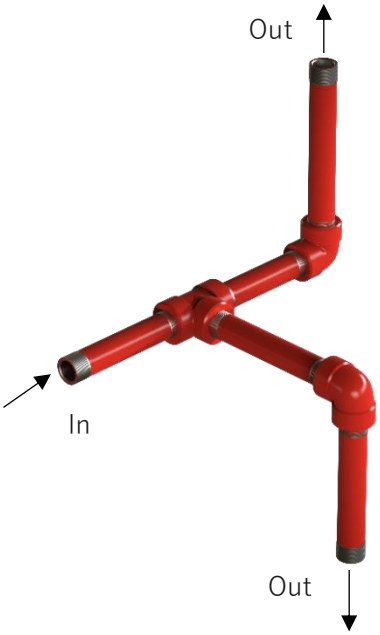


Figure 3.25.: Correct configuration-5

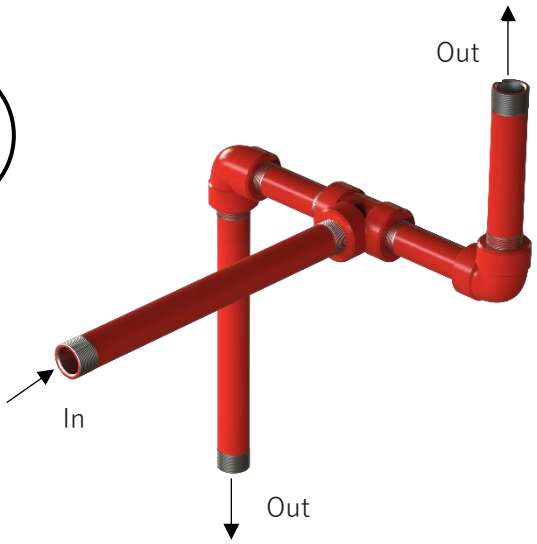


Figure 3.26.: Correct configuration-6

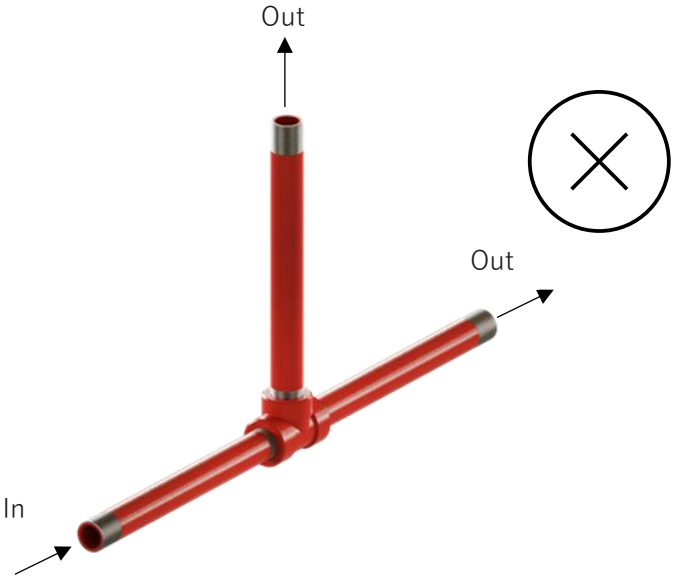


Figure 3.27.: In-correct configuration-1

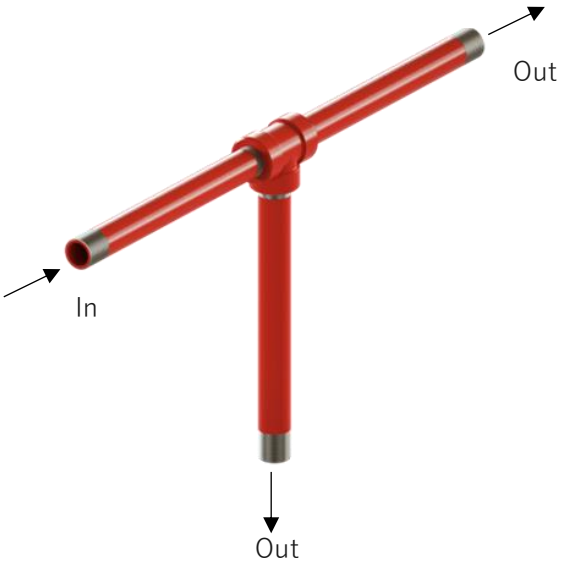


Figure 3.28: In-correct configuration-2

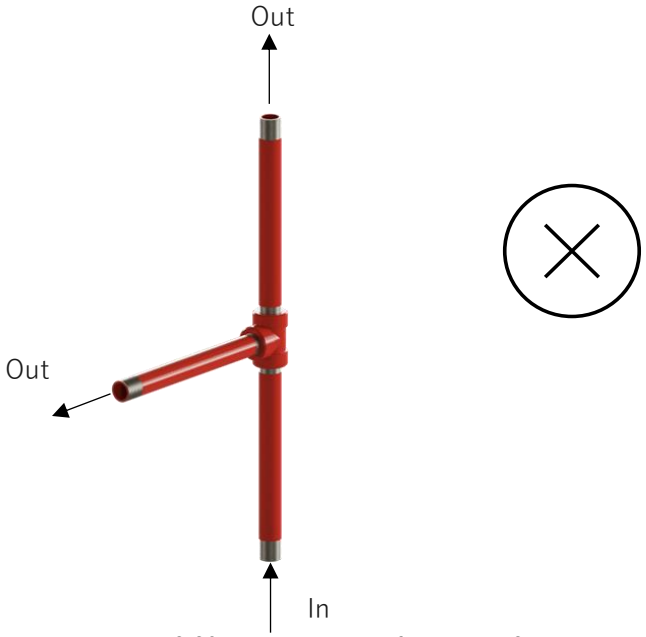


Figure 3.29.: In-correct configuration-3

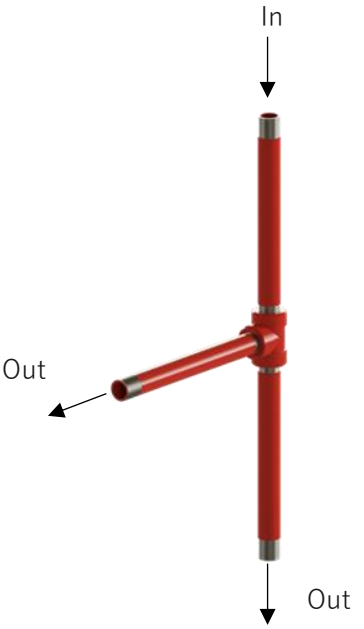


Figure 3.30.: In-correct configuration-4

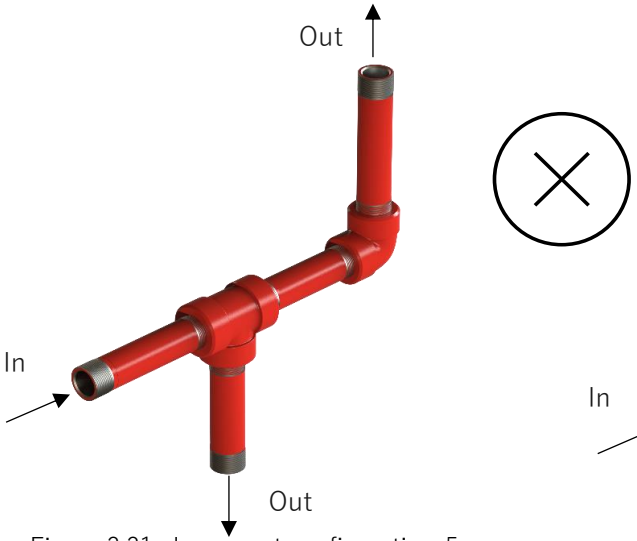


Figure 3.31.: In-correct configuration-5

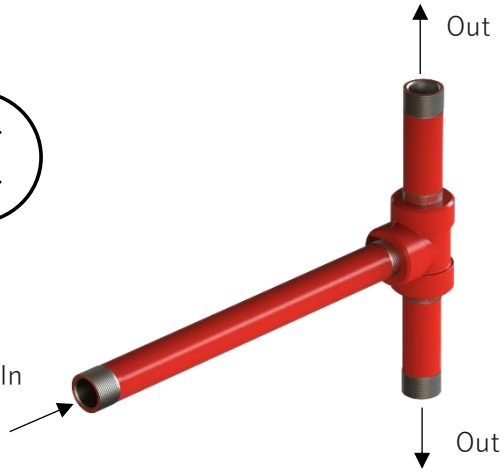


Figure 3.32.: In-correct configuration-6

3.2.10. Estimated Pipe Size

Table 3.17. Estimated Pipe Size for Schedule 40					
Pipe Size		**Minimum Design Flow Rate** (System Limitation)		**Maximum Design Flow Rate** (System Limitation)	
mm	**in.**	**kg/s**	**lb/s**	**kg/s**	**lb/s**
15	1/2"	0.50	1.1	1.361	3.0
20	3/4"	0.90	2.0	2.520	5.5
25	1″	1.58	3.5	3.930	8.6
32	1 1/4"	2.72	6.0	5.670	12.5
40	1 1/2"	4.08	9.0	8.970	19.7
50	2″	6.35	14.0	13.610	29.9
65	2 1/2"	9.07	20.0	24.950	54.9
80	3"	13.61	29.9	40.820	89.8
100	4"	24.95	54.9	56.700	124.7
125	5″	40.82	89.8	90.720	199.6
150	6″	54.43	119.7	136.100	299.4

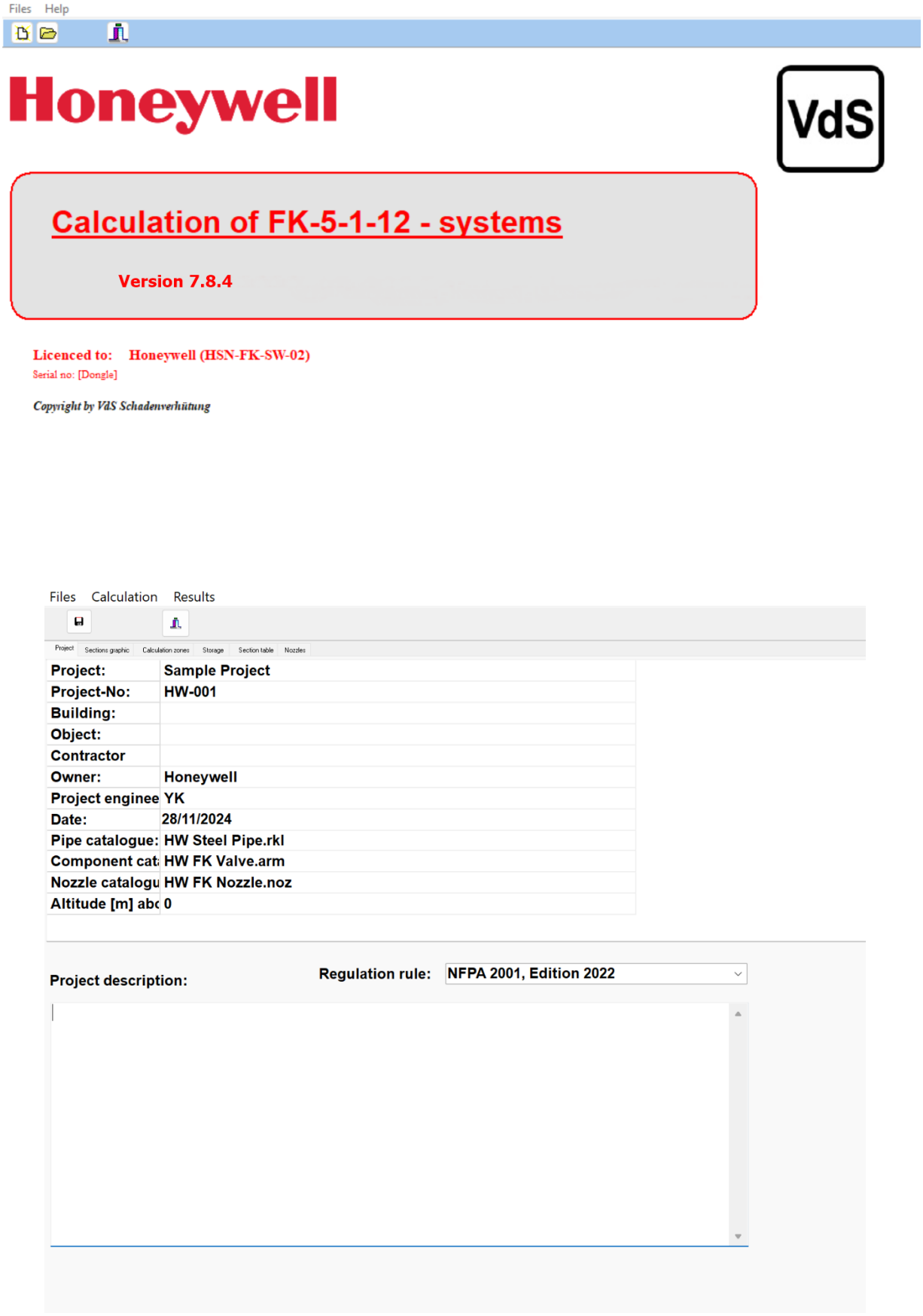
IMPORTANT NOTICE:

