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FSL 1230™ Engineered System Design, Installation & Maintenance Manual

Foreword

This manual provides instructions and information on the design, installation and maintenance of the FSL 1230™ FK-5-1-12 Engineered System, referred to hereinafter as the FSL 1230™.

Systems shall be designed, installed and maintained in accordance with this manual and the internationally recognised standards:

- J NFPA 2001, Standard on clean agent fire extinguishing systems
- J EN 15004-1, Fixed firefighting system – Gas extinguishing systems

Note: The system is approved for use in Europe and countries which accept European Approvals. The references to NFPA 2001 are for information and may be applicable when users require a European product and NFPA system design.

The NFPA 2001 allows for FSL 1230™ system pressures of 25/42 bar.

The manual must be read in conjunction with the International Standards because the requirements from the standards are excluded from the text.

FSL 1230™ systems must be designed, installed, commissioned and maintained by qualified and competent personnel who have the relevant training and experience. Systems are total flooding and suitable for buildings, plant or other structures. See EN 15004-1 Section 1.0.

Any questions, queries and suggested improvements should be brought to the attention of Firetec System Limited.

This design manual does NOT include the use of the FSL 1230™ system for local application or explosion suppression systems and marine or aviation use. All are Engineered Total Flooding systems which must be designed using the VdS hydraulic calculation program. Pre-engineered systems are NOT covered.

Eurotech Fire Protection Ltd and Firetec Systems Limited strive to continually improve its products and systems. Please check regularly that you are using the latest version of the manual.

The pressure vessel containing the fire extinguishing agent is generally referred to as a cylinder or container. This manual generally uses the word container.

All units are in metric.

The manual must be used by a trained and competent technician who follows the manual and appropriate national and international standards. The company disclaims any responsibility or liability for any use of the products or systems outside of the instructions contained within this manual and the international standards.

The systems are suitable for storage and environmental conditions from -20°C to +50°C.

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1. Introduction

The system provides a total flooding fire suppression system in accordance with EN 15004-1 or NFPA2001.

FK-5-1-12 may be used in the protection of the following types of facilities:

- J Data processing
- J Process control rooms
- J Telecommunications facilities
- J High value assets

FK-5-1-12 is *NOT* suitable for:

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

1.1. Fire detection and Controls

This manual covers the design and installation of the fire suppression/extinguishing system not the fire detection, actuation, or control requirements. These are important aspects to ensure the correct operation of the extinguishing system and must be completed by skilled and competent personnel to appropriate international standards e.g. EN15004-1, NFPA2001, BS 5839, BS 7273.

These systems require fast detection and discharge to minimise the fire damage and the extinguishant decomposition. Do not delay the extinguishant discharge longer than is necessary to evacuate the protected space. Any delay will allow the fire to increase in size, producing more products of combustion and result in more decomposition products during the extinguishing process.

2. Approvals

This manual has been reviewed by the Loss Prevention Certification Board (LPCB) for the Design of FSL 1230™ Clean Agent Engineered Systems. The Approval was obtained against LPS 1230; reference: LPCB Certificate numbers 1222A, 1222B, 1222C and 1222D dated October 2014.

Full details of the Scope, Qualifications/limitations can be found on the BRE Red Book live web site (www.redbooklive.com/).

Approved System design concentrations.

Product Name	Risk	EN 15004-2 Design Concentration** % vol.	LPCB Approved Design Concentration** % vol.
FSL 1230™	Class A (Standard)	5.3%	5.3%
FSL 1230™	Higher Hazard Class A (Cables)	5.6%	5.5%
FSL 1230™	Class B	5.9%	6.5%
** The design concentrations include a safety factor of 1.3 over the extinguishing concentration. Note: Inerting is excluded from the scope of the LPCB approval			

Note: The approval uses the Eurotech name, and we have amended this to FSL.

3. Extinguishing agent and safety

3.1. FK-5-1-12 Physical Properties

3M™ Novec™ 1230 Fire Protection Fluid (CF₃CF₂C(O)CF(CF₃)₂-Dodecafluoro-2methylpentan-3-one) is colourless, odourless and electrically non-conductive. It leaves no residue and has acceptable toxicity for use in occupied spaces.

Novec 1230 suppresses a fire by a combination of chemical (principally heat absorption) 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.

The system should be designed to discharge within 10 seconds. Novec 1230 is clean, efficient, environmentally acceptable, and leaves no residue, thus minimizing any downtime after a fire. Most materials contained in areas protected by Novec 1230, such as aluminium, brass, rubber, plastics, steel, and electronic components, are unaffected when exposed to Novec 1230.

Novec 1230 is stored as a liquid in steel containers and super pressurized with nitrogen to 25 bar or 42 bar to increase its discharge flow characteristics. When discharged, Novec 1230 will vaporize at the discharge nozzles and effectively mix with the air throughout the protected area.

Novec 1230 is suitable for extinguishing Class A and B type risks. Refer to the System Design section for specific guidance.

3M™ Novec™ 1230 Fire Protection Fluid Physical Properties

Chemical formula	CF ₃ CF ₂ C(O)CF(CF ₃) ₂
Chemical name	Dodecafluoro-2methylpentan-3-one
Molecular Weight	316.04
Boiling Point AT 1.013 Bar (absolute) ^a	49.2°C
Freezing Point	-108°C
Critical Temperature	168.66°C
Critical Pressure	18.646 bar ^a
Critical Volume	494.5 cc/mole
Critical Density	639.1 kg/m ³
Heat of Vaporization @ Boiling Point	132.6 kJ/kg
Vapour Pressure at 20°C	0.3260 bar ^a
Liquid Density at 20°C	1.616 g/ml
Saturated vapour density at 20°C	4.3305 kg/m ³
Specific volume of superheated vapour at 1.013 bar and 20°C	0.0719 m ³ /kg
Heat of vaporization at boiling point	88 kJ/kg
Ozone Depletion Potential	zero
Global Warming Potential	1

3.2. Safety Considerations

FK-5-1-12 has acceptable toxicity for use in occupied spaces as a total flooding agent. Refer to the NFPA2001 and EN 15004-2 or national guidelines for specific exposure limitations and discharge controls.

The Material Safety Data Sheet (MSDS) covering FK-5-1-12 should be read and understood prior to working with the agent. Safety items such as personnel training, evacuation plans, and fire drills should be considered.

Refer to, EN 15004-2 for current toxicity levels. The no observed adverse effect level (NOAEL) is 10% by volume and the lowest observed adverse effect level (LOAEL) is > 10%. For egress times from the protected space Annex G of EN 15004-1 give guidance.

We advise that all personnel are evacuated from the protected space prior to actuating the system to avoid them breathing the fires products of combustion. During the extinguishing process some decomposition products are produced, the amount of which is proportional to the fire size. Very low concentrations will be an irritant which will be a disincentive to enter the protected space and thus protect the health of personnel. The products of combustion and decomposition products can be acidic and corrosive to the contents of the protected space and should not be allowed to remain in the protected space. These products must be promptly and thoroughly ventilated from the protected space prior to allowing re-entry.

The gases may have migrated to neighbouring areas. Ensure that these areas are thoroughly ventilated.

3.2.1. Agent Decomposition Consideration

An unchecked fire will produce 'products of combustion' and at the seat of the fire only, FK-5-1-12 will decompose to extinguish the fire. These decomposition products are hazardous to health and should not be breathed.

On very hot surfaces (e.g., furnaces and ovens) FK-5-1-12 could decompose (typically above 600°C). The effects of FK-5-1-12 decomposition on equipment should be considered in hazards with high ambient temperatures.

Consideration should be given for providing adequate means of venting the protected area after a discharge.

3.2.2. Visibility

The discharge of FK-5-1-12 into a space may cause a reduction in visibility due to the moisture in the air condensing for a brief period. This will disappear in seconds as the agent warms to the surroundings.

3.2.3. Chilling

The FK-5-1-12 is stored as a liquid and vaporises at the nozzle. Any direct contact with the issuing agent will cause rapid cooling and possibly frostbite. Do not mount any delicate equipment adjacent to the discharge nozzles.

3.2.4. Noise

The discharge may result in some noise from the nozzle.

3.2.5. FK-5-1-12 agent storage containers

These are heavy and must be handled with care and the correct handling facilities. To prevent accidental discharge or damage to the equipment when not fully restrained (in the installed location) all actuators must be disconnected or removed where possible, all anti-recoil devices must be in place and transport caps fitted.

4. Systems configuration

FK-5-1-12 systems are intended to be used to suppress fires involving equipment or specific hazards. It is very effective where an inert, electrically non-conductive agent is required, or when clean-up of other agents presents a problem. Each FK-5-1-12 system is specifically designed to accommodate the individual demands of the areas to be protected. The wide range of configurations of the components provides the flexibility necessary for this custom design.

An engineered system requires that hydraulic flow calculations are undertaken to size the pipe work and discharge nozzles. Only the approved hydraulic calculation program shall be used, with the normal system design shall be at 20°C.

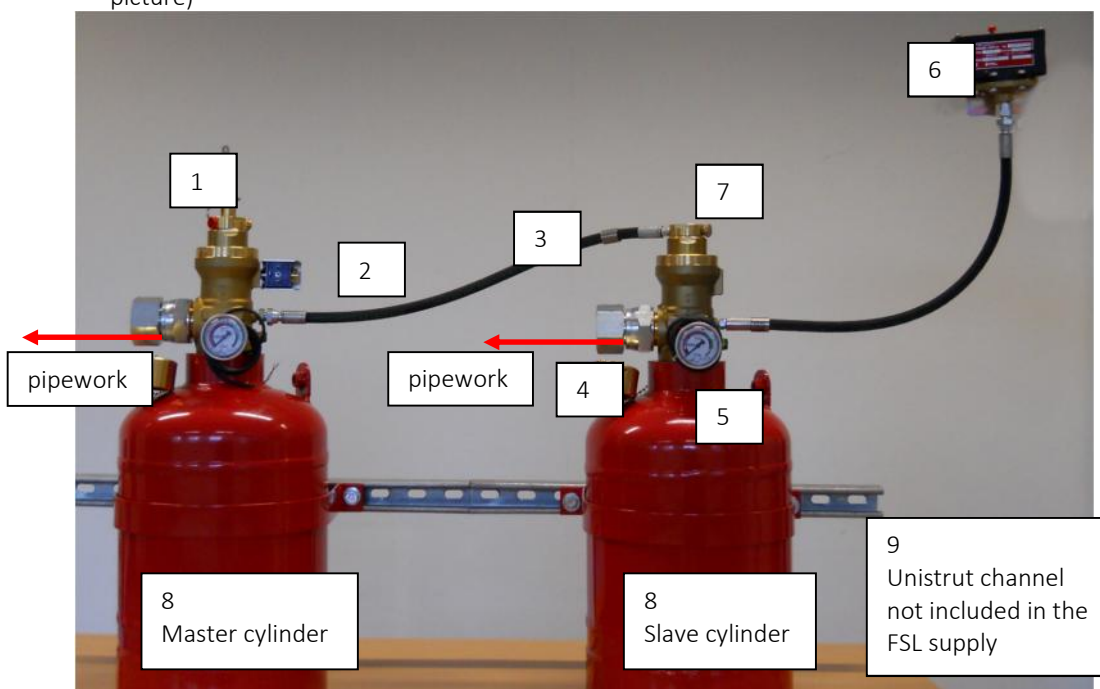
The system is composed by one or more cylinders connected to discharge nozzles by a pipework. The agent is released by operating one or more solenoid or manual actuators installed on master cylinders assemblies. Each master cylinder can open maximum 4 slave cylinders in cascade (total 5 cylinders). If the protection of one zone requires more than 5 cylinders, it is necessary to use more than one master cylinder.

The connection between the cylinders and the pipework may be accomplished in two different ways according to customer needs: by outlet adaptors or flexible hoses.

4.1. Dedicated system with outlet adaptors

The system is designed to protect one risk in the most common configuration. The outlet adaptor connects the cylinder directly to the discharge piping. Each cylinder has a separated pipework:

1. Pneumatic manual actuator (part no. NF26030)
2. Integrated Solenoid (included in master cylinder assemblies no. NF22****01*)
3. Pneumatic Actuator Connection Hoses (part no. NF271***)
4. Outlet Adaptors (part no. NF23**050*)
5. Cylinder Pressure gauge (part no. NF28****)
6. Discharge pressure switch (assembly no. NF280210A)
7. Pneumatic actuator (part no. NF26020)
8. Cylinder/valve assembly, including straps (assembly no. NF22****0**)
9. Unistrut (not included in the FSL supply)
10. Discharge nozzles (part no. NF2515*** to NF2550***, not represented in the following picture)
11. Signs and Labels (part no. NF290111, NF290211, NF22000613, not represented in the following picture)