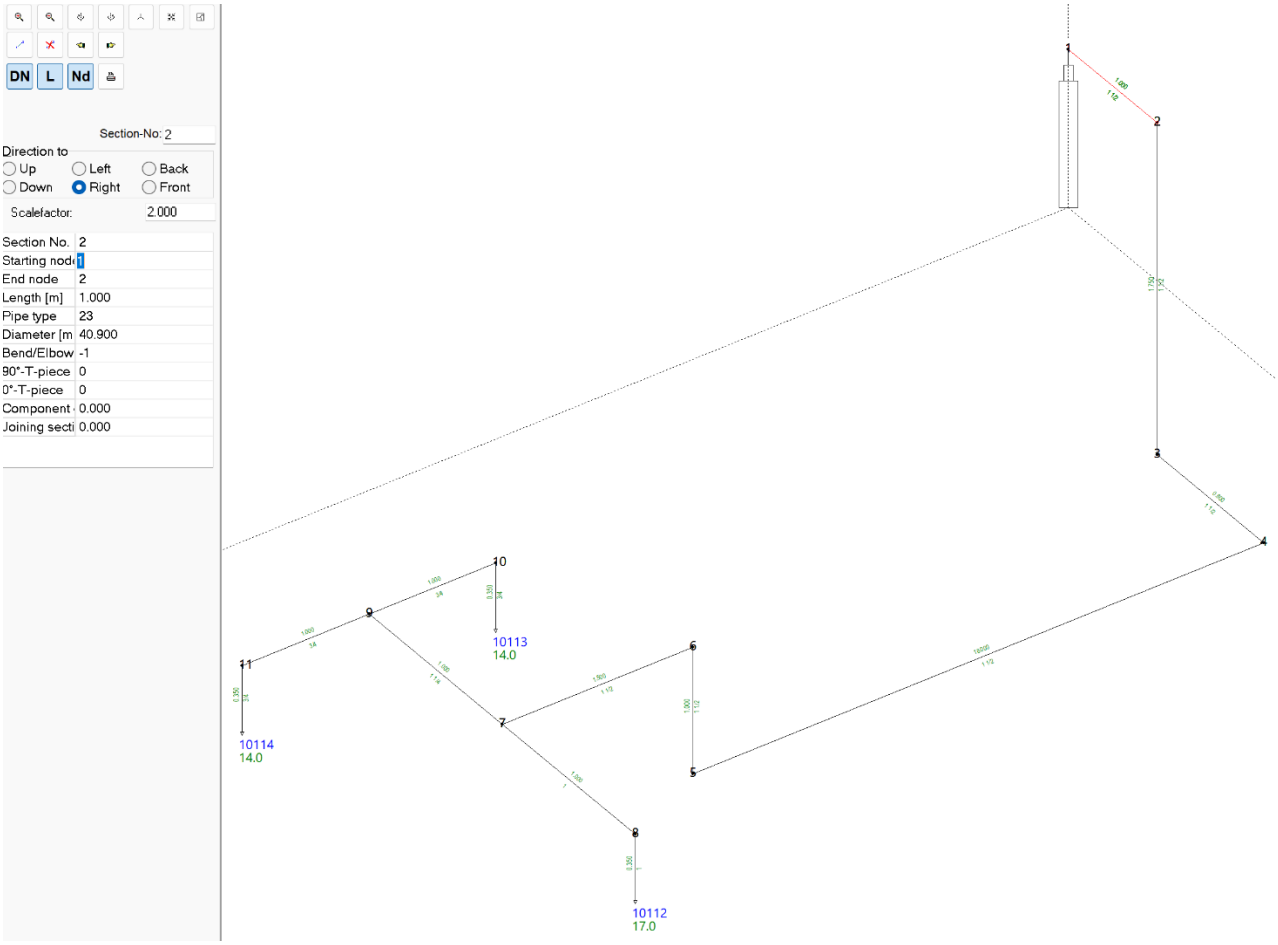
The Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software must be used to determine the final pipe sizes. Please use this table for the estimations.

3.2.11. Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software

Design / Flow Calculation Limitations

• Minimum nozzle pressure:	6.77 bar (98.2psi)
• Maximum Piping Variance for Each Nozzle:	%21
• Maximum Pressure Variance for Each Nozzle:	4.2 bar (60.90psi)
• Agent percentage in pipe (filling portion ratio):	%76
• Minimum pipe volume ratio before first tee:	%18
• Maximum agent arrival time imbalance:	1.12s
• Side tee split limit:	Side tee (%11 to %28), Through tee (%89 to %72),
• Bull tee split limit:	%32 to %68
• Minimum fill density:	0.5 kg/L (31.2 lb/ft^3)
• Maximum fill density:	1.2 kg/L (74.9 lb/ft^3)
• Discharge time:	6s to 10s
• Maximum configurable cylinder arrangement:	1 pc Master + 8 pcs slave
• Minimum pipe lengths after fittings:	10 x internal pipe diameter
• Maximum elevation in pipe run:	15.8 m (51.84 Ft)
• Maximum horizontal pipe run:	18.0 m (59.06 Ft)


Files Help
Honeywell
VdS
Calculation of FK-5-1-12 - systems
Version 7.8.4
Licenced to: Honeywell (HSN-FK-SW-02)
Serial no: [Dongle]
Copyright by VdS Schadenverhütung
Files Calculation Results
Project Sections graphic Calculation zones Storage Section table Nozzles
Project: Sample Project
Project-No: HW-001
Building:
Object:
Contractor
Owner: Honeywell
Project enginee YK
Date: 28/11/2024
Pipe catalogue: HW Steel Pipe.rkl
Component cat HW FK Valve.arm
Nozzle catalogu HW FK Nozzle.noz
Altitude [m] abc 0
Project description:
Regulation rule: NFPA 2001, Edition 2022



Select the calculation zone: ENCLOSURE-1

Current Calculation zone: ENCLOSURE-1

Total volume:	101.964	m³
Volume of building parts:	0.000	m³
Total surface of the zone:	129.880	m²
Max. overpressure	1.000	mbar
Design temperature:	30.0	°C
Calculated volume:	101.964	m³

Regulation rule: NFPA 2001, Edition 2022

Class A Fire, NFPA 2001 (Edition 2012)

Extinguishing concentration:	4.50	%
Safety factor:	1.200	Class A Fire
Number of piping Tees	2	
Design concentration:	5.400	% Enable
Design quantity:	78.000	kg
Minimum supply quantity:	78.000	kg

Available Nozzles in the project:

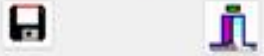
Assigned Nozzles	Nozzle	CZ-No.
10112	10112	1
10113	10114	1
10114	10113	1

Volume of a single storage container:	80.0	l	**Available Cylinders: 8l, 13.4l, 26.8l, 40l, 67.5l, 80l, 120l, 180l**
Maximum filling ratio of a container:	1.2	kg /l	**Maximum filling ratio is 1.20 kg/l**
Filling pressure:	44.0	bar abs	
Storage temperature:	30.0	°C	
Design factor:	1.0		
Discharge time:	10.0	s	

Project Sections graphic Calculation zones Storage Section table Nozzles

No.	Start	End	Orientation	Length [m]	Heigthdiff. [m]	Pipe type	Diameter [mm]	Bend/Elbow	90°-T	0°-T	Component	Number of container
1	0	1	up	0.100	0.100	20	31.5	0	0	0	245	1.000
2	1	2	right	1.000	0.000	23	40.9	-1	0	0	0.000	0.000
3	2	3	down	1.750	-1.750	23	40.9	-1	0	0	0.000	0.000
4	3	4	right	0.800	0.000	23	40.9	-1	0	0	0.000	0.000
5	4	5	front	18.000	0.000	23	40.9	-1	0	0	0.000	0.000
6	5	6	up	1.000	1.000	23	40.9	-1	0	0	0.000	0.000
7	6	7	front	1.500	0.000	23	40.9	-1	0	0	0.000	0.000
8	7	8	right	1.000	0.000	23	26.6	0	1	0	0.000	0.000
9	8	10112	down	0.350	-0.350	23	26.6	-1	0	0	0.000	0.000
10	7	9	left	1.000	0.000	23	35.0	0	1	0	0.000	0.000
11	9	11	front	1.000	0.000	23	20.9	0	1	0	0.000	0.000
12	11	10114	down	0.350	-0.350	23	20.9	-1	0	0	0.000	0.000

Files Calculation Results



Project Sections graphic Calculation zones Storage Section table Nozzles

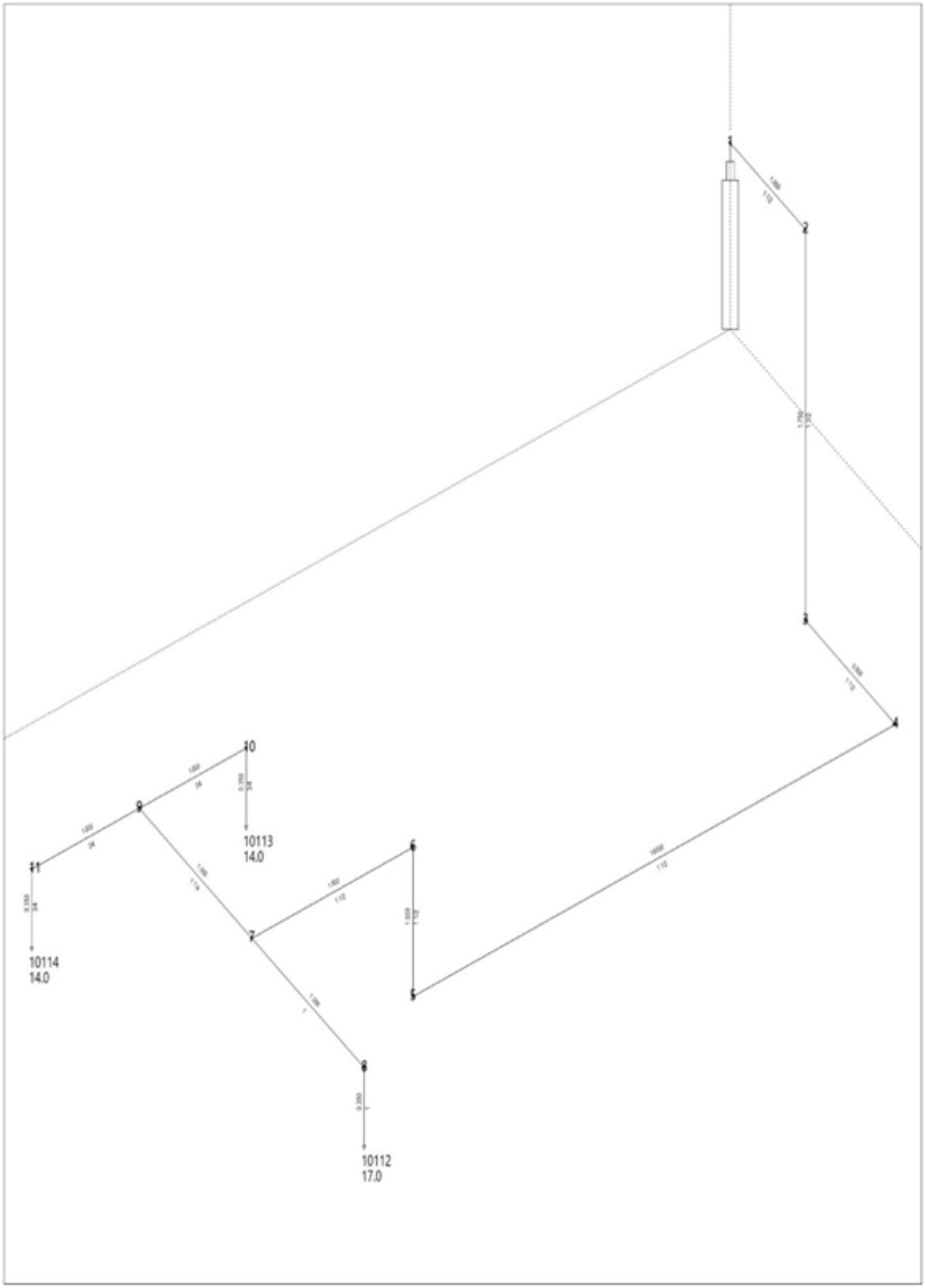
Nozzlelist:

Nozzle	Diameter [mm]	Calc.-zone
10112	17.0	No. 1 ENCLOSURE-1
10113	14.0	No. 1 ENCLOSURE-1
10114	14.0	No. 1 ENCLOSURE-1

Example of The Hydraulic Calculation Reports:

Project:	
Project-No:	
Building:	
Object:	
Contractor:	
Owner:	Honeywell
Project engineer:	YK
Date:	28/10/2024
Regulation rule for calculation of FK-5-1-12 quantities:	NFPA 2001, Edition 2022
Altitude above sealevel:	0 m
Pipe catalogue:	HW Steel Pipe.rkl
Component catalogue:	HW FK Valve.arm
Nozzle catalogue:	HW FK Nozzle.noz

Error messages:


10113
14.0
10114
14.0
10112
17.0

Input data

Pipe system data:

Section-No.	Start node	End Node/ Nozzle	Length [m]	Height-diff. [m]	Pipe type	Dia-meter [mm]	Fitting *	Component Code	Component Coeffi-cient	Number of containers
1	0	1	0.100	0.100	20	31.5	C	245	6.53	1
2	1	2	1.000	0.000	23	40.9	E	-	-	0
3	2	3	1.750	-1.750	23	40.9	E	-	-	0
4	3	4	0.800	0.000	23	40.9	E	-	-	0
5	4	5	18.000	0.000	23	40.9	E	-	-	0
6	5	6	1.000	1.000	23	40.9	E	-	-	0
7	6	7	1.500	0.000	23	40.9	E	-	-	0
8	7	8	1.000	0.000	23	26.6	T-90°	-	-	0
9	8	10112	0.350	-0.350	23	26.6	E	-	-	0
10	7	9	1.000	0.000	23	35.0	T-90°	-	-	0
11	9	11	1.000	0.000	23	20.9	T-90°	-	-	0
12	11	10114	0.350	-0.350	23	20.9	E	-	-	0
13	9	10	1.000	0.000	23	20.9	T-90°	-	-	0
14	10	10113	0.350	-0.350	23	20.9	E	-	-	0

* C=Component, B=Bend, T=T-Piece, E=Elbow, R=Restrictor

Legend of pipetypes

Type	Pipeclass	Pipe roughness
20	ASTM SCH40	smooth
23	ASTM SCH40	black pipe

Legend of components

Code	Type	Resistamce coefficient
245	HW FK5112 DN33 Assem	6.500

Calculation zone data:

Calculation of design quantity:

Total volume [m³]	Volume of building parts [m³]	Calculated volume [m³]	Total surface [m²]	Max. Over pressure [mbar]	Design temp. [°C]	Temp. corr. factor	Extinguish conc. [% Vol]	Design factor	Design conc. [% Vol]	Design quantity [kg]
102.0	0.0	102.0	129.9	1.000	30.0	1.000	4.5	1.2	5.40	78.0

Regulation rule for calculation of FK-5-1-12 quantities: NFPA 2001, Edition 2022

Calczone no. 1: Class A Fire, NFPA 2001 (Edition 2012)

Calculation results:

FK-5-1-12 storage data:

Design quantity:	78 kg
Supplement factor:	1
Minimum storage quantitiy:	78 kg
Container volume:	80.0 l
Filling ratio:	0.98 kg/l
Filling pressure:	44.0 bar abs
FK-5-1-12 -mass per container:	78 kg
Number of containers:	1
Actual storage quantity:	78 kg
Storage temperature:	30.0 °C
Starting container pressure:	45.8 bar abs

Discharge time:

Discharge time air:	0.4 s
Total gas discharge time:	0.5 s
Two-phase discharge time:	8.2 s
Total discharge time:	8.8 s

System information:

Container working pressure:	16.5 bar abs
Container working temperature:	22.5 °C
Total network volume:	34.3 l
Medium pipe content:	40.7 kg FK-5-1-12
Filling portion in pipe system:	0.52 kg FK-5-1-12 /kg FK-5-1-12 -storage

Pipe system:

Section- No:	Starting-node	Endnode Nozzle	Pressure [bar abs]	Flowrate [kg/s]	Pipedimension Di [mm]	DN
1	0	1	13.31	9.0	31 . 5 *	--
2	1	2	12.90	9.0	40.9	1 1/2
3	2	3	12.67	9.0	40.9	1 1/2
4	3	4	12.27	9.0	40.9	1 1/2
5	4	5	10.58	9.0	40.9	1 1/2
6	5	6	10.01	9.0	40.9	1 1/2
7	6	7	9.48	9.0	40.9	1 1/2
8	7	8	8.94	3.9	26.6	1
9	8	10112	8.29	3.9	26.6	1
10	7	9	9.02	5.0	35.0	1 1/4
11	9	11	8.56	2.5	20.9	3/4
12	11	10114	7.68	2.5	20.9	3/4
13	9	10	8.56	2.5	20.9	3/4
14	10	10113	7.68	2.5	20.9	3/4

Nozzle data:

Calculation-zone no.	Nozzle no.	Nozzle type	Number of orifices	Pipeconnection Di [mm]	Pipeconnection DN	Orifice [mm]	FK-5-1-12 output [kg]
1	10112	1	1	26.6	1	17	34.2
1	10113	1	1	20.9	3/4	14	21.9
1	10114	1	1	20.9	3/4	14	21.9

Two-phase discharge time: 8.2 s
Released two-phase FK-5-1-12 : 78 kg

Max. transport time diff. between Nozzles 10114 and 10112 is: 0.17 s

Calculation-zone no:	Nozzle no.	Outlet velocity [m/s]	Transport time [s]	Jetdistance [m]	Evaporation distance [m]
1	10112	23.4	4.29	8.46	3.9
1	10113	23.1	4.46	6.9	3.2
1	10114	23.1	4.46	6.9	3.2

Concentrations:

Calculation zone no:	Gascomposition after the discharge [%]		
	O2	FK-5-1-12	N2
1	19.8	5.4	73.9
Total flooded FK-5-1-12 mass:	78 kg		

Pressure relief opening:

Calculation zone no:	Area [m2]	Recommended area against overpressure	
		Overpressure [mbar]	Max. flow [kg/s]
1	0.09	1	9

Component list:

Cylinder Valve Assemblies and Selector Valves

Type	Amount	Code	Coefficient
HW FK5112 DN33 Assem	1	205	6.500

Nozzles

Type	Amount	C1	C2	C3	C4	C5	C6
1	3	0.000	0.741	0.072	0.000	-0.091	0.000
Restrictor	1	0.000	0.000	0.000	0.000	0.000	0.741

Pipes

Pipe-type	DN	Di [mm]	Length [m]
20	--	31.5	0.1
23	1 1/2	40.9	24.1
23	1 1	26.6	1.3
23	1/4	35	1
23	3/4	20.9	2.6

Pipe Bends (+) and Elbows (-)

Bend-type	DI [mm]	DN	Number
-90	40.9	1 1/2	6
-90	26.6	1	1
-90	20.9	3/4	2

Number of T-distributors (in- and outdiameter)

Number	Input	90-out	90-out	0-out
1	40.9	26.6	35	0
1	35	20.9	20.9	0

4. Installation

4.1. General Equipment Installation

FK-5-1-12 clean agent fire extinguishing system must be installed to facilitate proper inspection, testing, manual operation, recharging and any other required maintenance as may be necessary.

Equipment must not be subject to severe weather conditions or mechanical, chemical or other damage that could render the equipment inoperative. Equipment must be installed in accordance with NFPA2001 (current edition).

4.2. Order of Installation

- Cylinder installation
- Piping and nozzles
- Actuation controls
- Ancillary equipment
- Completion procedures

Specific installation drawings must be prepared for the hazard area in accordance with system design as calculated by The Honeywell FK-5-1-12 Flow Calculation 7.8.4 Software. These drawings should be followed closely to ensure the system meets its design criteria. The pipe network is sized to obtain correct discharge time, nozzle pressures, agent quantity and various other design considerations. If for any reason, the pipe network requires. Modifications to the system must be recalculated before proceeding with installation. Installation drawings contain the following information.

- Enclosure volumes
- Agent quantities
- Scaled pipe network plan
- Pipe network isometric
- Pipe diameters, pipe length drops and rises
- Nozzle data
- Cylinder data
- Actuator technical data
- Low pressure switch wiring chart
- Fittings data

Installation drawings shall be submitted for approval to the appropriate authority prior to system installation. The cylinder weight is checked at the factory prior to dispatch and recorded on the label attached to the cylinder. If there is any doubt regarding the weight, or leakage is suspected, the cylinder should be weighed to confirm there is no weight loss.

4.2.1. Cylinder installation

The cylinder location is identified on the system drawings and should be protected from extremes of temperature and be accessible for service and maintenance. The cylinders must be installed vertically on the floor and firmly secured to a wall or bulkhead. No safety outlet and actuation caps should be removed at this stage.

4.2.1.1. Single cylinder installation

1. Fix the back channels of the mounting brackets to the wall at the appropriate heights using suitable anchor type bolts.
2. Position the cylinder against the back channel with the valve outlet pointing left.
3. Insert the cylinder brackets at top and bottom and secure with the bolts.
4. Remove the safety outlet cap from the valve outlet adaptor.
5. With the outlet cap removed from the valve outlet adaptor, connect flexible discharge hose or valve outlet adapter.
6. Remove the protection cap from the cylinder valve actuation port.
7. Install the manual and solenoid actuator to the cylinder valve actuation port.



Figure 4.1.: Single cylinder assembly

4.2.1.2. Multiple cylinders installation

Cylinders are manifolded together for three main reasons:

• To reduce the amount of piping required by connection to one feeder pipe.

• For systems that require main and reserve system configuration.

• Combining the correct cylinders to obtain the required quantity of agent within a specific hazard area.

1. Fix the back channels of the mounting brackets to the wall at the appropriate heights using suitable anchor type bolts. (see Figure 4.2)

2. Position the cylinders against the back channels with the valve outlets pointing left at the required spacing for the manifold ports. (see Figure 4.3)

3. Insert the cylinder brackets at top and bottom and secure with the nut bolts. (see Figure 4.3)

4. Remove the safety cap from one cylinder outlet port and connect the flexible discharge hose to the cylinder outlet port. (see Figure 4.4 and 4.5)

5. Remove the protection caps from the cylinder actuation ports. (see Figure 4.5)

6. Install the manual, solenoid and pneumatic actuators to the cylinder valve actuation ports. (see Figure 4.5 and 4.6)



Figure 4.2.: Manifold and bracket assembly for multiple cylinder



Figure 4.3.: Cylinder assembly with cylinder protection cap



Figure 4.4.: Cylinder assembly after removing cylinder protection cap.



Figure 4.5.: Discharge and actuation line assembly for multiple cylinder

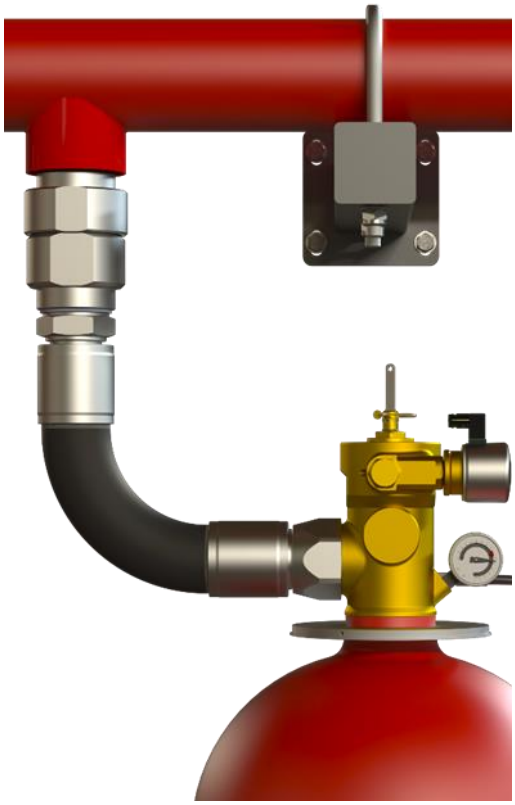


Figure 4.6.: Assembly of discharge hose & check valve with cylinder

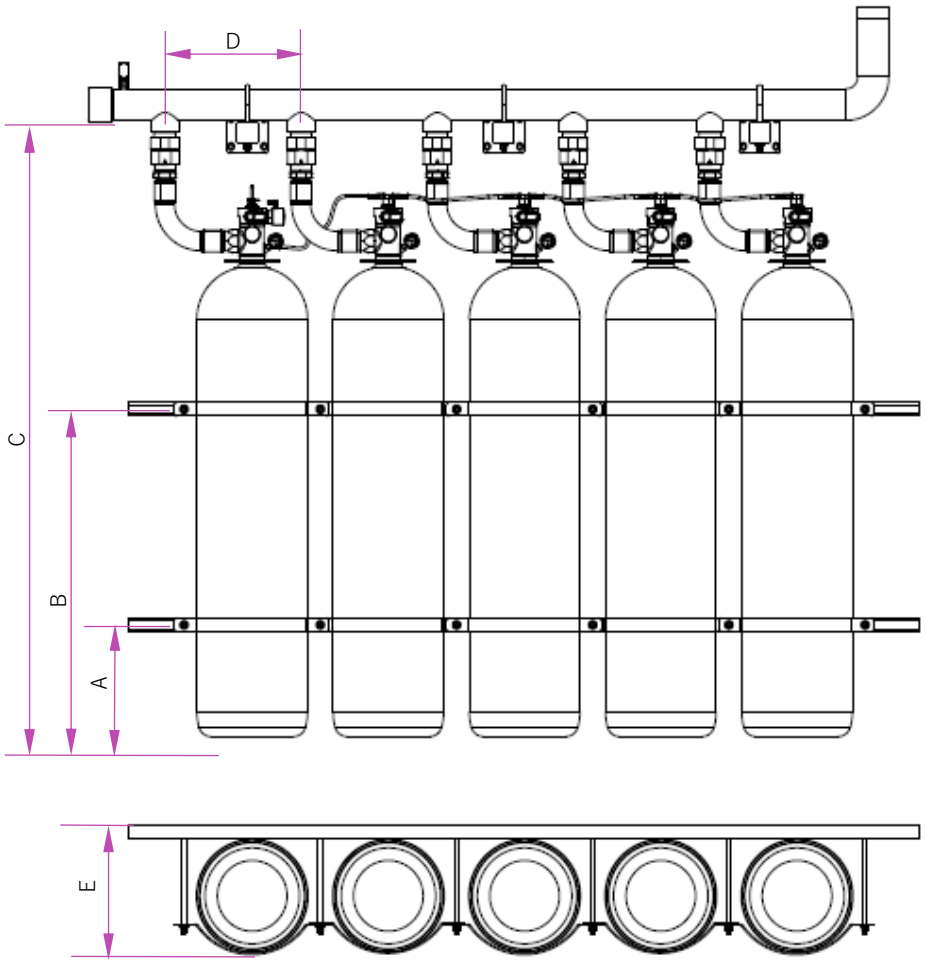


Figure 4.7.: Multiple cylinder installation dimensions

Table 4.1. Multiple Cylinder Installation Dimensions					
Type	**A (mm)**	**B (mm)**	**C (mm)***	**D (mm)**	**E (mm)**
67.5L	400	1150	1740	500	330
80L	400	1250	1740	500	330
120L	400	1200	1500	500	420
180L	500	1350	1700	500	470

**These can change according to manifold dimension and discharge hose length.*

4.2.2. Pipe installation

In general, the installation should commence at the union elbow/manifold assembly and progress along to the discharge nozzles. Install the pipework to the installation drawings provided, ensuring that the following is adhered to:

1. The piping material must conform to the requirements of NFPA2001.

2. The pipe must be reamed, blown clear and swabbed with an appropriate solvent to remove mill varnish and cut oil before assembly.