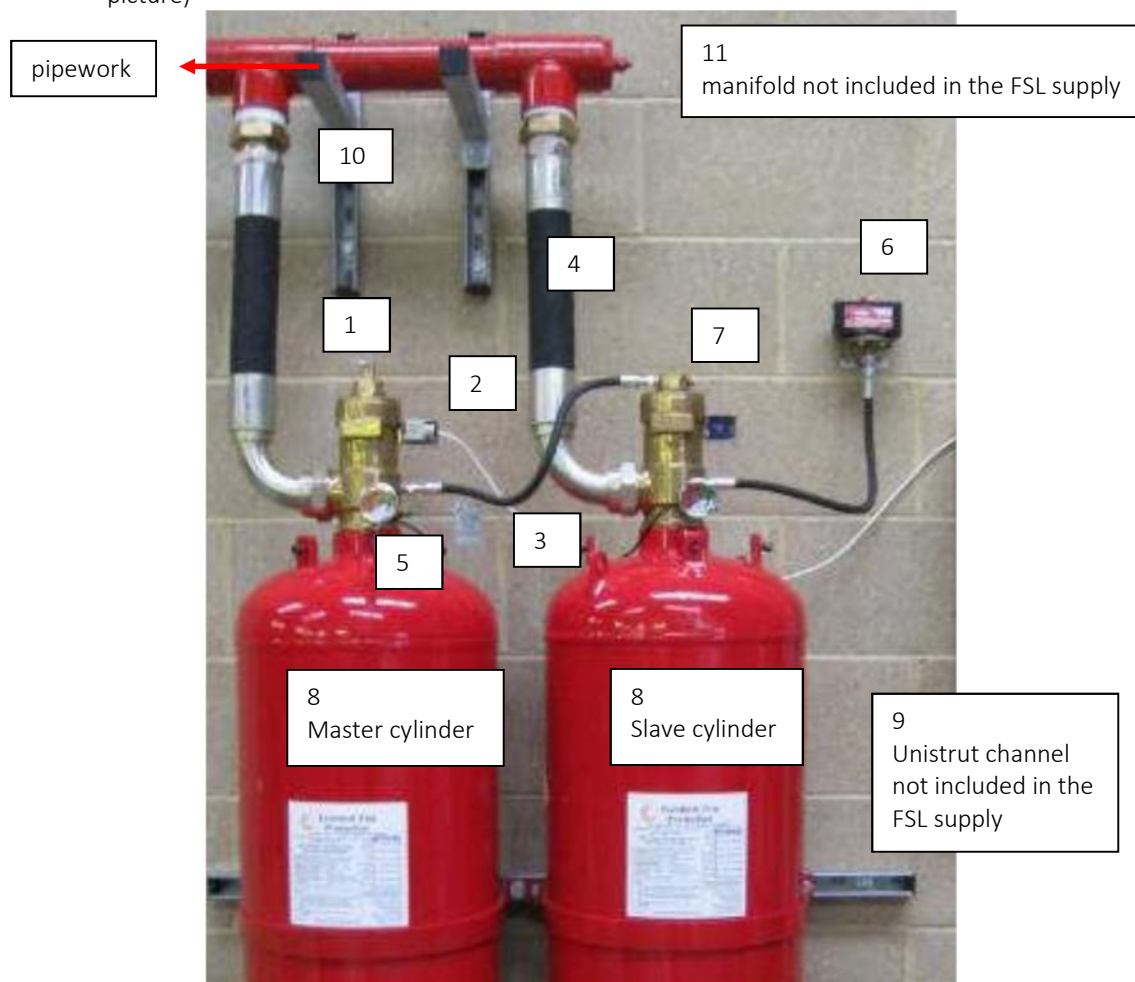


Dedicated 2-cylinder system with outlet adaptors

4.2. Manifolded system with discharge flexible hoses & check valves

The system is designed to protect one risk in the most common configuration. The flexible hose connects the cylinder directly to the discharge piping in systems composed by one cylinder only (check valve not needed). Each cylinder has a separated pipework. If the system is composed by 2 or more cylinders connected to the same pipework, it is necessary to use check valves.

1. Pneumatic manual actuator (part no. NF26030)
2. Integrated Solenoid (included in master cylinder assemblies no. NF22****01*)
3. Pneumatic Actuator Connection Hoses (Part no. NF271***)
4. Discharge flexible hoses (part no. NF23*****)4.14.2
5. Cylinder Pressure gauge (part no. NF28****)
6. Discharge pressure switch (assembly no. NF280210A)
7. Pneumatic actuator (part no. NF26020)
8. Cylinder/valve assembly, including straps (assembly no. NF22****0**)
9. Unistrut (**not included in the FSL supply**)
10. Discharge Check Valves (part no. NF24*****)
11. Manifold (**not included in the FSL supply**)
12. Discharge nozzles (part no. NF2515*** to NF2550***, not represented in the following picture)
13. Outlet Spacer, only for 180L cylinders with discharge flex hose (part no. NF234980, not represented in the following picture)
14. Signs and Labels (part no. NF290111, NF290211, NF22000613, not represented in the following picture)



Dedicated 2-cylinder system with manifold

4.3. Selector Valve Systems

Systems may be configured to protect more than one risk with a common storage facility (container bank). If this is required refer to the company for advice and component selection and configuration.

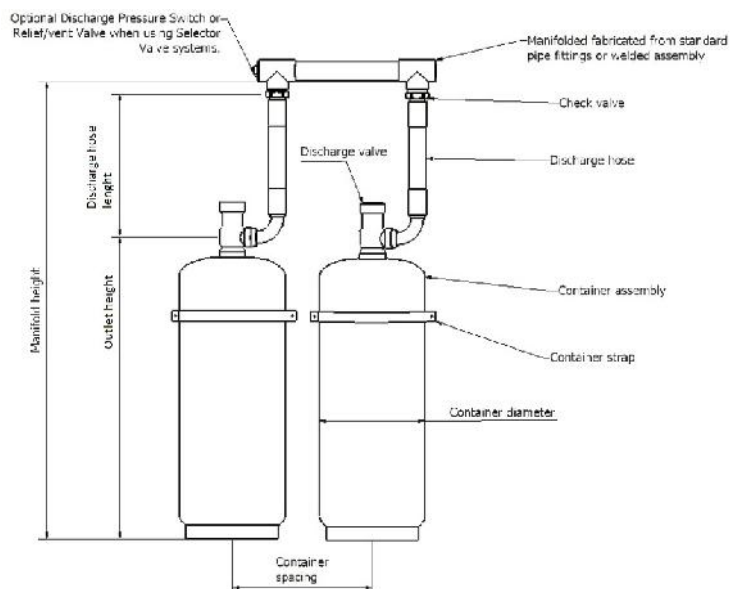
5. Equipment Description

5.1. Cylinder/Valve Assembly (assembly no. NF22****0**)

FK-5-1-12 is stored in specially designed cylinder assemblies. Cylinders are available in various sizes. All assemblies include:

- J Quick-release valve
- J Dip/siphon tube which extends from the discharge valve to a closely controlled distance from the base of the container. The minimum distance between the flat inlet to the dip tube and the base of the container, considering the worst-case tolerance of the dip tube and container internal depth shall be 50% of the bore diameter of the dip tube. Maximum gap shall be the dip tube bore. This ensures a full liquid discharge of agent. Dip tubes are screwed into the valve and retained with a thread sealant;
- J Valve protection cap;
- J Super pressurization with dry nitrogen to a pressure of 25 bar or 42 bar at 20°C;
- J Brackets for wall installing (NOTE: Unistrut channel is not included in FSL supply)

Do not leave the containers where they can be exposed to rapid changes of temperature from cold to hot because the internal pressure can rise significantly;



FSL 1230™ Container assemblies' dimensions

FSL 1230™ Container assembly numbers and technical specifications

Assy. Part no.	Container Assembly	Valve	Empty Weight. [kg]	Volume [L]	Diam.	Cont. Spacing	Outlet height	Hose length	Manifold height
NF22015#0*	15 litre	33	19.5	15	254	314	453	500	NA
NF22030#0*B	30 litre	33	28.5	30	254	314	773	500	1325
NF22050#0*B	50 litre	33	42	50	324	384	809	500	1358
NF22080#0*B	80 litre	49	63	80	324	384	1215	550	1833
NF22120#0*B	120 litre	49	90.5	120	406	466	1192	550	1810
NF22150#0*B	150 litre	49	105	150	406	466	1432	550	2060
NF22180#0*	180 litre	49	129	180	462	522	1322	550	1950

Code #=2 25bar system;

#=4 42bar system

Code *=0 No integrated solenoid (slave);

*=1 Included integrated solenoid (master)

Tolerance +/- 10mm on cylinder heights.

All cylinder will be supplied with an identification nameplate indicating the quantity of FK-5-1-12, pressurisation level and filling station. This filling label has a separate part number to consider different languages (NF22000613 for English).

Each cylinder assembly shall only be mounted in a vertical position with the valve uppermost and secured with the supplied straps to sound wall or secured racking.

Note: Container sizes and weights may vary dependent on the manufacturer and approval standard. Check for the latest data sheet.

5.1.1. Cylinder

Containers/cylinders shall be constructed to national standards and be independently certified for use in the region of use. Acceptable standards for use in:

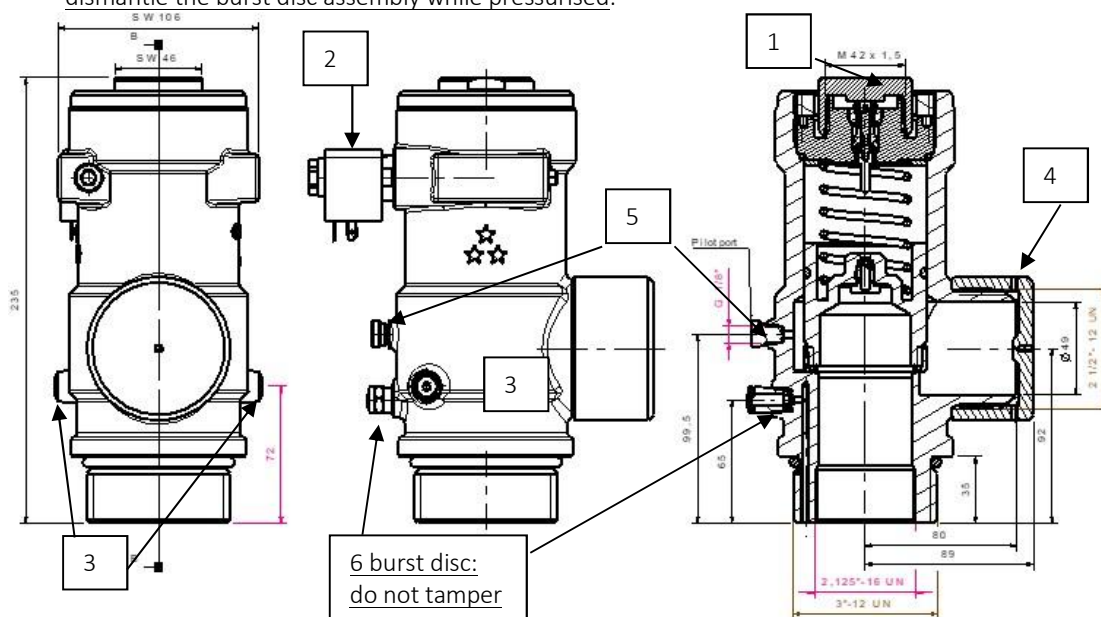
- J Europe are EN 13322-1 Transportable cylinders – welded, EN ISO 9809-1 to 4 transportable cylinders – seamless, Transportable Pressure equipment Directive (TPED 2010/35/EU) and the carriage of dangerous goods by road regulations (ADR).
- J USA is DOT 4BW500
- J India IS7285-2

5.1.2. Quick release valve

The minimum flow cross sectional area is compatible with the valve outlet sizes of 33 (855mm²) and 49mm (1886mm²). The actual flow characteristics are built into the VdS flow calculation program which must be used for all system calculations.

The cylinder valve has five connections:

1. Top mounted actuator connection.
2. Integrated electrical actuator. (Dependent on valve version).
3. Pressure gauge/pressure switch connection: this is a threaded connection housing a check valve and must be fitted with supplier approved devices to function correctly.
4. Outlet with JIC male connection.
5. Discharge pressure connection to pressure actuate slave cylinders or operate a discharge pressure switch.
6. Each valve is fitted with a burst disc which is set to protect the pressure vessel from excessive pressure. Burst disc to discharge the top gas chamber of the container should the working pressure of the container be exceeded. Burst discs are supplied rated for the charge pressure and the maximum working pressure of the container. Refer to the stamping on the disc holder. Do NOT attempt to dismantle the burst disc assembly while pressurised.



Quick-release valve. The version shown here includes the Integrated Solenoid Release

5.2. Extinguishing agent (part No. NF1230)

3M™ Novec™ 1230 Fire Protection Fluid is filled in liquid phase and super pressurized with nitrogen at 25/42bar. Each system stores the exact quantity of extinguishant needed to protect the enclosure. See 3 for Physical Properties and Safety considerations. Material safety datasheet of pure substance is in 11.

5.3. Discharge Valve Pressure Gauge, Pressure Switch (part no. NF28****)

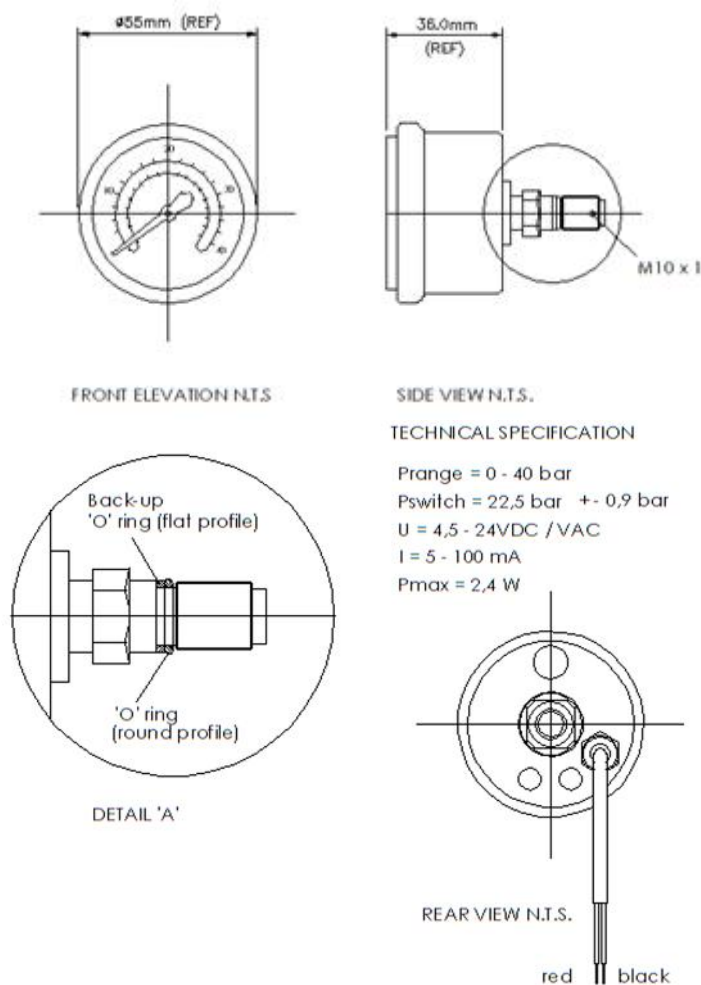
The pressure gauge, pressure gauge with limit signal generator or pressure switch are connected to the valve via the M10x1 connection port. There are two ports on either side of the valve which can be used. Any unused port must have the plug fitted.