4.2.2.1. Pipe type

Piping must be of noncombustible material having physical and chemical characteristics, such that its integrity under stress can be predicted with reliability. The computer flow program has only been verified for the specific types and schedule of pipe and fittings covered in this manual.

There is a risk that the system may not supply the required quantity of agent in unbalanced.

IMPORTANT NOTICE: Cast iron and non-metallic pipes shall not be used.

4.2.2.2. Piping joints and fittings

The type of piping joint shall be suitable for the design conditions and shall be selected with consideration of joint tightness and mechanical strength.

Fittings shall have a minimum rated working pressure equal to or greater than the minimum design working pressure specified in NFPA2001 for the system pressure being used.

IMPORTANT NOTICE: Class 150 and cast-iron fittings must not be used.

4.2.2.3. Installation of pipe and fittings

Pipe and fittings must be installed in strict accordance with the system drawings and good commercial practices. The piping between the cylinder and the nozzles must be the shortest route possible, with a minimum of fittings. Any deviations in the routing or number of fittings must be approved by the design engineer before installation. Piping must be reamed free of burrs and ridges after cutting, welding or threading. Joint compound or thread tape must be applied only to the male threads of the joint, excluding the first two threads. All piping must be blown clear with dry nitrogen or compressed air before installing the discharge nozzles.

4.2.2.4. Piping support installation

Pipe supports shall be of a non-combustible material, shall be suitable for the expected temperature and shall be able to withstand the dynamic and static forces involved. Due allowance shall be made for the stresses induced in the pipe work by temperature variations (From -20 °C to +50 °C). Adequate environmental protection shall be given to support and associated steelwork. The distance between pipe supports shall be as the following table:

Table 4.2. Maximum Pipework Support Distance

Pipe Diameter	Max. Distance (m)	Pipe Diameter	Max. Distance (m)
15mm (1/2″)	1.5	50mm (2″)	3.4
20mm (3/4″)	1.8	65mm (21/2″)	3.5
25mm (1″)	2.1	80mm (3″)	3.7
32mm (11/4″)	2.4	100mm (4″)	4.3
40mm (11/2″)	2.7	150mm (6″)	5.2

4.2.3. Master / Slave Cylinder Installation

1. Position the cylinder in designated location and secure in place with cylinder bracket and attaching hardware (see Figure 4.2 and Table 4.1) Orient cylinder with valve outlet angled toward system piping.

2. Remove the safety cap from the cylinder valve outlet port.

3. Connect a flexible discharge hose or valve outlet adapter to the cylinder outlet port.

4. Install the master / slave cylinder actuator kit.

5. Remove the protection cap from the cylinder valve actuation port.

6. Install pneumatic actuator and actuation line hose; do not attach solenoid actuator to slave cylinder valve actuation port at this time.

7. Install solenoid actuator and actuation line hose to slave cylinder.

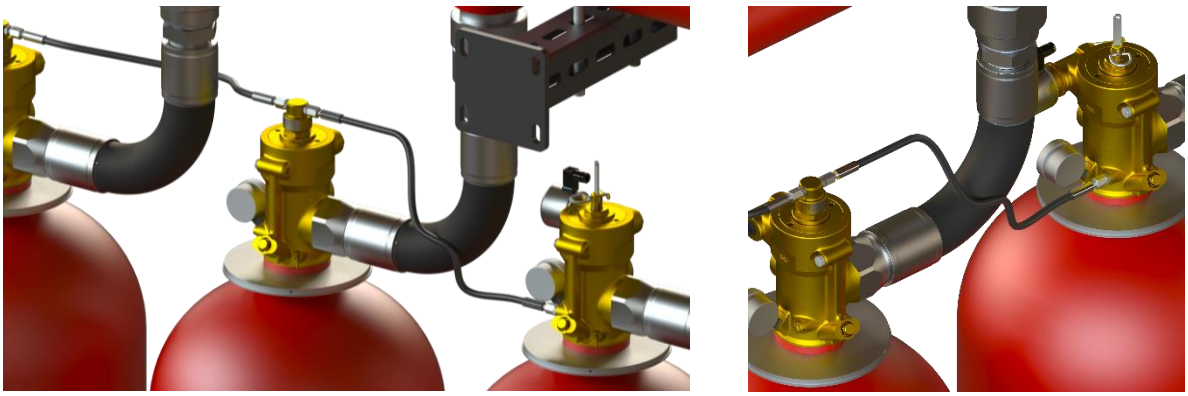


Figure 4.8.: Assembly of actuation line with master and slave cylinders

IMPORTANT NOTICE:

Maximum configurable cylinder arrangement shall be 1 pc Master + 8 pcs slave

4.2.4. Installation of Pressure Switch

Pressure switches must be connected to the discharge manifold or piping in an upright position. Pressure switches have DN15 (1/2") BSP pressure inlets to connect to the system piping.

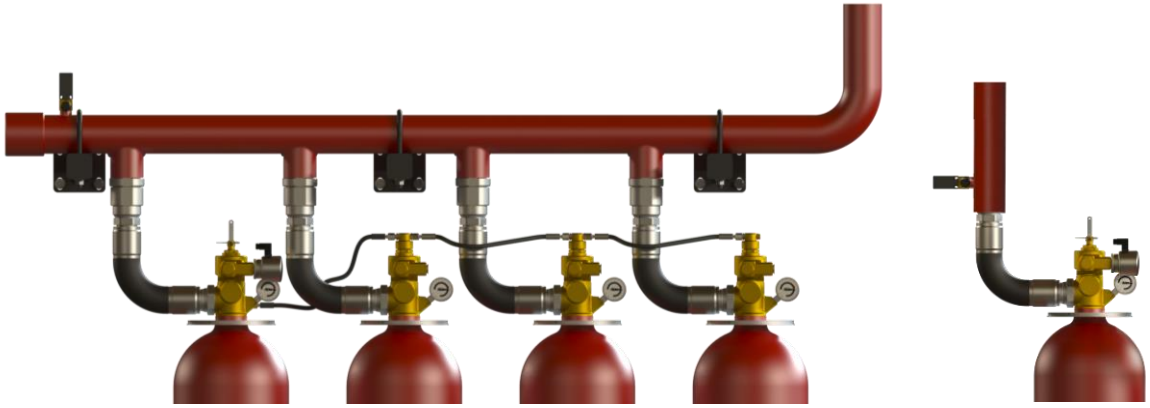


Figure 4.9.: Typical discharge pressure switch assembly on manifold or/and single cylinder

4.2.5. Installation of Nozzles

Nozzle type, style, and orifice diameter are determined based upon flow calculations made by the FK-5-1-12 clean agent flow software during the system design. Discharge nozzles are female BSP thread. Due to the thrust generated from a 180° corner or 360° sidewall nozzle, a rigid hanger or support must be located within 300mm (12") of the nozzle to prevent pipe movement and / or nozzle rotation during discharge.

4.2.6. Discharge Piping Pressure Test

All fittings be checked for tightness and pressure tested. Remove the nozzles and install pipe caps. Remove the discharge piping from the cylinder valve and install the safety cape onto the cylinder discharge outlet. Connect a source of dry compressed air or nitrogen to the distribution piping. Slowly increase the pressure in the piping to 3 Bar (43.5 psi) and then close the valve supplying pressure. Check the pressure after 10 minutes. If the pressure is above 2.7 Bar (39.2 psi) (80 % of test pressure) the system is considered sealed. If it drops below 2.7 Bar (39.2 psi) check and tighten all fittings then re-run the test. After completing the test, remove pipe caps, reinstall nozzles, and reconnect discharge piping to cylinder.

Dry compressed air or nitrogen must be discharged through the piping network and nozzles to verify the flow is continuous and that the piping and nozzles are unobstructed. Make certain air/nitrogen is discharging from all nozzles. Check all nozzles to be sure the correct nozzles are installed as shown on the installation drawing, installed securely to the pipe, properly anchored, and properly oriented. Check all nozzles for any obstructions or objects placed in the direct pattern of discharge. NFPA2001 should be considered in all other matters not specified.

Perform a full functional test of the control system in accordance with the appropriate technical manual and system design drawings including verification that all control functions such as damper and door closure, HVAC shut down, and power shut down occur as intended. If the HVAC is not being shutdown prior to system discharge it must be of the re-circulating close loop type and enough agent must be provided to compensate for the volume of the duct and plenum.

4.2.7. Hand-Over Procedures

The entire system shall be thoroughly inspected to make sure that it is complete and that all tests required during installation have been properly carried out. NFPA2001 should also be consulted. Additional procedures may be required by the local Authority Having Jurisdiction (AHJ). In addition, the following items are particularly important.

1. Conduct a room integrity (door fan) test in accordance with NFPA2001. The results of this test will provide equivalent leakage area and, when conducted in accordance with the manufacturer's instructions, will predict the timeline for a descending interface to fall to a given height and estimate how long the extinguishing concentration will be maintained in the protected room.

2. A cylinder should be refilled or replaced when it shows a loss in agent quantity of more than 5 % or loss in pressure (Table 7.6. Filling Pressure vs Temperature Chart) of more than 10 %.

3. Check security and tightness of cylinder mounting brackets to a solid structure and cylinder brackets.
4. Piping should be checked for correct size, length, and grade and compared to the installation drawings, FK-5-1-12 clean agent flow calculation results, and manual limitations.
5. Check pipe supports for proper type, mounting, and spacing.
6. Check that nozzle location, size, and drill diameters of orifices match both installation / design drawings and calculations.
7. Check the cylinder weight information label according to the system requirement. If there is any doubt or loss of pressure, the cylinder must be weighed.
8. Ensure that the system is in operation and that the operating systems are functioning.

Ensure that adequate escape routes are provided with directional signs. Issuance of appropriate documentation will mean that the handover procedure has been completed. Appropriate records will be issued by firefighting teams or area by insurance authorities on the hazard suitability, acceptability and availability of the system.

4.2.8. Warning Notification

Appropriate warning notices should be affixed inside the protected room informing its occupants about the type of protection and modes of actuation in case of fire. All these signs should be clearly legible and resistant to environmental conditions. It is advisable to provide adhesive labels with a red or green background and white letters. Notices should incorporate at least the following messages:

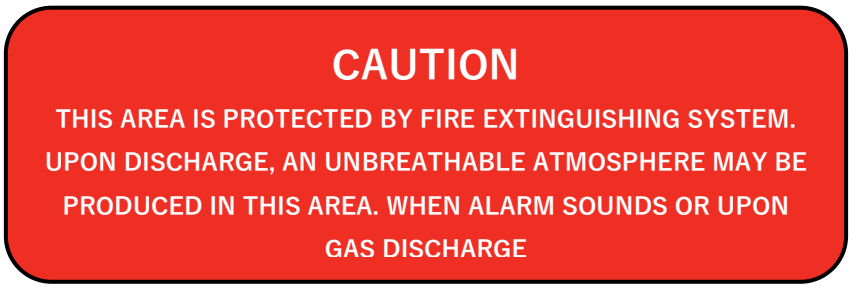
Typical sign inside the protected enclosure:



Typical sign outside the protected enclosure:



Typical sign affixed near the protected areas:



Typical signs placed at every manual actuation device:



Figure 4.10.: Caution sign variations for protected rooms

5. System Operation

5.1. General Comments

The personnel required to work in the protected area should be conversant with the detection and extinguishing equipment installed and trained in fire procedures. All life-saving equipment must be properly maintained. The method of system operation is chosen at the design stage to suit the protection required for the hazard area and the environmental factors appropriate to that area. This part of the document provides information relevant to all the standard operational systems to cover the eventuality of changes to, or expansion of the original design.

5.2. System Actuation

Each system is designed to suit the hazard area, whether the area is normally manned or unmanned, and whether the detection / actuation devices are to be manual or automatic. The permutation of systems is large but from an operational point of view, the systems are best grouped as:

- Manual
- Fully Automatic
- Automatic with Manual Intervention

5.2.1. Manual system

Manual systems depend on human detection of a fire in the hazard area and prompt action to actuate the local or remote strike knob for the FK-5-1-12 system to discharge and flood the protected area and extinguish the fire. Where there fire alarm systems provided for the hazard. In case of fire, detection system will generate audio-video alarm, and it will indicate person present in the hazard to evacuate from the hazard area.