Pressure gauge codes

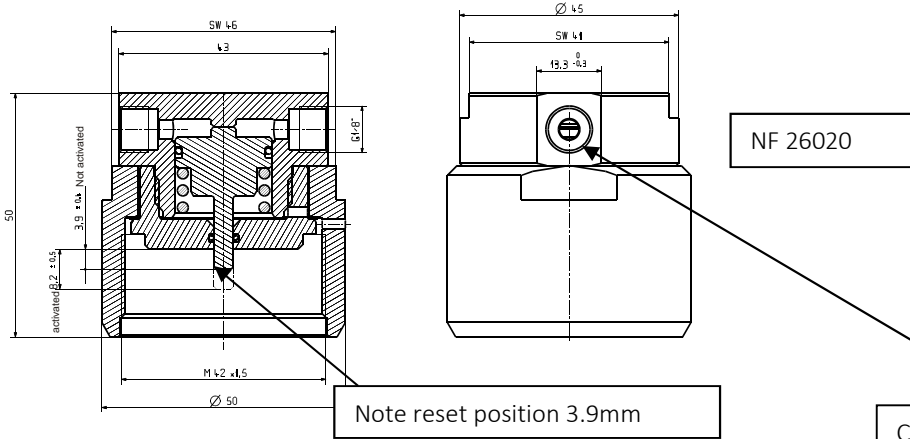
Part number	Pressure switch value	Switch status	Pressure gauge range
NF284004	no	N.A.	0-60bar
NF285022	22.5bar falling	N.O. low pressure N.C. normal pressure	0-40bar
NF285012	22.5bar falling	N.C. low pressure N.O. normal pressure	0-40bar
NF285024	38bar falling	N.O. low pressure N.C. normal pressure	0-60bar
NF285014	38bar falling	N.C. low pressure N.O. normal pressure	0-60bar

N.O. = normally open; N.C. = normally closed

The gauges and switches can be mounted and removed with the valve pressurised.



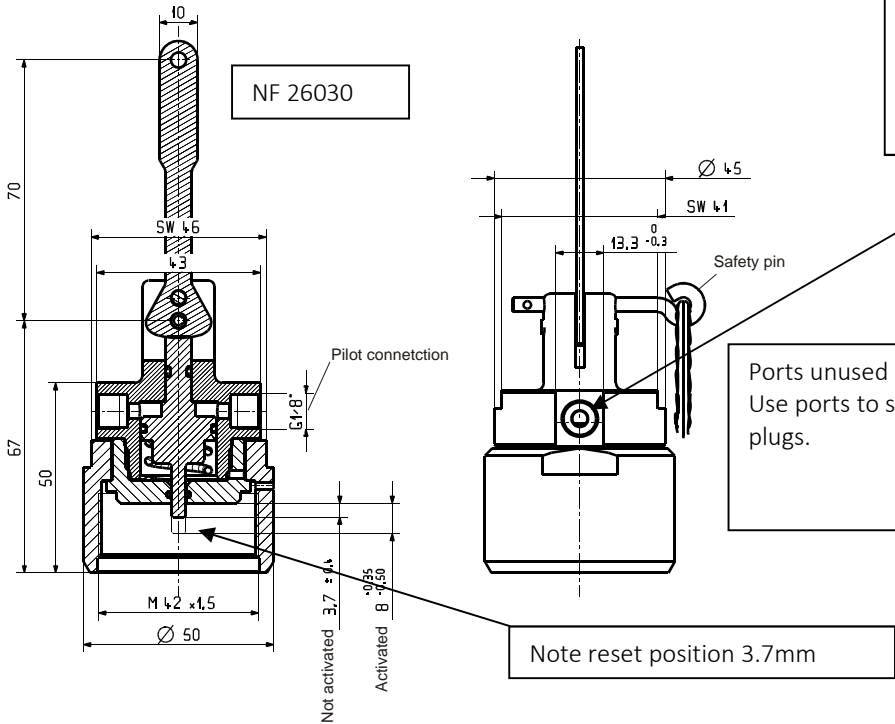
Dimensions and technical specifications of NF2850*2



NF 26020

Note reset position 3.9mm

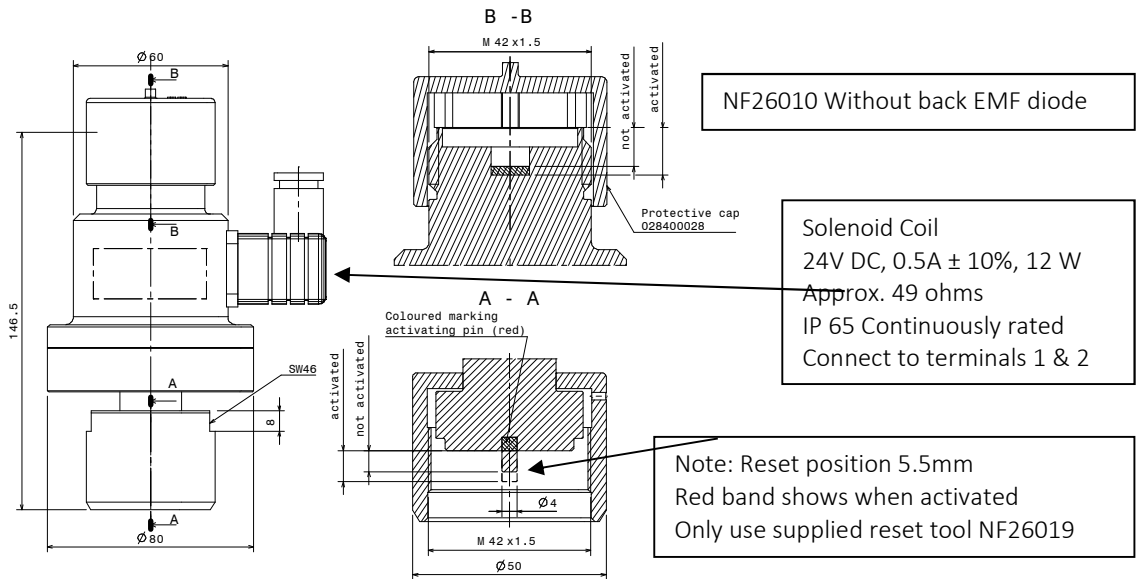
Connection G1/8 for pilot line
Seal the last open port with the G1/8 plug which was removed from the discharge valve Pilot port.



NF 26030

Note reset position 3.7mm

Ports unused on master discharge valve.
Use ports to store any spare valve Pilot plugs.



NF26010 Without back EMF diode

Solenoid Coil
24V DC, 0.5A ± 10%, 12 W
Approx. 49 ohms
IP 65 Continuously rated
Connect to terminals 1 & 2

Note: Reset position 5.5mm
Red band shows when activated
Only use supplied reset tool NF26019

Removable cylinders actuators and reset positions

5.4. Cylinder Valve Actuators (part no. NF260*0*)

In addition to the integral electrical actuator the cylinder valve can be fitted with a pneumatic actuator, pneumatic/manual actuator and an electrical solenoid actuator (see the previous figure), providing the following methods of actuation.

Cylinders actuators and accessories

Type	Part Number	Comments
Cylinder assembly with integrated solenoid in discharge valve (standard on master cylinder)	NF22****01*	24Vdc ±10%, 0.25A ±10%, 6W for 10 seconds, about 88ϕ, IP65
Pneumatic (standard on slave cylinder)	NF26020	Minimum operating pressure 21bar
Pneumatic/Manual (standard on master cylinder)	NF26030	Minimum operating pressure 21bar
Solenoid actuator kit (option)	NF26010A	Including NF26010, NF26030, NF26019
Solenoid without diode	NF26010	24Vdc ±10%, 0.5A ±10%, 12W for 10 seconds, about 49ϕ, IP65
Solenoid reset tool	NF26019	To reset NF26010 solenoid

5.5. Pneumatic Actuator Connection Hoses (part no. NF271***)

Pilot hoses are used to actuate slave valves. Pilot hoses are supplied with fittings and adaptor to suit connection onto the pneumatic actuators. Hose ends are R1/8". Only use the hoses supplied.



Pilot hose connections

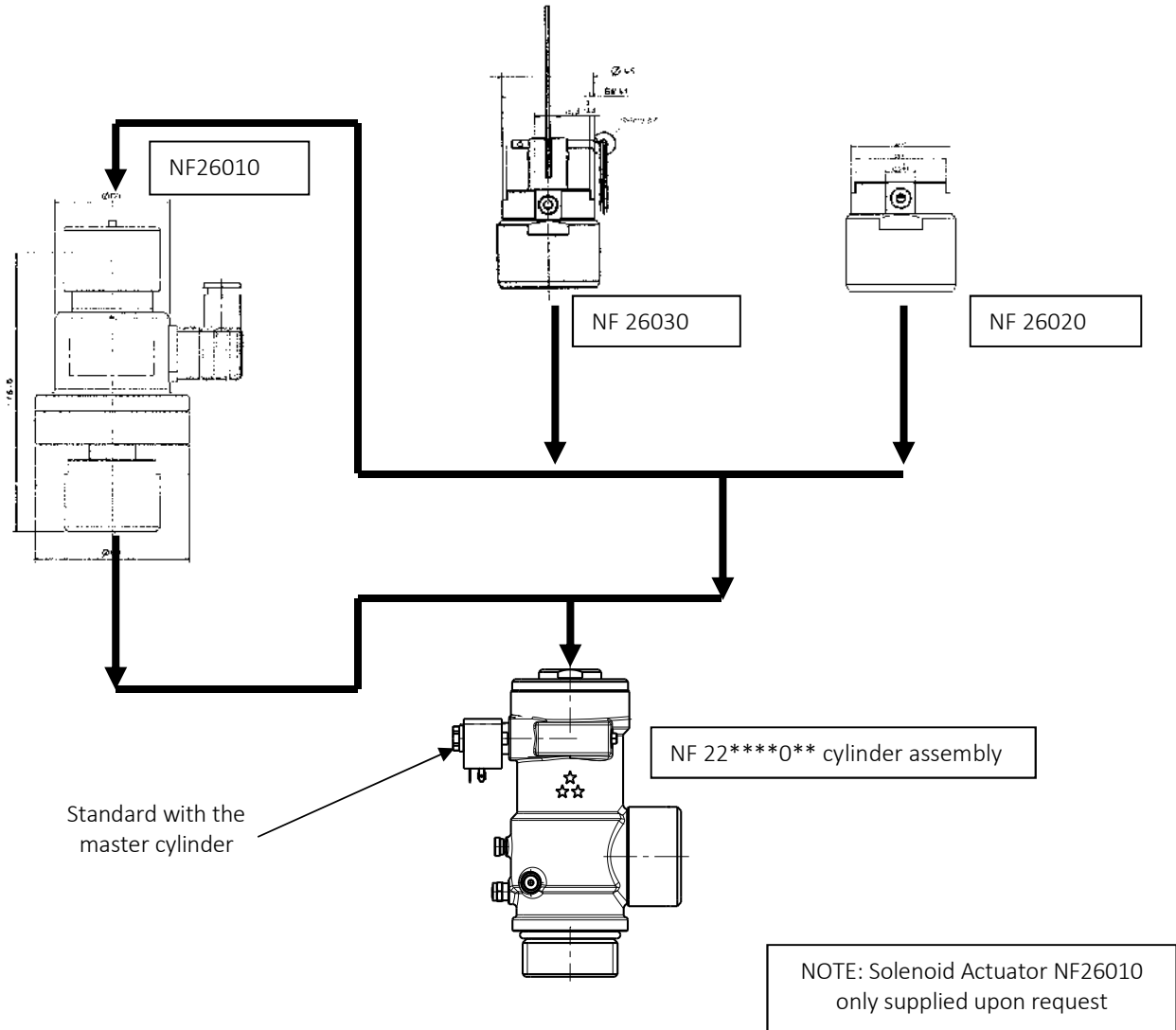
Pilot hoses part numbers and technical specifications

Part Number	Length	Maximum working pressure	Min Bend Radius
NF271560	560mm	210bar	110mm
NF271300	1300mm	210bar	110mm

Materials have been selected to give an extended life. Refer to the maintenance section for details of life and inspection requirements.

5.6. Actuation Options

Actuators can be used in combination. The standard master cylinder option is a master cylinder assembly with integrated solenoid NF22****01* with the manual actuation NF26030. The standard slave cylinder option is a slave cylinder assembly NF22****00* with the pneumatic actuation NF26020.