On the total evacuation, the system can be triggered with the help of manual actuator, mounted on the master cylinder of clean agent system unit. Since the system is designed for manual actuation. A nominated person must be there, who should be fully aware of how to trigger the system manually. On periodic time fire drill to be performed with the staff, who are working in this hazard area or and around.

All other instructions associated with manual operation form part of the user's procedures on safety precautions and fire drill.

5.2.2. Fully Automatic System

Where a sensitive fire detection system is included for the automatic release of extinguishing agent, the system shall only be capable of automatic release when two or more sensors detect the fire. The number of detectors and their spacing is designed to ensure a satisfactory response time. To ensure personnel may safely evacuate the risk area an adjustable time delay should be fitted such that sufficient time may elapse prior to system discharge. Ideally, the delay period shall not exceed 30 seconds. Prior to system discharge (and at the commencement of any time delay period) a

clearly audible alarm different from any other used shall sound and continue until the complete system is reset. In areas of high ambient noise level, a visual indication may also be required, in addition to the audible warning.

5.2.3. Fully Automatic System with Manual Intervention

Manual intervention of an automatic system may be included for the following condition;

Where personnel are required to work within the protected area.

In protected areas where personnel are present and the concentration is greater than NOAEL, it is recommended that the automatic feature of the system is isolated during occupation. This may be achieved either by an electrically contacted lock assembly or by a clearly marked key switch at a suitable location outside the risk area.

5.3. Actions Following a Fire

These notes are only applicable to the hazard area(s) protected by a FK-5-1-12 clean agent fire extinguishing system. Where such a system may form part of or combine with other forms of fire protection systems, then composite instructions for all systems are necessary to ensure the safety of personnel and property following a fire.

5.3.1. Actions Immediately Following a Fire

These actions should, at a minimum, include the following:

1. Advise the emergency services, Fire or Police if appropriate.
2. Organize a ‘rollcall’ of employees and any visitors.
3. Prevent unauthorized personnel from entering the hazard area.
4. In the case of deep-seated fires, the hazard space should be kept tightly closed for at least 60 minutes after discharge of the FK-5-1-12 clean agent extinguishing agent. It is essential that the fire be completely extinguished before ventilating the space. Before permitting anyone to enter space, ventilate thoroughly or ensure self-contained breathing equipment is used.
5. Do not enter the hazard area in which fire has been extinguished with an open flame or lighted cigarettes, the possible presence of flammable vapors may cause re-ignition or explosion. Should it be necessary to enter a space containing FK-5-1-12 clean agent or decomposition products the following precautions should be taken;

1. Use a fresh air mask or self-contained breathing equipment.
2. Do not use a filter mask or canister type mask.
3. Do not enter space unless you are under observation from outside the space or tethered by a lifeline.
4. Ensure that all pressurized equipment is isolated or safe from release.

6. Maintenance

6.1. Introduction

This chapter contains maintenance instructions for FK-5-1-12 clean agent fire suppression system.

6.2. Maintenance Procedure

IMPORTANT NOTICE: FK-5-1-12 clean agent fire suppression system cylinder must be handled, installed and inspected by a qualified and trained by a personel in accordance with the manual.

6.2.1. General

1. A well planned and approved schedule is essential for the inspection and testing of the system, keeping in view, the following.
2. At least once a year, all systems shall be thoroughly inspected and tested for proper operation by competent personnel. Discharge tests are not necessary.
3. The inspection report along with recommendations shall be filed and always available with the owner and the same shall be produced to the authorities concerned when demanded.
4. At least once in six months, the agent's quantity and pressure of the cylinders shall be checked and details logged in a register.
5. For FK-5-1-12 clean agent cylinder shows a loss in agent quantity of more than 5 percent or a loss in pressure (adjusted for room temperature) of more than 10 percent, it shall be refilled or replaced.
6. Date of inspection, gross weight of cylinder plus agent or net weight of agent, type of agent, person performing the inspection, and, where applicable, the pressure at a recorded temperature shall be recorded on a tag attached to the cylinder.

6.3. Agent Storage Cylinders

Agent storage cylinders, approved by Transportable Pressurized Equipment Directive (TPED), are pressurized vessels containing FK-5-1-12 clean agent super-pressurized with nitrogen to 50 Bar gauge at 21°C (725 psi at 70°F). This pressure causes considerable thrust if the discharge valve is actuated, thus, the safety cap supplied with the cylinder must be installed when handling or storing the cylinder, or whenever it is not securely fastened down. The safety cap prevents objects from striking the burst disc valve and reduces and redirects the thrust if the cylinder is accidentally discharged.

Handle the cylinder carefully to prevent damaging the gauge and other attached fixtures. The cylinder must not be subjected to temperatures above 50 °C (122 °F), or the pressure relief device may operate, releasing the agent.

6.3.1. Cylinder test

1. Clean agent cylinders shall not be recharged without retesting if more than 5 years have elapsed since the date of the last test and inspection.

2. Transporting charged cylinders that have not been tested within 5 years shall not be allowed

3. Cylinders continuously in service without discharging shall be given a complete external visual inspection every 5 years or more frequently if required. The visual inspection shall be in accordance with the guidelines of TPED, so that the cylinders need not be emptied or stamped while under pressure. Inspections shall be made only by competent personnel and the results recorded on both of the following:

a) A record tag permanently attached to each cylinder,

b) A suitable inspection report.

4. A completed copy of the inspection report shall be furnished to the owner of the system or an authorized representative. These records shall be retained by the owner for the life of the system.

6.4. Hose Test

6.4.1. General

All system hoses shall be examined annually for damage. If visual examination shows any deficiency, hose shall be immediately replaced or tested as specified below.

6.4.2. Testing

a) All hoses shall be tested every 5 years.

b) All hoses shall be tested at 1½ times the maximum cylinder pressure at 54 ºC. The testing procedure shall be as follows:

1. The hose is removed from any attachment.

2. The hose assembly is then placed in a protective enclosure designed to permit visual observation of the test.

3. The hose must be filled with water before testing.

4. Pressure then is applied at a rate-of-pressure rise to reach test pressure within a minimum of 1 min. The test pressure is maintained for 1 full min. Observations are then made to note any distortion or leakage.

5. If the test pressure has not dropped or if the couplings have not moved, the pressure is released. The hose assembly is then considered to have passed the hydrostatic test if no permanent distortion has taken place.

6. Hose assembly passing the test must be completely dried internally. If heat is used for drying, the temperature must not exceed the manufacturer's specifications.

7. Hose assemblies failing a hydrostatic test must be marked and destroyed and replaced with new assemblies.

8. Each hose assembly passing the hydrostatic test is marked to show the date of test.

6.5. Enclosure Inspection

At least every 12 months, the enclosure protected by these agents shall be thoroughly inspected to determine if penetrations or other changes have occurred that could adversely affect agent leakage or change volume of hazard or both. Where the inspection indicates conditions that could result in inability to maintain the clean agent's concentration, they shall be corrected. If uncertainty still exists, the enclosures shall be retested for integrity.

6.6. Training

All people who could be expected to inspect, test, maintain, or operate fire extinguishing systems shall be thoroughly trained and kept thoroughly trained in the functions they are expected to perform. Personnel working in an enclosure protected by these agents shall receive training regarding agent safety issues.

6.7. Maintenance Procedures

Table 6.1. Maintenance Procedures by Time Schedule

Schedule	Requirement	Section
Daily	Check cylinder pressure	Paragraph 6.7.1
Monthly	Inspect hazard area system components	Paragraph 6.7.2
Check cylinder pressure	42 Bar gauge at 21°C (610 psi at 70°F)	Paragraph 6.3
Semi-Annually	Test pressure switches	Paragraph 6.7.3
	Check Agent qty. and cylinder pressure	
	Actuation functional test	
Every 2 Years	Blow out distribution piping with nitrogen	Paragraph 6.7.4
Every 5 Years	Agent cylinder pressure test or inspection	Paragraph 6.3
	Flexible hose pressure test	Paragraph 6.4

6.7.1. Daily

6.7.1.1. Check agent cylinder pressure

Check the cylinder pressure gauges for proper operating pressure (refer to Table 2.2.). If the pressure gauge indicates a pressure loss (adjusted for temperature) of more than 10 %, it shall be refilled. Remove and recharge the cylinder. For other requirement related to periodic maintenance of FK-5-1-12 clean agent unit please refer manual clause 6.2.1.

6.7.2. Monthly

6.7.2.1. General inspection

Make a general inspection survey of all cylinders and equipment for damaged or missing parts. If the equipment requires replacement.

6.7.2.2. Hazard access

Ensure access to hazard areas, manual pull stations, discharge nozzles, and cylinders are unobstructed and that nothing obstructs the operation of the equipment or distribution of FK-5-1-12 clean agent.

6.7.2.3. Inspect hoses

Inspect flexible actuation hoses for loose fittings, damaged threads, cracks, distortion, cuts and dirt. Tighten loose fittings and replace hoses with striped threads or other damage. If necessary, clean the parts. Inspect the adapters, couplings and tees at the cylinder pilot outlets and tighten couplings if necessary. Replace any damaged parts.

6.7.2.4. Inspect pneumatic actuators

Inspect the pressure actuators for physical damage, deterioration, corrosion, distortion, cracks, dirt and loose couplings. Tighten loose couplings. Replace damaged caps. Replace the control head if damaged. If necessary.

6.7.2.5. Inspect solenoid actuators

Inspect the solenoid actuators for damage, corrosion, and dirt. Check the solenoid actuators flexible electrical line for wear and damage. Check the solenoid actuator for loose coupling and tighten if necessary. Check that the indicator is in the SET position, the pull pin is installed in the manual lever, and the seal wire is intact. Replace the solenoid actuator if damaged.

6.7.2.6. Inspect cylinder and valve assembly

Inspect the Cylinder and Valve assembly for leakage and physical damage such as cracks, dents, distortion and worn parts. Check the burst disc and pressure gauges for damage. Replace damaged gauges or burst disc. If the gauge pressure is not 42 Bar gauge at 21°C (610 psi at 70°F) remove and recharge the cylinder.

6.7.2.7. Inspect brackets and mounting hardware

Inspect the cylinder brackets, cradles and mounting hardware for loose, damaged or broken parts. Check the cylinder brackets and associated parts for corrosion, oil, grease and grime. Tighten any loose hardware. Replace damaged parts. If necessary.

6.7.2.8. Inspect discharge hoses

Inspect the flexible discharge hoses for loose fittings, damaged threads, cracks, rust, kinks, distortion, dirt and frayed wire braid. Tighten loose fittings and replace hoses with stripped threads. If necessary.

6.7.2.9. Inspect discharge nozzles

Inspect discharge nozzles for dirt and physical damage. Replace damaged nozzles. If nozzles are dirty or clogged.

6.7.3. Inspection procedures, semi-annual

6.7.3.1. Discharge pressure switch test

1. Contact the appropriate personnel and obtain authorization for a shutdown.
2. Ensure that the hazard area operations controlled by the pressure switch are operative.
3. Manually operate the manifold switch by pulling up on the plunger and verify that the hazard area operations controlled by the pressure switch shut down.
4. Return the manifold pressure switch to the SET position.
5. Reactivate all systems that were shut down by the pressure switch (such as power, ventilation systems and compressors)

6.7.3.2. Solenoid actuator test

Solenoid actuator must be tested semiannually for proper operation. This test can be performed without discharging the cylinders. Test one hazard area at a time before proceeding to the next, as follows:

1. Remove all solenoid actuators from all cylinders serving the hazard area being tested. Let the solenoid actuators hang freely from the flexible electric conduit connections. Leave all pneumatic actuators and pilot actuation hoses attached to the cylinders.
2. Operate the System electrically. This can be accomplished by actuation of the control panel or by manual operation of an electric pull station.
3. If the manual actuator has not operated. Replace all damaged actuators.
4. Observe the instructions on the caution label attached to the manual actuator. Replace any damaged heads which fail to reset properly before reconnecting to cylinders. Reattach all actuators to the threaded port on the cylinder valve or pressure operated control head. Tighten the swivel nut securely. Make certain each actuator is in SET position before reconnecting to cylinders. Failure to follow this procedure will result in accidental system discharge.

6.7.3.3. Check cylinder weight

The cylinder weight shall be checked and compared to the gross weight marked on the cylinder. If the scale indicates a loss in agent quantity of more than 5 %, it shall be refilled. Remove and recharge the cylinder. For other requirements related to periodic maintenance of the Clean Agent Unit please refer manual clause 6.2.1.

6.7.4. Inspection procedures - 2 year

1. Remove any nozzles from the piping to allow foreign matter to blow clear.
2. Remove all pneumatic actuators from the cylinders.

3. Blow out all distribution piping with air or nitrogen to ensure it is not obstructed.

4. Reconnect all control heads.

6.7.5. Inspection procedures - 5 year

6.7.5.1. Clean agent cylinders

FK-5-1-12 clean agent system is using TPED specification for their cylinders. Clean agent cylinders continuously in service for more than five years without discharge shall be removed from rack and given a complete external inspection incompliance with Authority Having Jurisdiction. Where external inspection indicates that the cylinder has been damaged, the same shall be sent for hydraulic testing. However, a hydraulic test shall be carried out after discharge of cylinder.

6.7.5.2. Flexible hose

All system hoses shall be visually inspected annually for damage. If visual examination shows any deficiency, hose shall be replaced or tested. As per the NFPA2001 hydrostatic test to be conducted at interval of every 5 years.

6.7.5.3. Record

All inspection and test records are to be maintained by end user. This record should be made available to the auditor during safety audit.

6.8. Check List

Table 6.2. Check List for Maintenance				
Features of the installation				
Installation Date		Type of the system		
Authorized Installer		Country of Installation		
Maintenance				
Maintenance date		Last maintenance date		
Authorized company		Authorized person		
Maintenance type	***Semi-annual*** *Visual inspection Control pressure of the cylinders* ☐	***Annual*** *Functionality* ☐	***Every 2 years*** *Revision of wear and tear parts* ☐	***Every 5 years*** *Cylinder and valve testing or/and refilling* ☐
System working pressure	..... bar	Cylinder capacity		 L
Cylinders storage pressures verified	☐	Cylinders and labels are fine		☐
Safety valve in good state	☐	Electrical connections checked		☐
Revision of nozzles and internal discs satisfactory	☐	Operation test of the solenoid actuator satisfactory		☐
Extinguishing panel functional test is ok	☐	General visual inspection OK		☐
Blow out test with nitrogen to cleaning of the dirty and dusty ambient (each 2 years)				☐
General maintenance (each 5 years)				☐

7. Refilling Process

7.1. Introduction

The general situations that may require refilling are explained as follows;

1. A cylinder is going to discharge after system activation in case of fire.

2. A cylinder should be refilled when it shows a loss in agent quantity of more than 5 % or loss in pressure of more than 10 %.

3. Recovering the gas in the cylinder whose hydrostatic test inspection period has expired and refilling it after the hydrostatic test process.

These situations occur, the cylinders should be sent to an authorized filling station for refilling process.

IMPORTANT NOTICE:

The initial filling or refilling of cylinders must be carried out by trained and authorized personnel in UL approved filling facility. Unauthorized and/or untrained personnel must never attempt to fill cylinders. Even if the field has suitable conditions, the refilling process must be done at an authorized filling station. Transportation process shall be completed according to TPED Directive 2010/35/EU.

7.2. Clean Agent Filling Procedure

7.2.1. Authorized and Certified Filling Facility

Honeywell has a filling facility at the address below; refills must be done at this address and/or at one of the alternative filling facilities authorized by Honeywell and certified by UL. Contact with Honeywell Technical Team to learn about the authorized filling facility closest to you.

Honeywell Nexus Filling Facility:

Ovacik Mah. Ali İslam Cad. No:23/B, Basiskele, Kocaeli, Turkey, 41140

7.2.2. Filling Equipment

Filling equipment to be used in filling operations shall be supplied and/or existed equipment checked and approved by Honeywell. Filling operations cannot be performed with devices not supplied and/or approved by Honeywell.

IMPORTANT NOTICE:

All measuring devices shall be calibrated in ISO 17025 accredited laboratories within the relevant periods.

Clean agent charging equipment consists of following equipment;

1. Agent storage cylinder
2. Flexible hoses
3. Piping adapter
4. Control valves, strainer & pressure gauge
5. Filling adaptor set
6. Weighing scale
7. Nitrogen supply with pressure regulator
8. Agent filling pump station
9. Agent and nitrogen mixing station
10. Leakage control device

IMPORTANT NOTICE:

After an operation of the system, the cylinders shall be refilled with the correct amount of gas. All the information needed for the correct refilling (clean agent quantity, pressure etc.) appears in the labels of the cylinders. In case of doubt, please contact Honeywell Technical Team.

7.3. Performing the Refilling Process

Before refilling, must be checked that the cylinders meet the necessary conditions for refilling.

7.3.1. Refill Process Steps

General guidelines should be followed being careful while working with high pressures, chemical agents, heavy cylinders, etc. Be sure to follow any company training practices and other local code requirements when working with extinguishing system units and refill equipment.

If cylinder can be refill, follow the next steps correctly;

1. Check the cylinder for the last hydrostatic test date prior to charging.

2. Check the cylinder valve assembly for physical defects which are unacceptable.

3. With the cylinder ready for filling a check is made to the filling instruction sheet and the cylinder fill weight, time, date and fill details record. (for sample see the Table 7.5. Sample Record Book for FK-5-1-12 Clean Agent)

4. Connect the FK-5-1-12 agent supply lines to the cylinder valve.

5. Cylinder valve and filling adaptors connected each other and scale tare is arranged zero (after that every kg on the scale screen will show you net filled agent quantity).

6. Switch on the FK-5-1-12 agent pump and fill cylinder to required weight. When the fill is reached switch off pump.

7. Slowly increase the nitrogen pressure on the approved pressure regulator to the stated pressure on the filling instruction sheet, making the relevant allowances in pressure to compensate for the current room temperature (see the Table 7.6. Filling Pressure vs Temperature Chart). Calibrated pressure gauge or sensor attached to the extinguishing system to determine when the intended charging pressure has been reached. Read off the calibrated external fill pressure gauge to determine when the intended charging pressure has been reached. (Check that the cylinder pressure gauge reads within +/- 0.5bar of the fill gauge, replace cylinder gauge if outside this tolerance).

8. Shake the cylinder to accelerate nitrogen absorption into the agent and top up the pressure accordingly. Switch off nitrogen supply once absorption has stopped.

9. Turn off the nitrogen supply and open the vent valve to release remaining gas from filling adaptor.

10. At this time push the valve lock button which is located on the cylinder valve minimum 5 seconds. After that check the filling adaptor inside pressure, to be sure valve is closed and there

is no continues gas flow. If there is no gas flow, the valve is closed. Assemble the protection cap to valve outlet line. (to more detail see the Figure 7.3.: Valve locking after filling process)

11. Place cylinder in waiting area for leak monitoring for at least 24 hours prior to shipment.

12. After 24 hours a leak test on the cylinder is conducted. Move the leak test device probe back and forth slowly approximately 5 mm away from all potential leak points. (See the Figure 7.4.: Sample leak detector for final leaking control)

13. After leak test is complete, assemble all protection cap. (See the Figure 7.2.: Valve protection cap assemble to valve outlet line)

14. Insert fill information on to cylinder label.

15. Record the all data to filling station record book.

IMPORTANT NOTICE:

Record cylinder acceptance date, any comments or remarks, and initial filling or refill types in the filling station record book (See Table 7.5. Sample Record Book for FK-5-1-12 Clean Agent).

IMPORTANT NOTICE:

After the cylinder has been filled with the required quantity of agent and super-pressurized with nitrogen, it must be carefully checked for leaks. All potential leak points must be carefully inspected with a leak detector. The leak detector must be checked against a leak standard before each use, and after every five units tested or every half-hour, whichever comes first. For calibration purposes, the leak standard shall be set to the minimum leakage rate for the specific cylinder being filled. See Table 7.4. FK-5-1-12 Clean Agent Approximate Leak Rate by Cylinder Volume for details on approximate leak rates per cylinder.

7.3.2. Essential Points to Consider

1. Damaged or leaking valves have to be replaced immediately. Non-conformity report shall be prepared such kind of cases and take necessary actions according to related international regulations.
2. Shall take necessary actions when exceeding the permissible filling pressure or filling weight. To more information contact with Honeywell Technical Team.
3. Never tighten the release devices unless the cylinder is secured and fixed and unless the pipe work is connected to the cylinder valve outlet. (for more detail see the Figure 7.1.: Valve position during the filling process without release devices).
4. Sure about valve outlet protection cap is assembled on the valve after every filling process. An unintended actuation of the release device will release the system and could cause risk of injury and damage. (for more detail see the Figure 7.2.: Valve protection cap assemble to valve outlet line)

7.3.3. Instructions and Guidelines

The cylinder filling is only permitted without mounted release devices (solenoid, pneumatic or manual type).

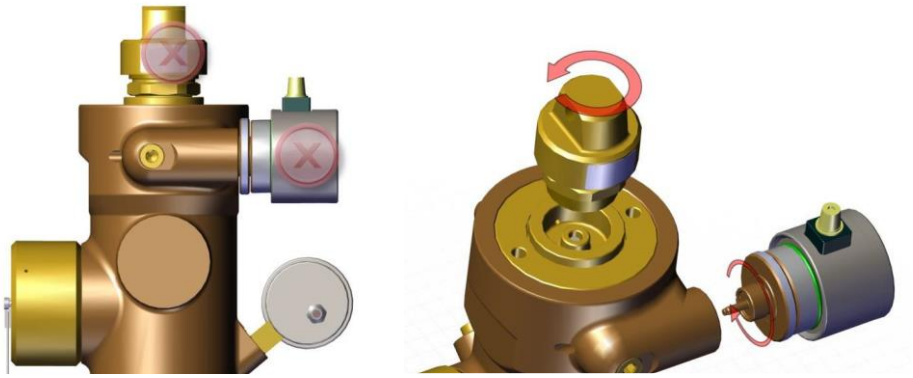


Figure 7.1.: Valve position during the filling process without release devices

Sure about valve outlet protection cap is assembled on the valve after every filling process.



Figure 7.2.: Valve protection cap assemble to valve outlet line

The cylinder valve is closing by a short actuation of the filling valve. (just pushing with the finger force, for over 4 seconds, all the way to the stop – no additional tools are allowed). The cylinder valve closes automatically.

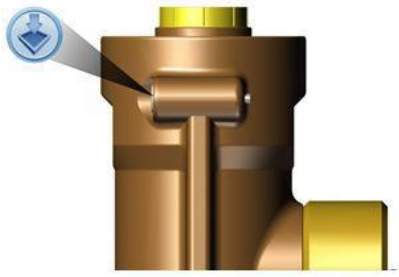


Figure 7.3.: Valve locking after filling process

After the filling process is completed, the cylinder is put on hold for 24 hours and then subjected to a leakage control test. The leakage control test is performed with a probe type special leak detector.

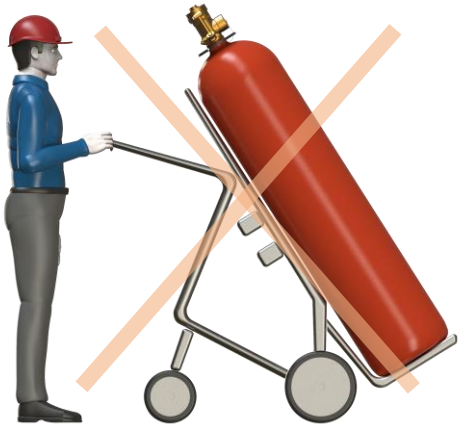


Figure 7.4.: Sample leak detector for final leaking control

When moving a cylinder from one point to another, a protective cover must be installed on the cylinder valve.



Correct application



Inccorrect application

Figure 7.5.: Correct and incorrect practices in cylinder handling operations

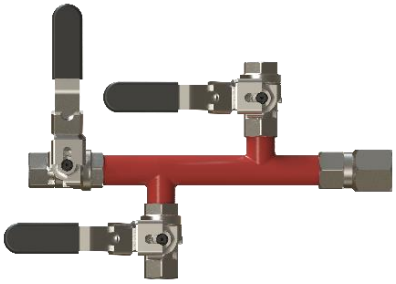
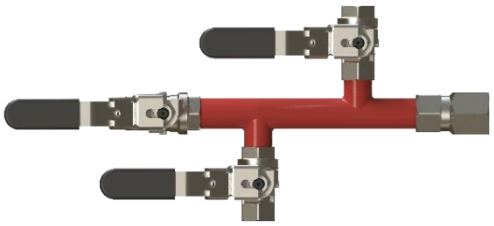
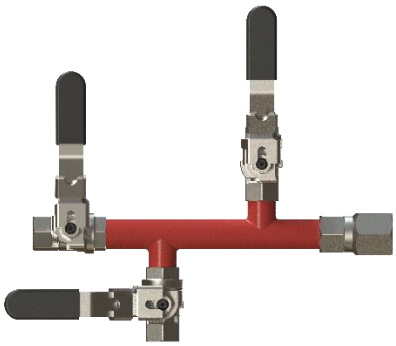
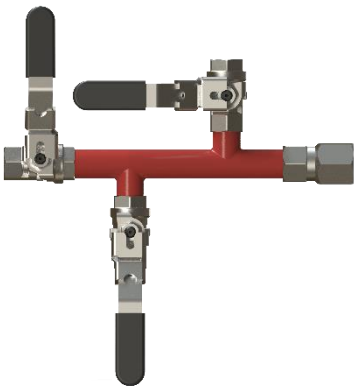
Table 7.1. DN12 Valve Filling Adaptor Positions During Filling Process	
Step-1	**Step-2**
Appropriate type of filling adapter is selected and aligned with the cylinder valve to be filled.	Filling adapter is tightened to the cylinder valve without any leakage from the filling port.
	
Step-3	**Step-4**
It is checked that all lines are closed.	Only agent supply line valve is open and pump start to filling process
	
Step-5	**Step-6**
Nitrogen supply line valve is open until to reach necessary storage pressure.	Remaining gas in the adapter is vented to the atmosphere.
	
For more information check the 2.2.18.1.Filling adaptor set for DN12 valve (P/N: HSN-FLA-12-01) and Section 7.3.1.Refill Process Steps.	