Master and slave actuation options: connection chart

In the following table the main combinations are reported:

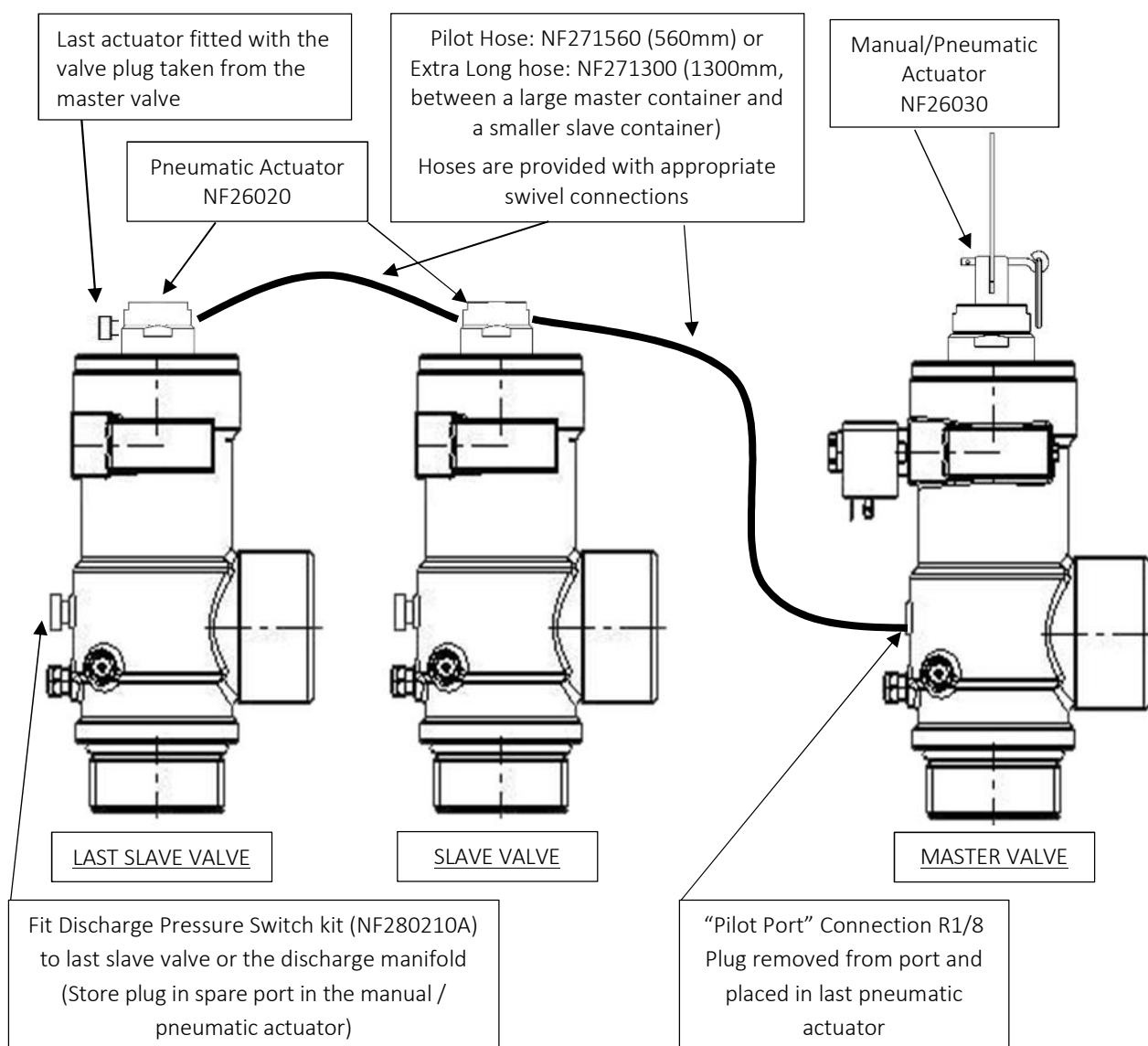
Type	Part Number	Comments
<u>Master cylinder standard</u>	NF22****01* NF26030	Integrated solenoid and manual actuation
Master cylinder option	NF22****01*	Integrated solenoid only
Master cylinder option	NF22****00* NF26010A	Solenoid actuator kit (which includes manual actuation) used on a valve without integrated solenoid
<u>Slave cylinder standard</u>	NF22****00* NF26020	Pneumatic actuator on a valve without integrated solenoid

Master and slave actuation options: part numbers

To open the cylinder valve fully, all the electrical release devices (integrated solenoid in assemblies NF22****01* and optional solenoid NF26010) shall be energized for at least 10 second by the control panel.

5.6.1. Slave actuation

One master valve may actuate up to four slave valves using the NF26020, NF26030 release devices. Pressure to be taken from master discharge valve "Pilot Port" using pilot hoses NF271***.



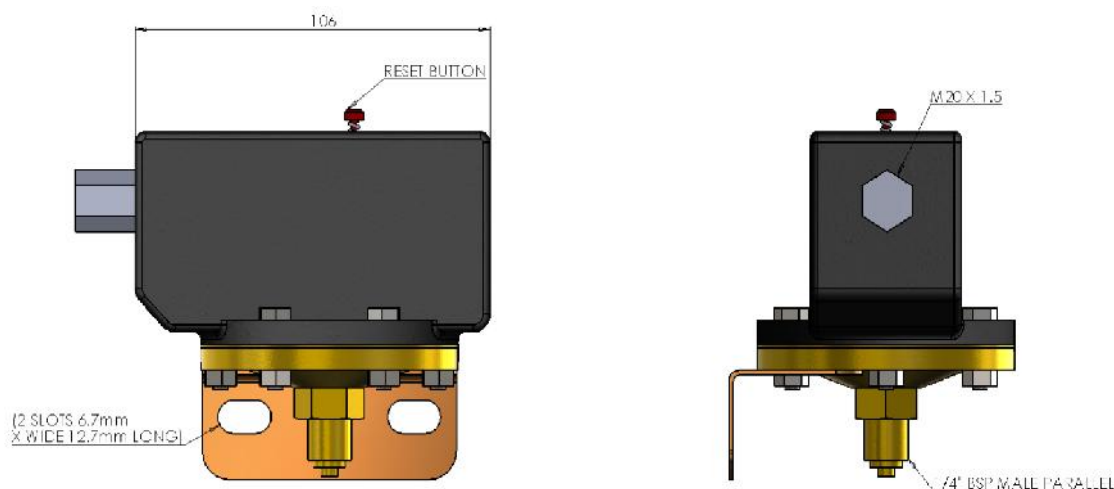
Pilot line with master/slave cylinders (1 master can actuate up to 4 slave, total 5 cylinders)

5.6.2. Pilot pressure actuation

The pneumatic actuation release pressure for actuators NF26020 and NF26030 may be derived from a separate pilot gas cylinder. The minimum supplied pressure to guarantee actuation shall be 21 bar (note: actual actuation will be at a lower pressure). The designer shall ensure that this can be achieved by the choice of pilot cylinder and the maximum pilot line run from the pilot cylinder to the actuator. The pressure should be maintained for 10 seconds (note the discharge valve will latch in the open position during discharge). Any pilot pressure supply must be continuously monitored.

5.7. Discharge pressure switch (assembly no. NF280210A)

Use to confirm the discharge of a system. The switch is wall mounted and connected to either the 'discharge pressure switch / pilot pressure port' on the discharge valve or the discharge manifold using the pilot hose NF280211.



Discharge pressure switch (NF280210)

Assembly number	NF280210A (includes pressure switch NF280210 and flexible hose NF280211)
Pressure switch NF280210	
Pressure connection	G1/4" (1/4" BSP male parallel)
Material wetted parts	Brass with beryllium copper diaphragm
Switch housing	Connection M20x1.5. Ingress protected to IP65
Electrical	SPDT Micro switch 10A 250V 50Hz, 1A 30V dc inductive load.
Set pressure	2 bar rising. Latching manual reset by top mounted button.
Mounting bracket	Included.
Connection hose NF280211	
Pressure connection	G1/8" (1/8" BSP male taper)
Hose length	560mm
Note: Not LPCB Approved	

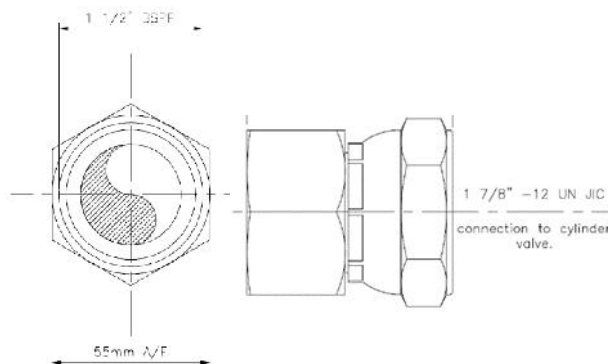
Discharge pressure switch technical specifications.

5.8. Outlet Adaptors (part no. NF23**050*)

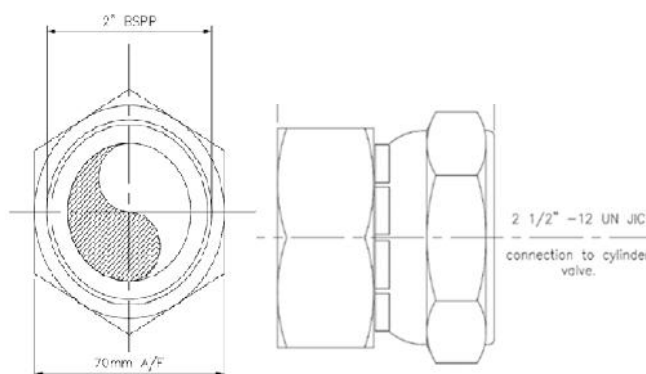
Provided with standard modular systems or single cylinder systems as an alternative to the discharge flexible hose. The adaptors can be provided with both BSPP and NPT outlet threads.

Outlet adaptors part numbers and connection threads

Part number	Inlet	Outlet
NF2333050	1.7/8"-12 UN JIC	1.1/2" BSPP
NF2333050N	1.7/8"-12 UN JIC	1.1/2" NPT
NF2349050	2.1/2"-12 UN JIC	2" BSPP
NF2349050N	2.1/2"-12 UN JIC	2" NPT



33mm Outlet Adaptor compatible with 15ltr, 30ltr & 50ltr cylinders - Outlet Size 1.1/2" BSPP or NPT (Female)



49mm Outlet Adaptor compatible with 80L, 120L, 150L, 180L cylinders - Outlet Size 2" BSPP or NPT (Female)



(Demonstration picture only, installing position of the adaptor)

5.9. Discharge flexible hoses (part no. NF23*****)

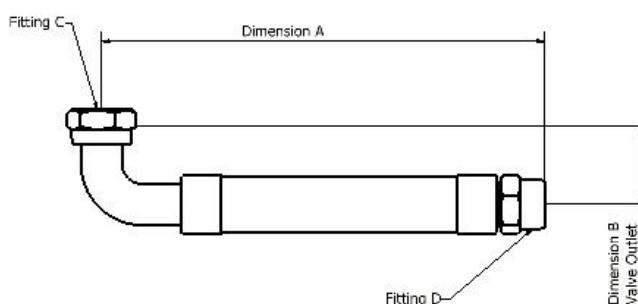
Provided with standard modular systems or single cylinder systems as an alternative to the outlet adaptor. Only the hoses supplied shall be used; these have an appropriate pressure and flow rating.

If multiple cylinders are banked together for discharge into a common manifold, then:

- J All cylinders must be of the same size and fill and pressurisation;
- J All discharge hoses must be fitted with a check/non-return valve;

Discharge flexible hoses part number and technical specifications

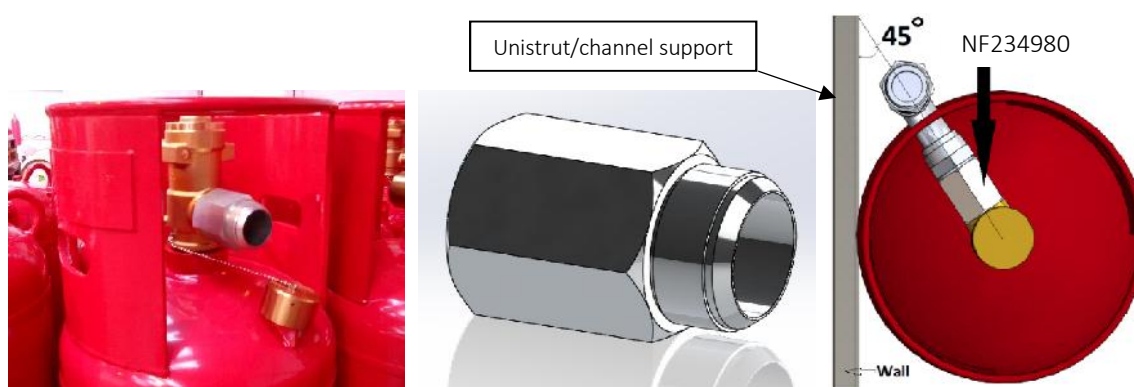
Part number	Min. bend radius (mm)	Dimension A (mm)	Dimension B (mm)	Valve fitting JIC C	Fitting ISO7-1 D	Minimum through bore (mm)
NF2333500	500	500	77	1.7/8"-12 UN JIC	1.1/2" BSPT	33.3
NF2333500N	500	550	77	1.7/8"-12 UN JIC	1.1/2" NPT	33.3
NF2349550N	635	550	99	2.1/2"-12 UN JIC	2" NPT	44.5



Discharge flexible hoses dimensions

5.10. Outlet Spacer (part No. NF234980)

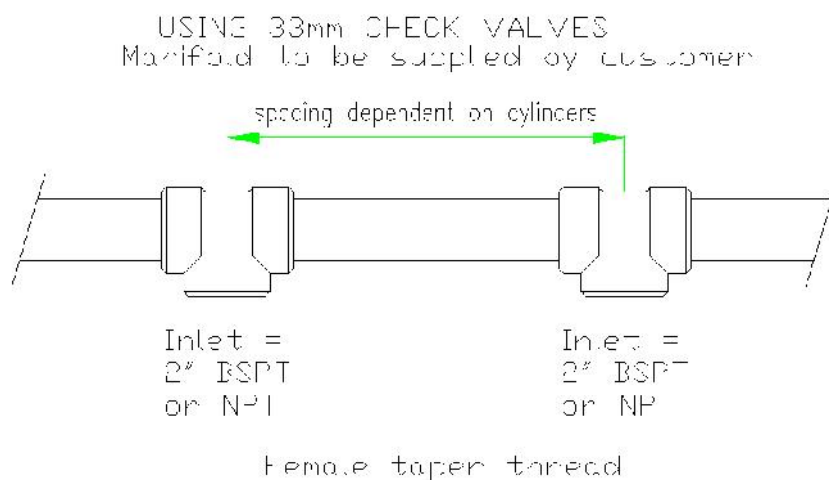
If the discharge flexible hose NF2349550N is used with an 180ltr container NF22180#1*B, then outlet spacer NF234980 must be used as well.



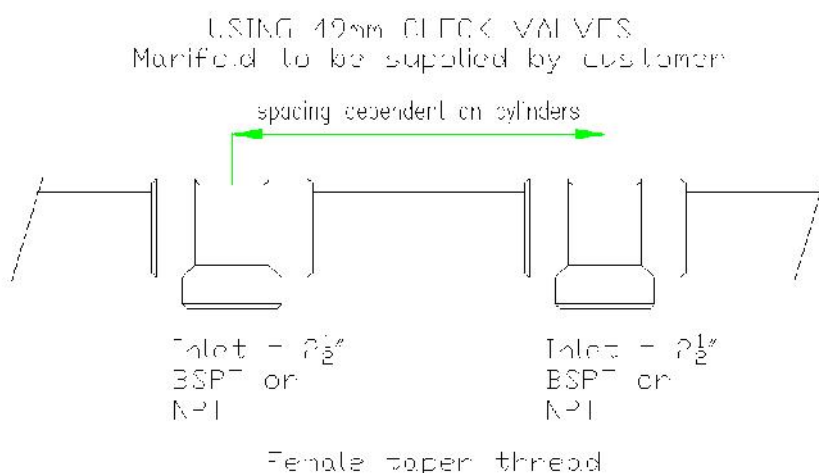
Outlet spacer used only in combination with discharge hoses and 180ltr cylinders

5.11. Manifold (not included in FSL supply)

The manifold is not included in FSL supply. Spacing, inlet connection size and installing height depend on cylinder size (see 5.1). Manifold size shall be determined by VdS flow calculation. Manifold shall be manufactured following the guidance in 7.2. Manifold arrangement is represented in the following figure.



Arrangement for 15ltr, 30ltr & 50ltr cylinders. Inlet threads may be NPT or BSPT according to check valves.



Arrangement for 80ltr, 120ltr 150 ltr & 180ltr cylinders. Inlet threads may be NPT or BSPT according to check valves.

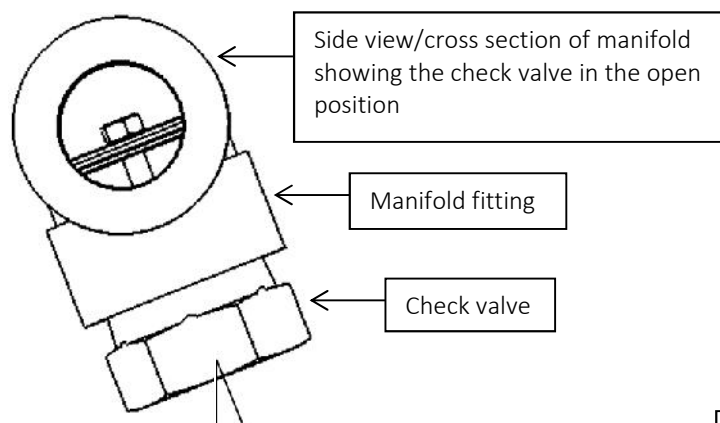
5.12. Discharge Check Valves (part no. NF24*****)

The check valves are used in manifolded system to prevent flow from the manifold when a cylinder is removed. The check valves can be provided with both BSP and NPT threads (for possible options please see the table).

Check valves part number and technical specifications

Part number	Inlet	Outlet	Minimum flow area	Use with Discharge Hose
NF24331	1 1/2" BSPT	2" BSPT	804mm ²	NF2333500
NF24332	1 1/2" NPT	2" NPT	804mm ²	NF2333500N
NF24492	2" NPT	2 1/2" NPT	1590mm ²	NF2349550N
NF24492-1	2" NPT	2 1/2" BSPT	1590mm ²	NF2349550N

Maximum service pressure 53 bar.



Check valve in the closed position

Manifold/Check valve side view

5.13. Discharge Nozzles (part no. NF2515*** to NF2550***)

The discharge nozzle plays an important role in the system in that it controls the flow of extinguishant and distribution of extinguishant into the protected space.

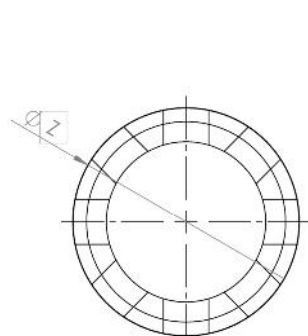
Two types of nozzle are available namely 180 degree for side wall mounting and 360 degree for centre space mounting. Both nozzles may be used for FSL 1230TM.

The nozzle orifice is calculated by the VdS hydraulic calculation program to discharge the agent within 10 seconds.

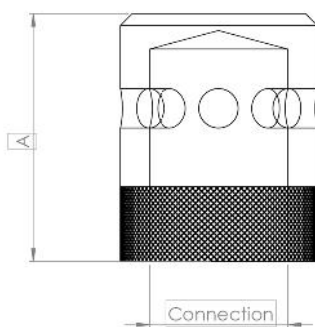
The minimum nozzle pressure shall be 5 bar.

360°/180° nozzle technical specifications

Dimension	Length, mm					
	1/2" DN15	3/4" DN20	1" DN25	1 1/4" DN32	1 1/2" DN40	2" DN50
A	34	41	51	63	71	103
zØ	24	32	40	50	60*	75*
Connection	1/2" BSPT	3/4" BSPT	1" BSPT	1 1/4" BSPT	1 1/2" BSPT	2" BSPT
Part Number 180°	NF 251521	NF 252021	NF 252521	NF 253221	NF 254021	NF 255021
Part Number 360°	NF 251522	NF 252022	NF 252522	NF 253222	NF 254022	NF 255022
Connection	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
Part Number 180°	NF 251521N	NF 252021N	NF 252521N	NF 253221N	NF 254021N	NF 255021N
Part Number 360°	NF 251522N	NF 252022N	NF 252522N	NF 253222N	NF 254022N	NF 255022N



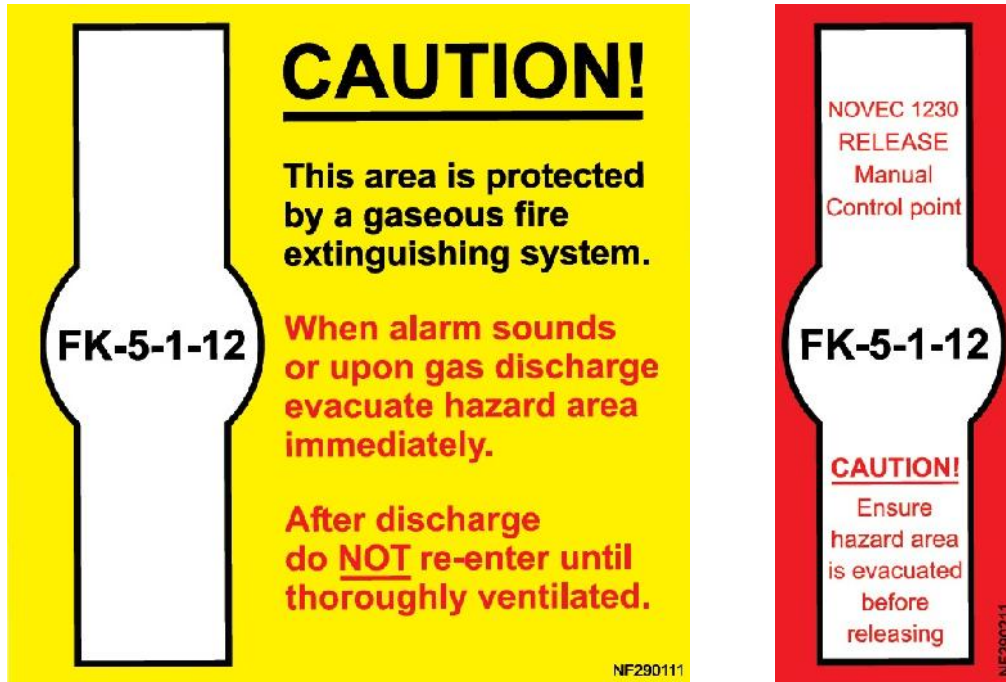
Chemical Nozzle dimensions



Chemical Nozzle 360° & 180°

5.14. Signs and Labels (part no. NF290111, NF290211, NF22000613)

All entrances to the protected space shall be identified as entering a space protected by FK-5-1-12. The form of the label shall follow the guidance in EN15004-1 or NFPA2001. This will contain a warning to evacuate the protected space upon the first fire alarm (see the yellow panel NF290111 in the following figure). Master cylinders with manual release shall be identified with an appropriate sign (see the red panel NF290211 in the following figure) where a warning remembers to check that the protected enclosure has been evacuated before releasing the agent.



Caution sign (yellow colour part n. NF290111) and Manual release sign (red colour part n. NF290211)

All cylinders have an identification nameplate NF22000613 indicating the quantity of FK-5-1-12, pressurisation level and filling station.



Fill label positioned on each cylinder body (part number NF22000613).

6. System Design

The information contained in this section covers the design of engineered systems. The designer must be fully conversant with the relevant design codes like EN 15004 or NFPA2001.

The design of the system consists of the selection and proper placement of the following equipment:

- J Container(s)
- J Mounting bracket(s)
- J Nozzle(s)
- J Pipe and fittings
- J Control panel(s)
- J Detection
- J Optional accessories

The selection and placement of the alarm and control devices shall conform to relevant International Standards.

6.1. Design quantity

Complete a risk assessment and survey of the space to confirm:

- J Sealing integrity (to prevent the loss of agent after discharge). The only way to ensure that the space is sufficiently sealed to retain the concentration for the minimum hold time is to undertake a room integrity test. In general, the protected space must be completely sealed. This manual does NOT cover extended discharge and all spaces must be sealed sufficiently to hold the concentration from the initial discharge.
- J Fire resistance of the enclosure
- J Measure the dimensions of the enclosure. Ensure that the difference between the gross and the net volume are taken into consideration. Follow EN 15004-1 in general ceiling and floor voids should be treated as separate spaces.
- J Use and occupancy
- J Hazards to be protected. Hazards to be protected e.g. Class A and B. Refer to EN 15004-1 7.1 and the LPCB listing for guidance on extinguishing concentrations.
 - a. Formula for calculating the quantity of agent is given in EN 15004-2 Table 3 (Specific vapour volumes against temperature, formula and pre-calculation tables) and the VdS hydraulic calculation program which should be run for every system automates this process and provides a record.
 - b. Always calculate the quantity of agent based on the minimum temperature of the protected space.
 - c. The table, formula and calculation program consider temperature, specific volume of vapour and altitude (see EN 15004-1 7.7).
 - d. The formula and tables consider the loss of gas through openings during the discharge.
 - e. The maximum discharge time shall be 10 seconds (see EN 15004-1 7.9.1). No pre-calculation tables are given here. Exceeding the discharge time may delay the extinguishing time and increase the decomposition products.
 - f. Should a single agent supply be available to protect more than one risk then the quantity should be enough for the largest risk. Take account of the achieved concentration in the smallest risk.
 - g. The calculation program considers the friction loss through the pipes, fittings and components and changes in elevation. All the information is contained within the VdS hydraulic calculation program and this shall be the only method of designing and calculating a discharge pipe work system.
- J As per EN 15004-1 7.8 the minimum hold time for the concentration shall be 10 minutes. This should be longer for deep seated fires where more than 10 minutes is required for the ignition source to cool. Annex E of EN 15004-1 gives formula for calculating the minimum hold time and refer to the vapour density given in the specific agent data. Pressure relief vents shall be self-closing.
- J Temperature range of the hardware is -20°C to + 50°C and -10°C to +100°C for the protected space.
- J All forced ventilation that is not 100% recycling the protected space air must be stopped prior to discharge.

- J Altitude (see EN 15004-1 7.7 for the altitude correction factor, from -1,000m up to +4,500m).
- J Ensure that no other gaseous extinguishing system is installed.
- J The agent will extinguish Class C Fires (European fire classification, flammable gases) but consider the build-up of flammable gas which could produce an explosion hazard.
- J This manual does not cover inerting. For information Inerting should be considered with care because the discharging extinguishant could produce a static charge and ignite a flammable atmosphere. Refer EN 15004-2 for guidance on concentrations. Generally higher concentrations are required for inerting.
- J Doors should open outwards and be fitted with self-closers to facilitate evacuation in the event of a fire.
- J Consider the environmental impact of the system selected. Use the system which gives the lowest environmental impact against firefighting effectiveness, speed of extinguishment, safety, weight and economics.
- J Use the concentrations derived from the approval fire testing stated here in the manual to determine the quantity of agent. The concentration should be based on the highest concentration required for the fuel present in the risk area. Note the differences between NFPA 2001 or EN 15004-2 standards on concentration requirements. For highly volatile fuel the higher concentrations may be necessary. Where the design concentrations for extinguishing are not given follow the advice given on how to determine these.
- J Ensure that the insurer, fire authority, building control authority and clients representative agrees to the design parameters.
- J A full discharge test should not be carried out because of the environmental impact of the extinguishing agent. Should there be any doubt about the viability of the system then alternative arrangements should be made.

All the above information and design parameters together with workings drawing must be submitted to the client’s representative for acceptance and approval. See EN 15004-1 7.2;

6.2. System configuration and number of containers

The number of containers used on a system is dependent on the system design configuration. A skilled system designer will consider all the variables to determine the optimum solution. Considerations may include:

Configuration	Consideration & benefits
Multiple modular containers spaced around the protected space	Simple piping arrangements reducing pipe runs.
Central storage with manifold	May be remote from the protected space and may protect more than one space. All containers must be of the same size, fill and pressure.
Selector valve	Systems may be configured to protect more than one risk with a common storage facility (container bank). Please contact FSL offices directly.

Determine the number of containers according to the maximum and minimum filling ratio. Design systems up to 0.9kg/litre. For very short pipe runs fill ration may be increased up to maximum filling ratio (undertake a system calculation to confirm).

Maximum and minimum cylinder filling ratio

System and superpressurization (bar)	Maximum filling ratio (kg/L)	Minimum filling ratio (kg/L)
FSL 1230™ 25bar	1.4	0.4
FSL 1230™ 42bar	1.2	0.4

6.3. Number of solenoid/manual actuators

One master cylinder can actuate up to four slave cylinders, therefore after a total of five cylinders, two master cylinders may be required.

Multiple modular containers spaced around the protected space require one actuator for each container.