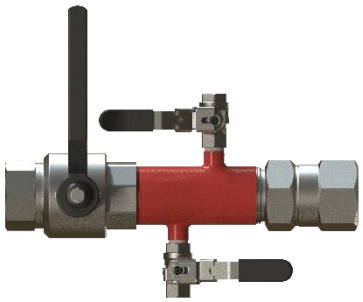
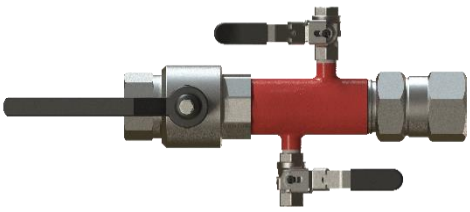
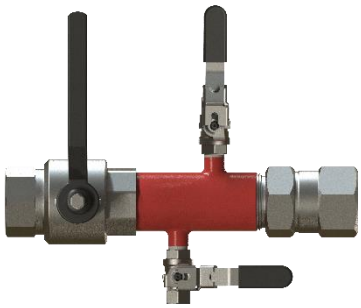
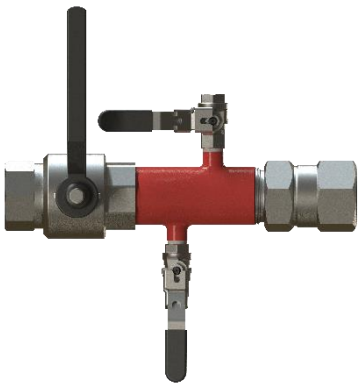
Table 7.2. DN33 Valve Filling Adaptor Positions During Filling Process	
Step-1	**Step-2**
Appropriate type of filling adapter is selected and aligned with the cylinder valve to be filled.	Filling adapter is tightened to the cylinder valve without any leakage from the filling port.
	
Step-3	**Step-4**
It is checked that all lines are closed.	Only agent supply line valve is open and pump start to filling process
	
Step-5	**Step-6**
Nitrogen supply line valve is open until to reach necessary storage pressure.	Remaining gas in the adapter is vented to the atmosphere.
	
For more information check the 2.2.18.2.Filling adaptor set for DN33 valve (P/N: HSN-FLA-33-01) and Section 7.3.1.Refill Process Steps.	

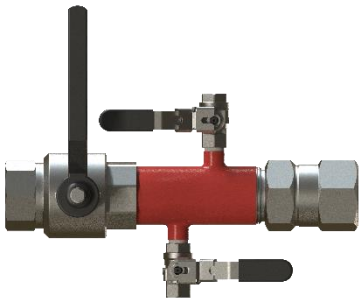
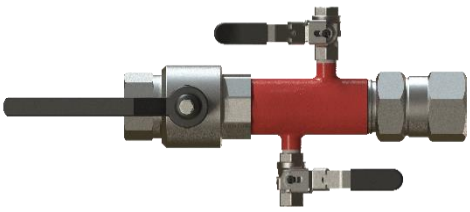
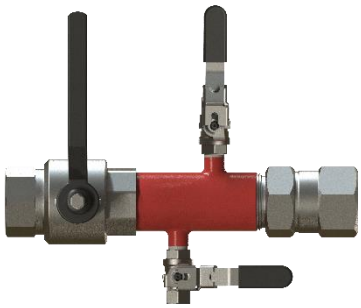
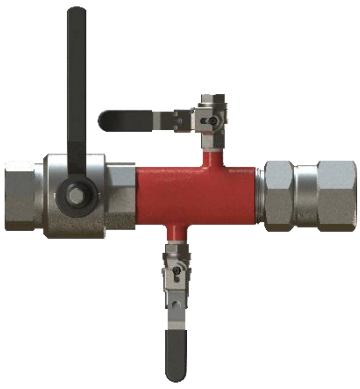
Table 7.3. DN50 Valve Filling Adaptor Positions During Filling Process	
Step-1	**Step-2**
Appropriate type of filling adapter is selected and aligned with the cylinder valve to be filled.	Filling adapter is tightened to the cylinder valve without any leakage from the filling port.
	
Step-3	**Step-4**
It is checked that all lines are closed.	Only agent supply line valve is open and pump start to filling process
	
Step-5	**Step-6**
Nitrogen supply line valve is open until to reach necessary storage pressure.	Remaining gas in the adapter is vented to the atmosphere.
	
For more information check the 2.2.18.3.Filling adaptor set for DN50 valve (P/N: HSN-FLA-50-01) and Section 7.3.1.Refill Process Steps.	

Table 7.4. FK-5-1-12 Clean Agent Approximate Leak Rate by Cylinder Volume		
Part Number	**Cylinder Volume** (L)	**Leak Rate** (g/year)
HSN-FK-US-SM-008-1	8	7.2
HSN-FK-US-SM-013-1	13.4	12.1
HSN-FK-US-SM-026-1	26.8	24.2
HSN-FK-US-SM-040-1	40	35.6
HSN-FK-US-SM-067-1	67.5	60.7
HSN-FK-US-SM-080-1	80	71.9
HSN-FK-US-SM-120-1	120	106.7
HSN-FK-US-SM-180-1	180	161.8

Table 7.5. Sample Record Book for FK-5-1-12 Clean Agent							
PO No	**Date**	**Cylinder Serial Number**	**Cylinder Vol. (L)**	**Initial or Refill**	**Filled Agent Weight (kg)**	**Storage Pressure (bar)**	**Leak Test Result**
24111	21.09.24	UN120F001	120	Refill	120.2	42	Passed
24112	12.10.24	UN080L001	80	Initial	76.4	42	Passed
24113	28.10.24	UN040Y001	40	Refill	42.2	42	Failed

IMPORTANT NOTICE:

Gas filling record book must be filled by authorized persons. Information of the persons who perform filling process, quality control and final approval must be recorded in the filling record book. Filling record book must be kept in secure environments as hard copy and soft copy. Filling certificates must be issued for cylinders that have completed the entire process correctly.

Table 7.6. Filling Pressure vs Temperature Chart			
Temperature		Nominal Pressure	
°C	°F	bar	psi
10	50.0	40.9	593
12	53.6	41.0	595
14	57.2	41.1	596
16	60.8	41.3	599
18	64.4	41.6	605
20	68.0	41.8	609
21	**69.8**	**42.0**	**610**
22	71.6	42.3	613
24	75.2	42.7	619
26	78.8	43.0	624
28	82.4	43.5	631
30	86.0	43.7	634
32	89.6	44.1	639
34	93.2	44.5	645
36	96.8	44.9	651
38	100.4	45.3	657
40	104.0	45.7	663
42	107.6	46.1	668
44	111.2	46.5	674
46	114.8	46.9	680
48	118.4	47.3	686
50	122.0	47.7	692

IMPORTANT NOTICE:

For intermediate values not shown in this table, the required intermediate value can be found by calculating with the interpolation method. When specifying the minimum or maximum gas filling quantities of cylinders, "Table 2.3. 42 Bar FK-5-1-12 Clean Agent Seamless Cylinders" criteria must be taken into account during the filling process.

8. Typical System Layout

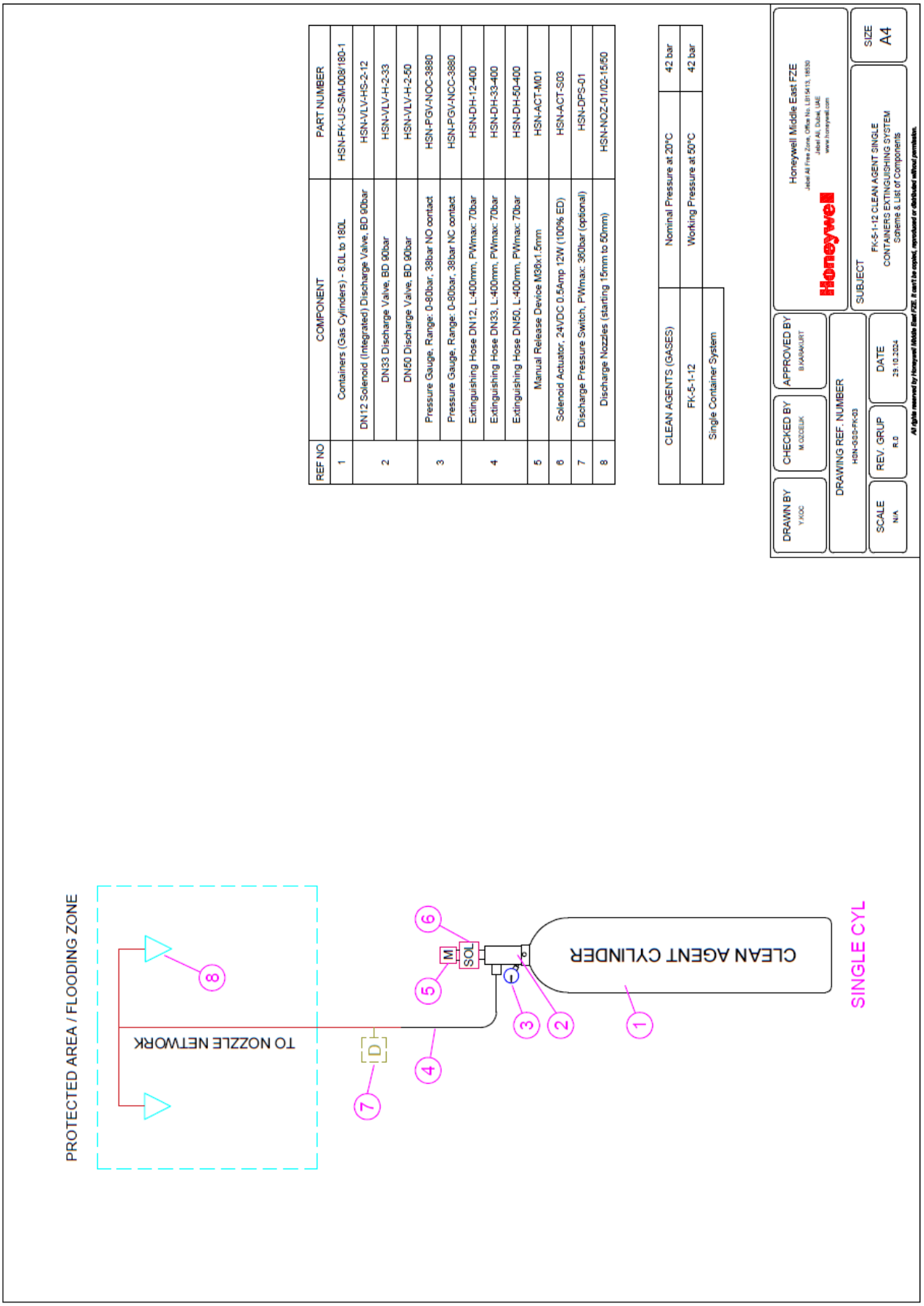
8.1. General

There are two main arrangements for a typical system layout.

- Single cylinder system arrangement
- Multiple cylinders system arrangement

The sections are intended to illustrate typical system drawings.

8.1.1. Single Cylinder System Arrangement



REF NO	COMPONENT	PART NUMBER
1	Containers (Gas Cylinders) - 8.0L to 180L	HSN-FK-US-SM-008/180-1
2	DN12 Solenoid (Integrated) Discharge Valve, BD 90bar	HSN-VLV-HS-2-12
	DN33 Discharge Valve, BD 90bar	HSN-VLV-H-2-33
	DN50 Discharge Valve, BD 90bar	HSN-VLV-H-2-50
3	Pressure Gauge, Range: 0-80bar, 38bar NO contact	HSN-PGV-NOC-3880
	Pressure Gauge, Range: 0-80bar, 38bar NC contact	HSN-PGV-NCC-3880
4	Extinguishing Hose DN12, L:400mm, PWmax: 70bar	HSN-DH-12-400
	Extinguishing Hose DN33, L:400mm, PWmax: 70bar	HSN-DH-33-400
	Extinguishing Hose DN50, L:400mm, PWmax: 70bar	HSN-DH-50-400
5	Manual Release Device M36x1.5mm	HSN-ACT-M01
6	Solenoid Actuator, 24VDC 0.5Amp 12W (100% ED)	HSN-ACT-S03
7	Discharge Pressure Switch, PWmax: 360bar (optional)	HSN-DPS-01
8	Discharge Nozzles (starting 15mm to 50mm)	HSN-NOZ-01/02-15/50

CLEAN AGENTS (GASES)	Nominal Pressure at 20°C	42 bar
FK-5-1-12	Working Pressure at 50°C	42 bar
Single Container System		

Honeywell Middle East FZE
Jebel Ali Free Zone, Office No. LB15413, 16830
Jebel Ali, Dubai, UAE
www.honeywell.com