6.4. Container Location

Container mounting considerations include:

- J Floor loading.
- J Access for installation, service and mechanical release of the system.
- J Tampering, obstruction and damage.
- J Environment (hot/cold, dirty, corrosive. Normally containers will be mounted with or adjacent to the protected space). Refer to the storage and use limitations.
- J Distance from the protected space.
- J Mount in a protected environment away from direct sunlight, corrosive atmospheres and away from wind and rain.
- J Protect from exposure to mechanical, chemical and any other damages and fire.
- J Temperature to be within -20°C to +50°C.
- J The container storage should be ventilated.
- J Always secure the containers to a wall or frame with the C shaped container straps provided.
- J Only containers with the same fill and pressure may be connected to the same discharge manifold.

Container can only be mounted vertically with the valve uppermost.

6.5. Personnel safety check

Whilst it is highly unlikely that the achieved FK-5-1-12 concentration could be greater than the design concentration. Calculate the achieved concentration using the formula:

$$C_{\max} \times \frac{100 | W_f | S_2}{f W_f | S_2 A V_{\min}}$$

Where:

C_{max} = Maximum concentration % by volume

W_f = Stored weight of agent kg

S₂ = Specific vapour volume at the design temperature in the hazard area. See EN 15004-2 for values.

V_{min} = Minimum net volume of the protected space m³

When the system is being used to protect manned areas, this concentration must be determined and compared to the safe limits indicated in the relevant design standards (EN 15004-2). If it is higher than the safe limits indicated, then the minimum safety precautions recommended in the relevant design standards must be included in the system design.

6.6. Nozzle Determination

Decide on the most appropriate nozzle locations. 180° nozzles may be wall mounted and 360° nozzles ceiling mounted centrally in the space. Nozzles should be spaced to give an even coverage and best results can be expected by discharging similar quantities from each nozzle. Refer to the diagram below for maximum coverage details.

The larger nozzles can have very high discharge rates. The flow rate should be less than 8 kg/s for all spaces with false ceilings and moveable objects or where a high flow rate may have an impact. For shallow voids a flow rate of more than 4 kg/s should be avoided.

High cabinets can restrict the head space between the ceiling and the obstruction. Generally, aim for a gap of 1m between ceiling and obstruction. For smaller gaps consider the obstruction as forming a compartment and add nozzles accordingly.

There will be some turbulence around the discharge nozzle and ceiling tiles etc. should be fixed for a radius of 1m around the nozzle.

Ensure that the discharge will not directly impinge on nearby objects such as light fittings or disturb any

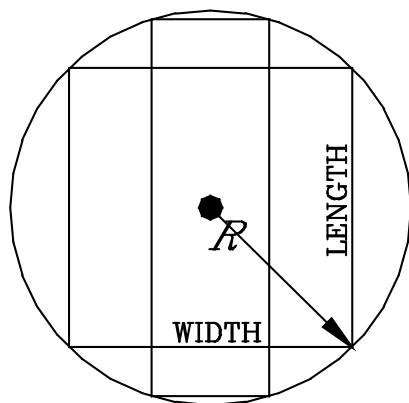
flammable liquids.

For floor and ceiling voids consider the degree of clutter and obstructions that will impede the discharge flow. Place extra nozzles to compensate.

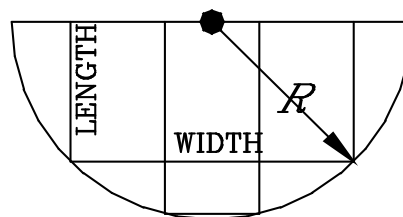
Position nozzles within 0.25m of the ceiling.

Nozzles may be mounted with their axis vertically down or up.

In dirty environments the nozzles should be protected by blow off caps (not LPCB approved) which must be light to prevent becoming a damaging projectile and must be replaced after a discharge.



360° Nozzle



180° Nozzle

Any box inside the radius.	360°	180°
R Max with void height $\geq 0.3\text{m}$	8m	11m
R Max with void height $< 0.3\text{m}$	4m	5.5m
Maximum distance between nozzles (WIDTH)		
void height $\geq 0.3\text{m}$	11m	15m
void height $< 0.3\text{m}$	5.5m	7.5m
Maximum distance from wall	Dependent on room width. See diagram.	0.15m
Room height. Use multiple rows over max. height	0.3m to 4.9m	0.3m to 5.0m
Maximum distance from ceiling (single row)	0.25m	0.25m

NOTE: For floor voids less than 150mm in depth, it may not be possible to place a nozzle within the void and therefore we would recommend that the 1 in 4 floor tiles be changed to grille tiles to allow the agent to flow into the void to provide the protection.

6.7. Piping and fitting specifications

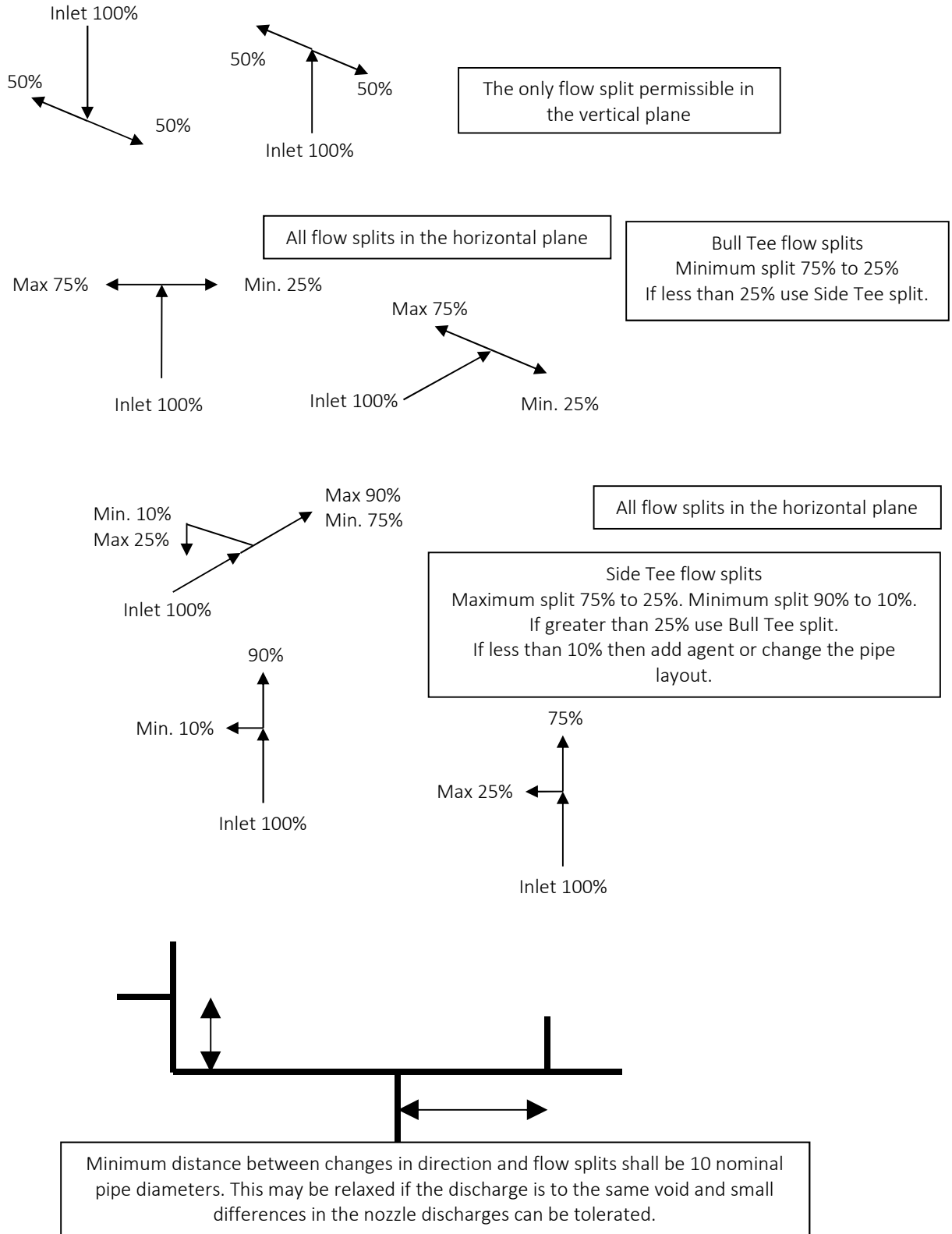
Only discharge piping as specified in NFPA 2001 or EN15004-1 shall be used while considering the system pressure and any potentially closed sections (between selector valves if fitted) and national regulations. All closed sections of pipe work shall be protected by a relief valve (Relief valves are not LPCB approved).

Piping must be non-combustible and be able to withstand the pressures during discharge. The developed pressure at 50 degC is 29 bar and 48bar for FSL 1230™ 25 and 42 bar respectively. Suitable standards for use in Europe are EN 10241 pipe fittings and EN 10255 tubes.

In corrosive environments the pipe work shall be protected. In general, all steel pipe work should be galvanised, or zinc plated.

6.8. Piping Configuration

The piping configuration should be kept as simple as possible with even flow splits which will aid the accurate distribution of agent. The flow splitting rules, as detailed below must be observed to ensure an accurate distribution. All flow splits MUST be in the horizontal plane except the 50% Bull head split shown below.



6.9. Piping diameters

Refer to the following table for an estimate of piping diameters.

Pipe work flow minimum and maximum flow rate

Nominal diameter, DN	Pipe Size (Inches)	Minimum flow rate (kg/s)	Maximum flow rate (kg/s)
15	1/2	0.5	1.5
20	3/4	1.0	2.6
25	1.0	1.5	3.8
32	1.1/4	2.6	5.9
40	1.1/2	3.8	8.8
50	2.0	5.9	15.0
65	2.1/2	8.8	26.3
80	3.0	15.0	43.1
100	4.0	26.3	57.6
150	6.0	57.5	143.8

6.10. System hydraulic calculations

Only use the VdS hydraulic calculation program. This program will:

- J Calculate the quantity of extinguishant based on the space volumes and temperature.
- J Calculate the optimum pipe sizes based on the input schematic.
- J Calculate the nozzle orifice size.

Containers, fills, valves, pipes and nozzles must be installed exactly as input to and specified by the program or the flow distribution and discharge time will not be accurate.

Should the 'as built' be expected to be different from the original design then calculate the system with a slightly shorter discharge time and only drill and fit the nozzles after recalculation using the 'as built' information.

The minimum nozzle pressure shall be 5 bar. Orifice plates should not be used to reduce the terminal pressure. The nozzle orifice area shall be a maximum of 90% of the feed pipe cross sectional area to ensure that the nozzle controls the flow not the feed pipe.

Nozzle orifice drilling

	DN15	DN20	DN25	DN32	DN40	DN50
Min. drill size (mm)	2.0	3.0	4.0	5.0	6.0	8.0
Max. drill size (mm)	5.1	6.9	8.8	11.5	13.5	14.5
Orifice size steps 0.1 mm < 10mm and 0.5 mm >10mm						

6.11. Venting Considerations

Venting of an enclosure may be necessary to relieve the under pressure due to the chilling of the air within the space and the following over pressure due to the extra volume being added to the space. The VdS calculation program will calculate the minimum free vent area based on the maximum pressure that the protected space can withstand. Refer to the buildings structural engineer.

The protected space structure including the windows, glazing, doors and penetrations needs to be of adequate strength to withstand these under and over pressures.

The actual value of free vent area can be calculated from the results of a Room integrity test, where the actual room leakage and the strength of the protected space can be considered.

Please refer to the FIA Guidance* for the design, selection and installation of vents to safeguard the structural integrity of enclosures and the post discharge venting provisions where used.

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www.firetec-systems.eu

* *“Guidance on the pressure relief and post discharge venting of enclosures protected by gaseous firefighting systems”, FIA Guidance for the Fire Protection Industry, www.fia.uk.com.*

6.12. Leakage from the protected space

After discharge the FK-5-1-12 must be retained for enough period to allow the cooling of the ignition source to prevent re-ignition. Refer to NFPA 2001, EN15004-1 for guidance on the period.

Generally, all openings into the protected space must be sealed to prevent leakage. To ensure that the retention time is achieved a room integrity test must be carried out in accordance with the standards.

Consider the possible migration and leakage from the protected space to other areas especially if higher concentrations are used in unmanned areas. Generally, the higher the concentration will result in a higher leakage rate from the protected space.

6.13. Control and release of the system

Refer to EN 15004-1 6.4 for guidance. Where an automatic system is used then there must also be a manual release adjacent to the exit from the protected space.

National requirements must be followed for fire detection and controls. Suitable standards are BS 5839, BS 7273, and BS 6266

The release and delays permitted are dependent on the type of occupancy see EN15004-1 5.2. For occupied spaces rules are given for concentration levels against the use of time delays, automatic/manual switch and Lock-off device. Separate requirements are given for ‘normally unoccupied areas’ and ‘unoccupied areas’

Reference to EN 15004-1 and BS 5839, 7273, 6266 for:

- J Manual control
- J Alarms
- J Hold switches
- J Time delays

7. Installation

7.1. Safety Procedure

To ensure the safety of personnel carrying out the installation and to prevent any accidental discharge of the container contents the steps below must be followed in order,

1. Fix discharge pipe work (including manifold and check valves) and cap all open ends
2. Leakage test of pipe work
3. Remove caps at ends and blow out with nitrogen, carbon dioxide, or dry compressed air prior to installing the discharge nozzles.
4. Install nozzles
5. Fit discharge flexible hoses (or outlet adaptors) to pipe work
6. All containers must have
 - a. Shipping cap fitted to the actuator port of the valve
 - b. Anti-recoil cap fitted to valve outlet
 - c. Actuators NOT fitted
7. Fix containers to mounting bracket considering the pipe work
8. Fit all system accessories except solenoids.
9. Remove the anti-recoil cap from valve outlet and fit discharge hose (or outlet adaptor) to container valve
10. Test actuators 'off' the container
11. Reset actuators and fit to valve once commissioning is complete.

7.2. Discharge Piping

- J Follow the guidance in the international standards and local regulations on protecting the system and pipe work from mechanical damage, the effects of fire, earthing (see EN 15004-1 5.5) and electrical clearance (see EN 15004-1 5.4), marking of pipe work and the competency of the installer. Do not install pipe work where it could be subjected to mechanical damage or the effects of a fire.
- J All pipe size reductions must be made with reducing fittings, concentric reducers, or reducing couplings.
- J All pipes must be adequately fixed as dictated by the standards. Attention must be paid to the bracing of all piping changes in direction and nozzles.
- J Manifolds and cylinders shall be firmly fixed to take all the thrusts during a system discharge. The manifold is not included in FSL supply. Spacing, inlet connection size and installing height depend on cylinder size (see 5.1). Fix the manifold to wall to the proper height considering the cylinder assembly dimensions
- J Screwed pipe and fittings should be clean cut with full length threads. Joints should be made with pipe sealing tape or compound ensuring that the first two threads are not covered. This will ensure that no tape or compound enters the pipe work.
- J Welded joints must permit full flow. Mitre weld fittings are not acceptable.
- J All pipe work must be free from deformities and ridges that can impede the flow and all burrs and sharp edges must be removed.
- J Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, utilizing a suitable non-flammable cleaner. The pipe network shall be free of particulate matter and oil residue before installation.
- J Only install the pipe work as shown on the installation drawing and ensure that all flow splits are horizontal and the distance between changes in direction and flow splits are maintained. (See Design section).
- J No changes to the pipe work layout are permitted without the authority of the system designer. Any changes in lengths, pipe diameter and number of fittings will have a significant impact on the flow calculations.
- J All pipe sizes, flow rates and pressure drops shall be calculated using the VdS calculation program. This takes into consideration pipe work and fitting friction pressure losses and changes in elevation as well as the minimum and maximum flow rate to ensure turbulent flow.

7.3. Hangers and Bracing

- J All system piping, both vertical and horizontal must be suitably supported with hangers.
- J Pipe hangers shall be capable of supporting the pipe under all conditions of operation and service. They shall allow the expansion and contraction of the piping, and prevent excessive stress resulting from transmitted weight being induced into the connected equipment.
- J Pipes must be anchored to the building structure such as beams, columns, concrete walls etc., to prevent longitudinal or lateral movement or sway. Where practical, riser piping shall be supported independently of the connected horizontal piping.
- J The piping must not be hung or supported from other piping systems (i.e. water, air pipes, etc.). Generally, no section of pipe should be without a hanger or brace.
- J Maximum recommended spacing between hangers are given in NFPA 2001 and EN 15004-1.

7.4. Outlet adaptors

For standard modular systems or single cylinder systems the valve outlet is connected directly to the piping by an outlet adaptor.

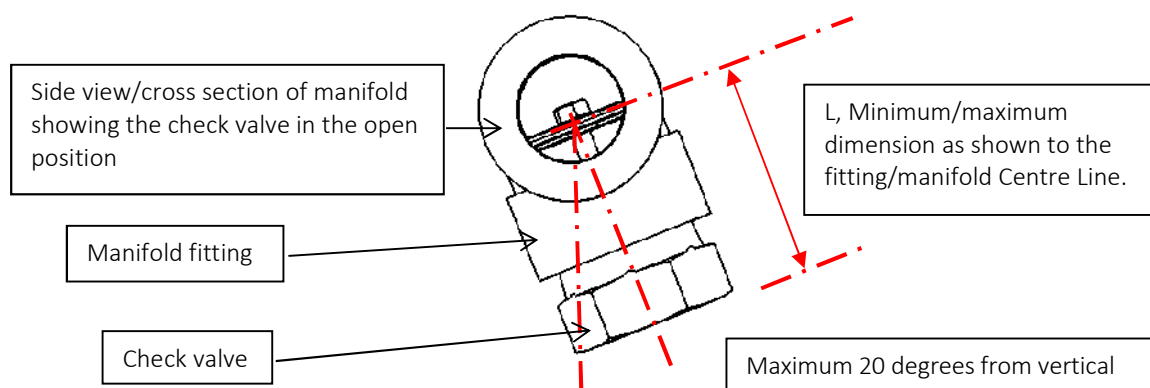
- J Check that the height and position is suitable to connect the valve outlet of cylinder assembly
- J Fit outlet adaptor to pipe work using thread sealing tape.
- J Do NOT fit the outlet adaptor to discharge valve until all pipe work is complete

7.5. Discharge Check Valves

The check valves are designed for fitment to welded socket* manifolds or screwed tee* fitting manifolds. Inlets must be at the bottom vertically downwards as the check is biased closed by gravity. (Do NOT use horizontally or with the check valve at the top of the manifold. The maximum installing angle from vertical in 20°.

Note: the fitting screw thread must be concentric with the fitting body with a minimum throughway of 47mm (R1.5 inlet) and 62mm (R2 inlet) throughway through the fitting.*

- J Fit check valve to manifold using thread sealing tape.
- J Ensure that the check valve fully opens and returns to the closed position after fitment. Pull the spindle until the check fully returns to its seat.



Check Valve shown in the OPEN position and maximum installing angle from vertical

Minimum and maximum distance L from fitting inlet to manifold centre

Part number	Inlet	Outlet	L Minimum	L Maximum
NF24331	1 ½" BSPT	2" BSPT	100	110
NF24332	1 ½" NPT	2" NPT	100	110
NF24492	2" NPT	2 ½" NPT	120	130
NF24492-1	2" NPT	2 ½" BSPT	120	130

7.6. Piping leakage test and blow out

See section 8.3 for the requirements of these operations.

- J Cap all open ends of the pipe work.
- J Leakage test of pipe work

- Remove caps at pipe work ends and blow out with nitrogen, carbon dioxide, or dry compressed air prior to installing the discharge nozzles.

7.7. Discharge Nozzles

The discharge nozzles shall be installed as directed by the installation drawing in a manner so that they will not potentially cause injury to personnel. When discharged from the nozzle, the agent should not directly impinge on areas where personnel might be found in the normal work area. The agent shall not impinge on any loose objects on shelves, cabinet tops, or similar surfaces where loose objects could be present and become missiles.

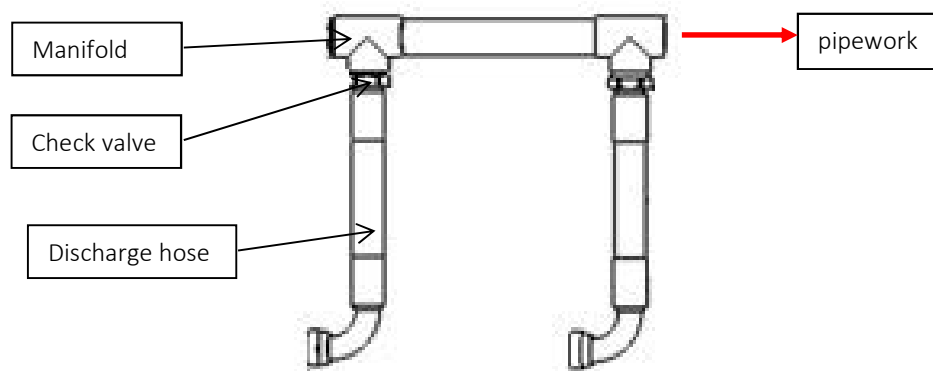
Always check that the right nozzle, see stamping on the nozzle, is in the correct position as directed by the installation drawing. Fitting the incorrect nozzle may impact the performance of the system.

7.8. Discharge Hoses

The discharge hose may be used in one-cylinder systems, without check valve, or in manifolded systems in conjunction with check valves.

- Check that the height and position of pipework/manifold is suitable to connect the discharge hose.
- If check valves are used, they must be installed before the discharge hose.
- Fit the discharge hose to pipework/check valve using thread sealing tape, before attaching to the discharge valve.
- Do NOT fit the discharge hose to discharge valve with the swivel connection until all pipe work is complete and containers are secured in their racks.

Note: see 5.9 for hose length and minimum bending radius.



Discharge hose installing position

7.9. Cylinders assemblies

The FK-5-1-12 cylinder is pressurized to 25/42 bar and must be handled carefully.

The discharge valve is constructed of heavy forged brass, it can be damaged if dropped or mishandled.

Discharge of an unsecured and disconnected cylinder could be extremely dangerous and may result in injury or death, and/or damage to property.

Under normal conditions, the discharge valve cannot be discharged without having the various actuators attached. Never connect the actuators or have the solenoid pilot valve wired to the system's electrical controls until the cylinder has been properly secured in the cylinder rack and the discharge connection fittings connected to the system piping.

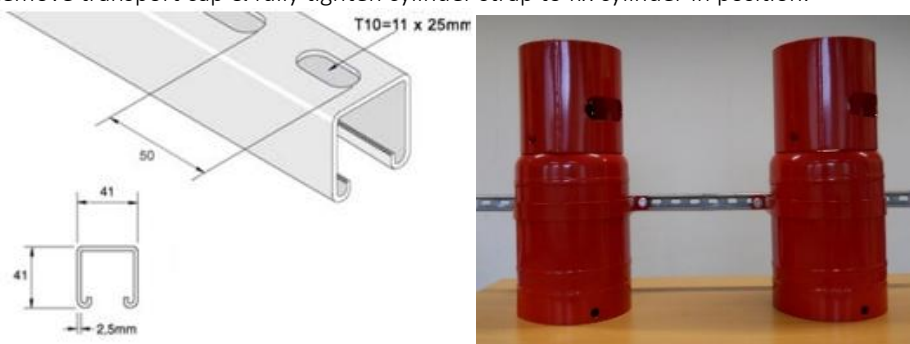
The anti-recoil cap should remain in place until removal is necessary to complete the connection of the valve to the system piping.

All racking systems use a BS6296:1988 rail (commonly known as Unistrut) as shown below.

Note: Wall rail supplied by the installer.

The procedure to install cylinder assemblies correctly is:

- J Install Unistrut channel to wall at 2/3 height of cylinders
- J Move cylinder in correct orientation for outlet pipe/manifold (see 5.1 for dimensions and note that a 180L cylinder used in conjunction with the discharge hose must have the outlet spacer NF234980 between valve and hose, see 5.10). Install the master cylinder at one extremity of the row.
- J Loosely fix the cylinder to wall by straps/brackets
- J Remove transport cap & fully tighten cylinder strap to fix cylinder in position.



Wall rail (unistrut) dimensions and Cylinder fixed to wall before transport cap removal

7.10. Discharge Valve Pressure Gauge, Pressure Switch

The pressure gauge, pressure gauge with limit signal generator or pressure switch are connected to the valve via the M10x1 connection port. There are two ports on either side of the valve which can be used. Any unused port must have the plug fitted.

Only fit Eurotech products to ensure correct safe operation and to prevent leakage.

The gauges and switches can be mounted and removed with the valve pressurised.

The pressure gauge, pressure switch is already fitted on the valve when delivered. If it is necessary to change its position:

- J Remove the gauge by hand only
- J Replace gauge port plug before opening opposite plug and moving gauge to the opposite gauge port

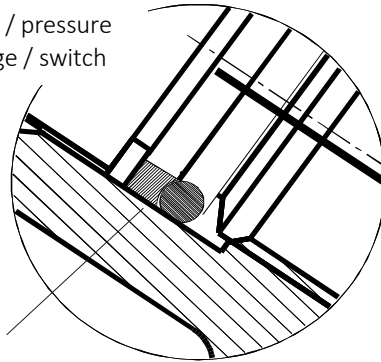


Port plug and hex key

- J Tighten gauge port plug into unused gauge port using 4mm hex key.
- J Make sure that the O-ring seal and back-up ring are not damaged. If replacement is required, note

the installation diagram below (O-ring towards the pressure).

Plug / pressure
gauge / switch



Screw in by hand

Back-up ring
O-Ring

Valve
NOTE. Gauges with a logo DO NOT
have back-up rings.

curvature of back-up ring
towards O-ring!

Gauge gasket positions

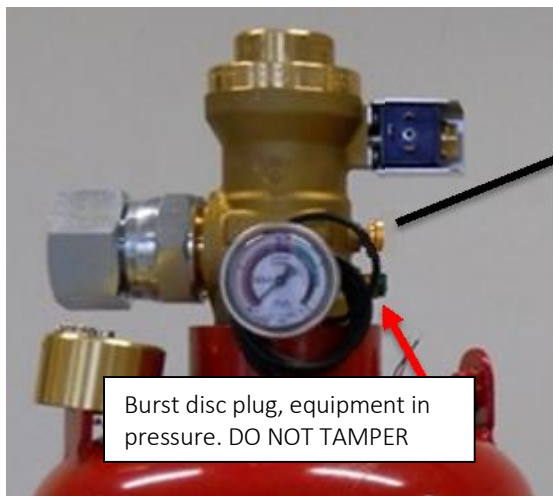
- J Remove the plug from the opposite port using 4mm hex key and keep for future use.
- J Screw fully the manometer in the port by hand only. DO NOT TIGHTEN.
- J Turn back a maximum of one revolution for correct orientation.

7.11. Discharge pressure switch

Complete the following steps on the last valve (that is the master valve for systems composed by 1 cylinder or on the last slave valve for systems composed by from 2 to 5 cylinders in total).

WARNING: DO NOT REMOVE THE BURST DISC PLUG DURING NEXT STEP

- J Remove the plug from discharge pressure connection port and keep for future use



Remove discharge
pressure connection
port plug

Discharge pressure switch installation on the last valve

- J Fit the hose of the pressure switch in the 1/8" port using thread sealing tape (no reducing fitting is required).

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www.firetec-systems.eu

- J Fit the discharge pressure switch at wall in the range of flexible hose
- J Fit the flexible hose to the discharge pressure switch by the swivel and giving counter-torque to the pressure switch connection. No tape sealant is required.



Discharge pressure switch to be mounted on wall

NOTE: if the system is composed by one cylinder only it is possible to skip next section 7.12.

7.12. Pilot line and pneumatic actuators

All container valves are designed for automatic actuation, by electric or pneumatic means, and manual actuation, by using the range of actuators shown in 5.4.