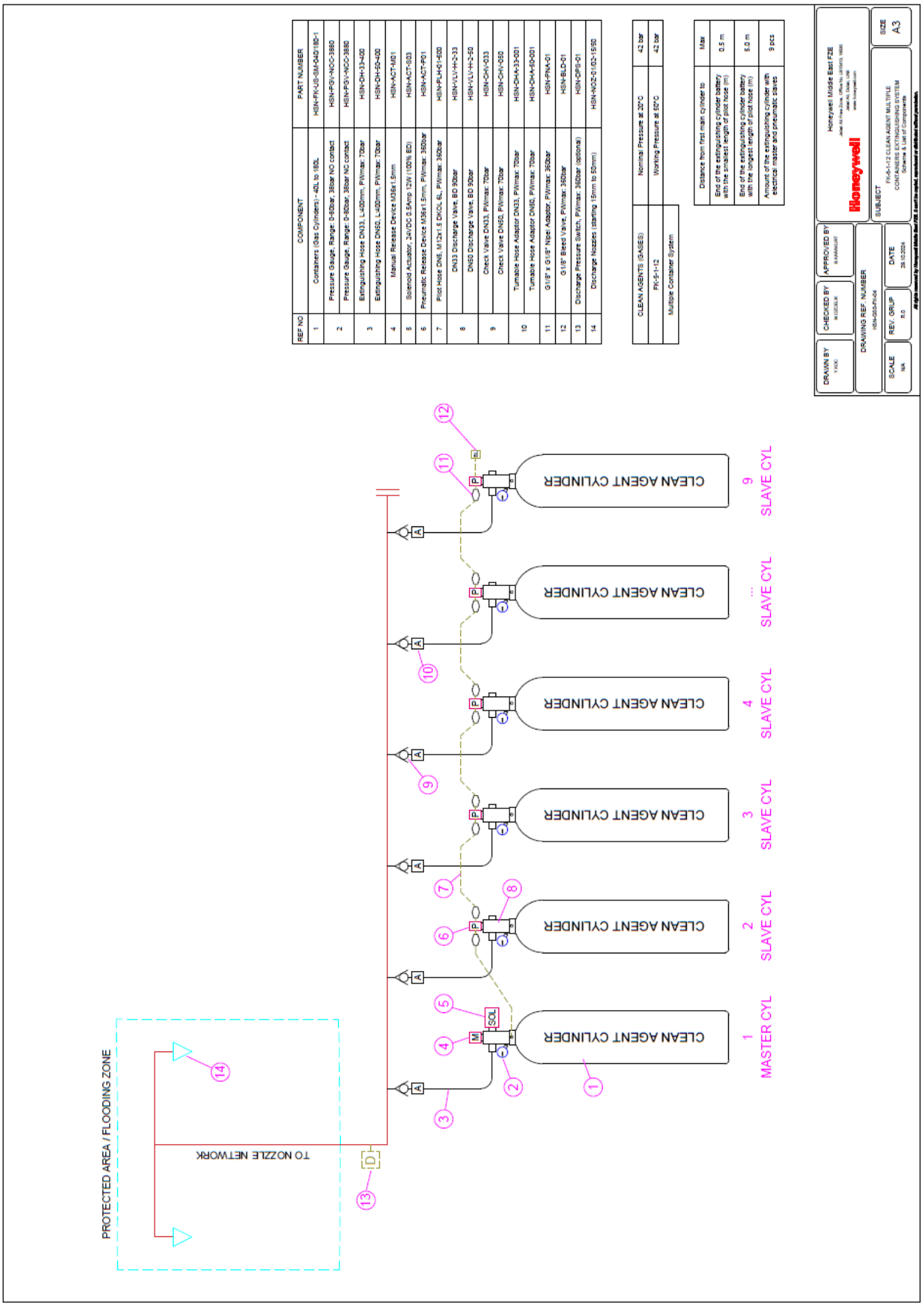
SUBJECT: FK-5-1-12 CLEAN AGENT SINGLE CONTAINERS EXTINGUISHING SYSTEM Scheme & List of Components

SIZE A4

DRAWN BY: Y.KOC
CHECKED BY: M.CEDELIK
APPROVED BY: B.KARAKURT
DRAWING REF. NUMBER: HSN-SSS-FK-03
SCALE: N/A
REV. GRUP: R.0
DATE: 29.10.2024

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8.1.2. Multiple Cylinders System Arrangement



Appendix A / Material Safety Data sheet for FK-5-1-12

SAFETY DATA SHEET

According to UN GHS, Annex 4 -Guidance on the Preparation of SDS

Fire Suppression Clean Agent FK-5-1-12

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Product name: Fire Suppression Clean Agent FK-5-1-12
Chemical name: 1,1,1,2,2,4,5,5,5- Nonafluoro-4-(Trifluoromethly)-3-Pentanone
CAS-No.: 756-13-8
REACH Registration No.: 01-2120426966-44-XXXX

Other means of identification

Synonym: Dodecafluoro-2-methylpentan-3-one
Dodecafluoro-2-methyl-3-pentanone
Perfluoro(2-methyl-3-pentanone)

1.2 Recommended use of the chemical and restrictions on use

Recommended use: Extinguishing agents, cleaning agents, solvents, hear transfer/cooling liquid
Uses advised against: No information available

1.3 Details of the supplier of the safety data sheet

Supplier

Honeywell Middle East FZE
Jebel Ali Free Zone, Office No. LB15413
18530, Jebel Ali, Dubai, UAE

Telephone: +971 4 450 5800
Fax: +971 4 450 5900

1.4 Emergency telephone number: +86-571-88844390

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Hazardous to the aquatic environment, long-term (chronic) Category 3

2.2. Label elements

Symbols/Pictograms: None
Signal word: None
Hazard statements: H412 - Harmful to aquatic life with long lasting effects

Precautionary statements: P273 - Avoid release to the environment
P501 - Dispose of contents/ cylinder to an approved waste disposal plant

2.3 Other hazards: No information available

SECTION 3: Composition/information on ingredients

Description: Substance

Chemical Name	CAS No	Weight-%
1,1,1,2,2,4,5,5,5- Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	756-13-8	>= 99.90

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice: Do not get in eyes, on skin, or on clothing. Do not breathe dust/fume/gas/mist/vapors/spray. In case of accident or unwellness, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Vapors are heavier than air and can cause suffocation by reducing oxygen available for breathing. Administer oxygen if breathing is difficult. Get medical advice/attention if you feel unwell.

Skin contact: Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Wash contaminated clothing before reuse. If skin irritation persists, call a physician.

Eye contact: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

Ingestion: Not an expected route of exposure. If swallowed, do not induce vomiting: seek medical advice immediately and show this cylinder or label. Never give anything by mouth to an unconscious person.

4.2 Most important symptoms and effects, both acute and delayed

No information available.

4.3 Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing: The substance can be used as extinguishing agent. Wear suitable respiratory equipment to protect from harmful gases caused by thermal decomposition.

Unsuitable extinguishing media: No information available.

5.2 Specific hazards arising from the chemical: Thermal decomposition can lead to release of irritating and toxic gases and vapors, such as carbon monoxide, carbon dioxide, hydrogen fluoride.

5.3 Protective equipment and precautions for firefighters:

Evacuate personnel to safe areas. Move cylinders from fire area if you can do it without risk. Cool drums with water spray. Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Stay upwind. Ensure adequate ventilation, especially in confined areas.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures:

Evacuate personnel to safe areas. Remove all sources of ignition. Ensure adequate ventilation, especially in confined areas. Avoid contact with eyes and skin. Do not breathe dust/ fume/ gas/ mist/ vapors/spray. Do not eat, drink or smoke when using this product. Wash thoroughly after handling.

6.2 Environmental precautions:

Local authorities should be advised if significant spillages cannot be contained. Prevent entry into waterways, sewers, basements or confined areas.

6.3 Methods and material for containment and cleaning up:

Avoid breathing dust/fume/gas/mist/vapors/spray. Avoid release to the environment.

Appendix A / Material Safety Data sheet for FK-5-1-12

SECTION 7: Handling and storage

7.1 Precautions for safe handling:

Handle in accordance with good industrial hygiene and safety practice. Do not handle until all safety precautions have been read and understood. Keep away from heat, sparks, flame and other sources of ignition. Ensure adequate ventilation, especially in confined areas. Avoid contact with skin and eyes. Do not breathe dust/fume/gas/ mist/vapors/spray. Do not eat, drink or smoke when using this product. Wash thoroughly after handling.

7.2 Conditions for safe storage, including any incompatibilities:

Keep cylinder tightly closed in a dry and well-ventilated place. Keep away from heat, sparks, flame and other sources of ignition. Keep locked up and out of reach of children. Keep away from food, drink and animal feeding stuffs. Store in accordance with local regulations.

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Exposure limits: No data applicable.

8.2 Appropriate engineering controls: Ensure adequate ventilation, especially in confined areas. Showers. Eyewash stations. Remove all sources of ignition.

8.3 Individual protection measures, such as personal protective equipment:

Respiratory protection: In case of insufficient ventilation, wear suitable respiratory equipment.
Hand protection: Wear protective gloves.
Eye/face protection: Wear safety glasses with side shields (or goggles).
Skin and body protection: Wear suitable protective clothing.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties:

Appearance: Liquid

Color:	Colorless
Odor:	Faint odor
Odor threshold:	Not determined
pH:	Not determined
Melting point/freezing point:	-108.0 °C
Boiling point/boiling range:	49.2 °C
Flammability (solid, gas):	Not flammable
Flammability limit in air:	Not determined
Flash point:	Not determined
Autoignition temperature:	Not determined
Decomposition temperature:	Not determined
Kinematic viscosity:	Not determined
Dynamic viscosity:	Not determined
Solubility(ies):	Practically insoluble in water
Partition coefficient (LogPow):	Not determined
Vapor pressure:	0.3260 bar (20 °C)
Density:	1.60 g/mL
Relative density:	Not determined
Vapor density:	11.6
Evaporation rate:	Not determined
Explosive properties:	Not an explosive
Oxidizing properties:	Not determined

9.2 Other information: No information available

SECTION 10: Stability and reactivity

Reactivity:	No information available.
Chemical stability:	Stable under recommended storage conditions.
Possibility of hazardous reactions:	Hazardous polymerization does not occur.
Conditions to avoid:	No information available**.**
Incompatible materials:	None known based on information supplied.
Hazardous decomposition products:	Carbon monoxide, carbon dioxide, hydrogen fluoride.

SECTION 11: Toxicological information

Acute toxicity:

Chemical name	Route	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Oral	Rat	LD50 > 5000 mg/kg
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Dermal	Rat	LD50 > 2000 mg/kg
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Inhalation	Rat (4 hours)	LC50 > 5000 mg/m^3

Skin corrosion/irritation:

Chemical name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Rabbit	Non-irritating to the skin.

Serious eye damage/eye irritation:

Chemical name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Rabbit	Non eye irritation

Sensitization:

Chemical name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Guinea pig	No sensitization responses were observed.

Germ cell mutagenicity: (Mammalian Chromosome Aberration Test & Mammalian Cell Gene Mutation Test)

Chemical name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	In Vitro	Not mutagenic

Carcinogenicity: No information available.

Reproductive toxicity: No information available.

STOT - single exposure: No information available.

STOT - repeated exposure: (28-Day (Subacute) Inhalation Toxicity Study)

Appendix A / Material Safety Data sheet for FK-5-1-12

Chemical name	Route	Target organ	Species	Test result	Exposure duration
1,1,1,2,2,4,5,5,5- Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Inhalation	liver | kidney and/or bladder | heart | endocrine system | hematopoietic system | muscles | nervous system | respiratory system | vascular system	Rat	NOAEL 3000000 mg/m3 (6h/d, 5d/w)	28 Days

Aspiration hazard: No information available.

SECTION 12: Ecological information

Ecotoxicity:

Chemical name	Algae/aquatic plants EC50	Fish LC50	Crustacea EC50
1,1,1,2,2,4,5,5,5- Nonafluoro-4-(Trifluoromethyl)-3-Pentanone (CAS: 756-13-8)	10.6 mg/L 96h Pseudokirchneriella subcapitata	> 1070 mg/L 96h Pimephales promelas	> 1080 mg/L 48h Daphnia magna

Persistence and degradability: Not readily biodegradable.
Bioaccumulation: BCF = 1.2 - 4.8
Mobility: No information available.
Other adverse effects: No information available.

SECTION 13: Disposal considerations

Waste treatment methods:

Waste from residues/unused products: Disposal should be in accordance with applicable regional, national and local laws and regulations.

Contaminated packaging: Disposal should be in accordance with applicable regional, national and local laws and regulations.

EU waste code (product a sold): 07 01 03* Organic halogenated solvents, washing liquids and other mother liquors. 14 06 02* Other halogenated solvents and solvent mixtures.

Appendix A / Material Safety Data sheet for FK-5-1-12

SECTION 14: Transport information

UN number: Not regulated
UN proper shipping name: Not regulated
Hazard class: Not regulated
Packing group: Not regulated
Environmental hazards: Non-marine pollutant
Special precautions: No information available
Transport in bulk according to Annex II of MARPOL and the IBC Code: Not applicable

SECTION 15: Regulatory information

15.1 International inventories:

Component	AICS	DSL/NDSL	EINECS/ELINCS	ENCS	IECSC	KECL	PICCS	TSCA
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone (>= 99)	X	X	X	X	X	X	-	X

"-" Not Listed
"X" Listed

SECTION 16: Other information

Key or legend to abbreviations and acronyms used in the safety data sheet

TWA - TWA (Time Weighted Average)
STEL - STEL (Short Term Exposure Limit)
Ceiling - Maximum limit value
TSCA - Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
IECSC - Chinese Inventory of Existing Chemical Substances
EINECS/ELINCS - European INventory of Existing Commercial chemical Substances/European LIst of Notified Chemical Substances
ENCS - Japanese Existing and New Chemical Substances
KECL - Korea Existing Chemicals List
NZIoC - New Zealand Inventory of Chemicals
PICCS - The Philippine Inventory of Chemicals and Chemical Substances

Appendix A / Material Safety Data sheet for FK-5-1-12

AICS - The Australian Inventory of Chemical Substances

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Note: The SDS document in this section is a sample reference only. Technically, SDS information is country and language specific.

-------- End of Safety Data Sheet --------