Discharge of the cylinder valve is initiated by the actuator depressing the control valve stem located at the top of the valve. During shipping and storage, the control valve is protected by a shipping cap (028605042) to prevent accidental discharge and should only be removed to connect the cylinder valve actuator. Never leave the valve without the cap or actuator fitted. Retain shipping cap for future use.

DO NOT connect any solenoid/manual actuators until the system is fully installed and tested. An inadvertent discharge can cause injury and damage.

7.12.1. Pneumatic actuator (from 2 to 5 cylinders systems)

Complete the following steps for systems composed by 2 to 5 cylinders.

- J Identify slave cylinders (master valve shall be at an extremity of the row)
- J Remove the red protection cap from slave cylinders and retain for future use.
- J Ensure that no contamination or foreign objects have entered the bore hole of the control valve or the pneumatic actuator.
- J Connect the actuators to the valves via the M42x1.5 connecting thread with a torque of 50Nm +0 - 15Nm by using the specific wrench (actuator 1/8" connections are oriented towards near valves, that is parallel to the wall).



Slave cylinder, no integrated solenoid. Left: plastic top red protective cap. Right pneumatic actuator installed.

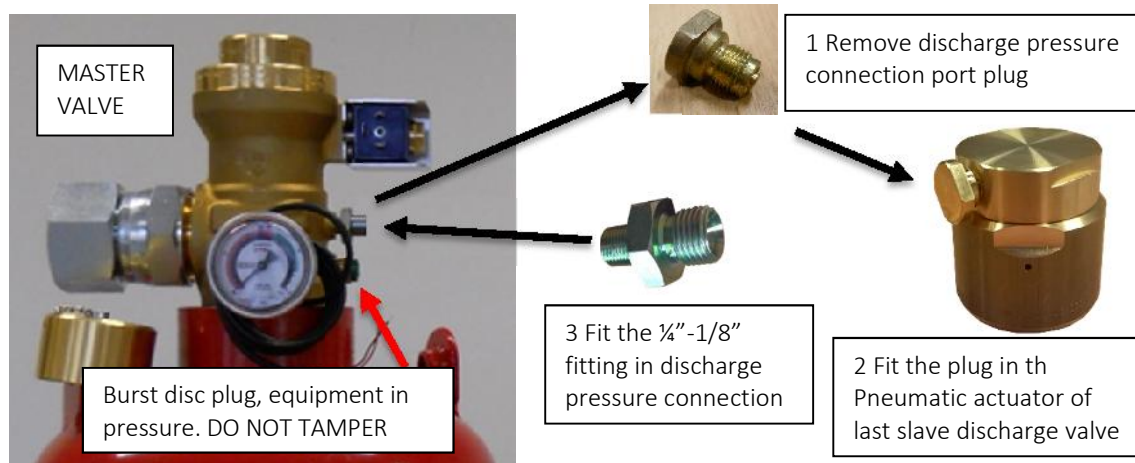
7.12.2. Pilot line on master valve and last slave valve (from 2 to 5 cylinders systems)

Complete the following steps for systems composed by 2 to 5 cylinders.

- J Identify master cylinder (master valve shall be at an extremity of the row)

WARNING: DO NOT REMOVE THE BURST DISC PLUG DURING NEXT STEP

- J Identify master cylinder (shall be at an extremity of the row).
- J Remove the plug from discharge pressure connection port and fit in the pneumatic actuator of the last slave valve. Use the port opposite to master cylinder
- J Remove the ¼" - 1/8" fitting from the pilot hose and fit in the discharge pressure connection port of master valve, using thread sealing tape.



Master valve. It may be identified by brass top protective cap and integrated solenoid.

- J Fit the pilot flexible hose in the free port of pneumatic actuator installed on last slave valve. Use thread sealing tape.



Pneumatic line on last slave valve: pilot hose connection

NOTE: if the system is composed by two cylinders, it is possible to skip next section 7.12.3.

7.12.3. Pilot line on middle slave valves (from 3 to 5 cylinders systems)

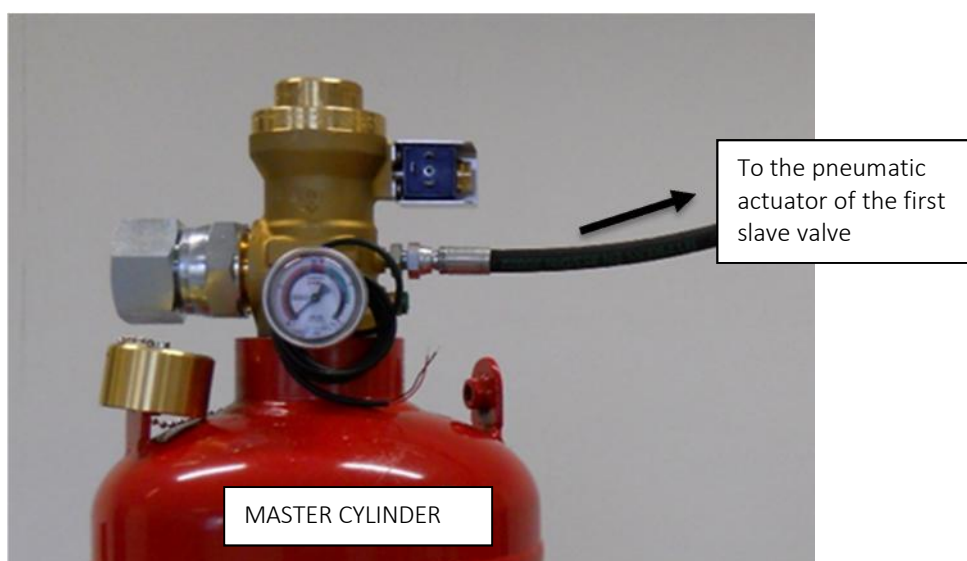
Complete the following steps for systems composed by 3 to 5 cylinders. Start from the second to last slave valve.

- J Fit the pilot hoses on pneumatic actuator port 1/8". Use the port towards master cylinder. Use thread sealing tape.
- J Remove the 1/4" - 1/8" fitting from the pilot hose and fit in the remaining pneumatic actuators port (use the port opposite to master cylinder). Use thread sealing tape.
- J Connect the pilot hose installed in the pneumatic actuator of the near valve to the 1/4" - 1/8" fitting installed during the previous step. Use the swivel and give counter-torque to the 1/4" - 1/8" fitting. No sealing tape is required.
- J Repeat previous steps for each pneumatic actuator with free ports.



7.12.4. Pilot hose connection to master valve (from 2 to 5 cylinders systems)

- J Connect the pilot hose installed in the pneumatic actuator of the first slave valve to the 1/4" - 1/8" fitting installed in the master valve. Use the swivel and give counter-torque to the 1/4" - 1/8" fitting. No sealing tape is required.



7.13. Valve-pipework connection

Before installing the manual/solenoid actuators it is necessary to connect valve outlets to pipework

- J Remove the outlet protection cap from valve
- J Fit discharge hose (or outlet adaptor) by swivel to container valve. No tape sealant is required

7.14. Electrical actuator

Before fitting the actuator to the valve, check that the cylinders are secured, and the valves have been connected to the pipe work.

Do not connect the actuator to the discharge control panel until the panel and wiring are fully checked and the system is to be brought into service.

7.14.1. Integrated Electrical Actuator

- J Wire and test the actuator as indicated in 8.5.1.
- J Ensure that the actuator is not activated (test electromagnet by passing steel object through solenoid (should NOT be attracted). An activated actuator would cause an unintentional release while mounting the actuator onto the valve.
- J Slide the solenoid in position
- J Fit the nut and tighten to 5Nm.

7.14.2. Optional detachable electrical actuator

- J Wire and test the actuator as indicated in 8.5.2.
- J Ensure that the actuator is not activated and is in the reset position, see 5.4. An activated actuator would cause an unintentional release while mounting the actuator onto the valve.

WARNING: if any hissing or discharge of gas is noticed during connection of the actuator - STOP AT ONCE and disconnect actuator from the valve.

- J Remove the brass shipping cap (028605042) from the valve of the master cylinder
- J Ensure that no contamination or foreign objects have entered the bore hole of the control valve.
- J Connect the actuator to the valve via the M42x1.5 connecting thread with a torque of 50Nm +0 - 15Nm by using the specific wrench.

7.15. Manual actuator

Before fitting the actuator to the valve, check that the cylinders are secured, and the valves have been connected to the pipe work. The manual actuator can be fitted on the optional detachable electrical actuator too. If this is the case, the manual actuator shall be installed after the wiring, testing and installation of the optional detachable actuator.

WARNING: do NOT test the manual actuator.

- J Ensure that the actuator is not activated and is in the reset position, see 5.4. An activated actuator would cause an unintentional release while mounting the actuator onto the valve.

WARNING: if any hissing or discharge of gas is noticed during connection of the actuator - STOP AT ONCE and disconnect actuator from the valve.

- J Remove the brass shipping cap (028605042) from the valve of the master cylinder (or from the optional detachable electrical actuator). Never leave the valve without the cap or actuator fitted.
- J Ensure that no contamination or foreign objects have entered the bore hole of the control valve.
- J Connect the actuator to the valve (or to the optional detachable electrical actuator) via the M42x1.5 connecting thread with a torque of 50Nm +0 -15Nm by using the specific wrench.



Manual actuator on master cylinder with integrated solenoid.

7.16. Installation Check List

Prior to verification and test the installer should check the following:

Containers	
<input type="checkbox"/> Correct weight	
<input type="checkbox"/> Pressure	
<input type="checkbox"/> Fixed	
Piping	
<input type="checkbox"/> Continuous	
<input type="checkbox"/> Blow through	
<input type="checkbox"/> Correct size	
<input type="checkbox"/> Flow splits correct	
<input type="checkbox"/> Fixed	
Nozzle	
<input type="checkbox"/> Correct size and orifice	
<input type="checkbox"/> Correct type	
<input type="checkbox"/> Orientation	
Labels	
<input type="checkbox"/> Container	
<input type="checkbox"/> Manual release	
<input type="checkbox"/> Door warning	
<input type="checkbox"/> System installer/maintenance	

8. Verification and Test

8.1. General

Prior to placing the completed system in service, the installation should be inspected and tested to confirm:

- J Conformance to system design.
- J Suitability of piping, its correctness to project design, and its support and bracketing.
- J Conformance to the system stated operating sequence.
- J The suitability of the hazard environmental control, safety precautions, sealing etc.
- J Compliance with the requirements of the relevant design code.

8.2. Containers

- J Inspect container(s) and ensure bracketing and piping are secure.
- J Check pressure gauge and ensure pressure is correct for temperature of the container. Pressure should be $\pm 10\%$ at 20°C of the charge pressure. Correct for the actual temperature back to 20°C. Refer to NFPA 2001 and EN15004-2 figure 1 for the pressure temperature relationship. Note that the pressure is dependent on the fill ratio of the container.
- J Verify that the weight of the container contents is clearly shown on the label and that the liquid level is marked.
- J Ensure that appropriate identification, operating and warning signs are mounted or posted.
- J Ensure that components are installed in accordance with the appropriate project drawings.

8.3. Piping

Closed sections of pipe shall be hydraulically tested prior to installation to 1.5 times the working pressure. The pipe must be fully dried before installation. EN 15004-1 8.2.3.12 allows for a physical check of tightness as an alternative.

Field installed piping shall be tested as per EN15004, NFPA 2001:

After the installation of the system piping is completed, and prior to the connection of the containers, nozzles, actuators, etc., the discharge piping shall be pneumatically tested for leakage.

Plug or cap all piping outlets and pneumatically test in a closed circuit for a period of 10 minutes at 2.5/3.0 bar. Hold the pressure for at least 10 minutes. At the end of 10 minutes, the pressure drop shall not exceed 20% of the test pressure. Under no conditions should water be used in testing.

As per and EN15004 the pressure test may be omitted if the total piping contains no more than one change in direction fitting between the storage container and the discharge nozzle, or if all piping is physically checked for tightness.

Pneumatic testing can be dangerous ensure that all personnel are away from the area and that appropriate safeguards have been taken.

All piping must be blown out with nitrogen, carbon dioxide, or dry compressed air prior to installing the discharge nozzles.

8.4. Nozzles

Each nozzle has orifices drilled to suit the specific location and discharge flow requirements. The part number stamped on the bottom of each nozzle identifies the number and size of the drill holes.

- J Verify that pipe and nozzle orifice sizes are as indicated on the drawings and that the nozzles are orientated to discharge correctly i.e. orifices pointing towards the remote parts of the protected space.
- J Ensure that each nozzle pipe drop is bracketed or braced against the nozzle discharge thrust, and that the nozzle cannot swivel on its pipe fitting.

8.5. Electrical

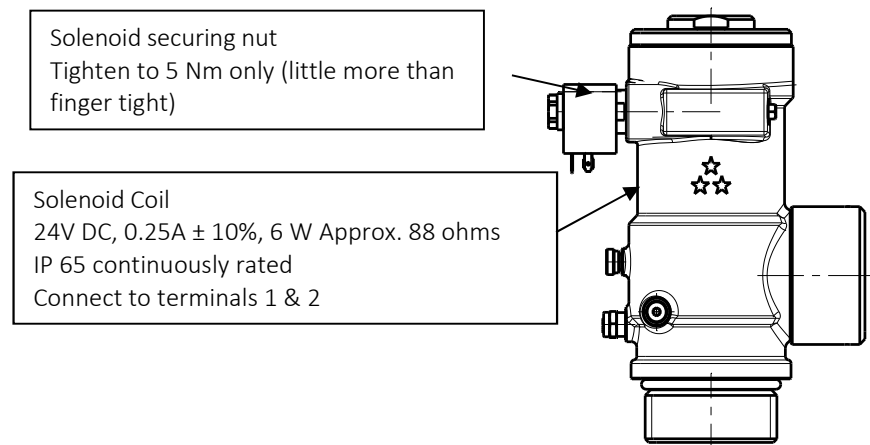
All testing of the extinguishing system electrical circuits shall be carried out in accordance with the firefighting system control panel manual.

WARNING: all testing is to be performed with the actuator disconnected from the valve.

8.5.1. Integrated electrical actuator

The electrical connection procedure is:

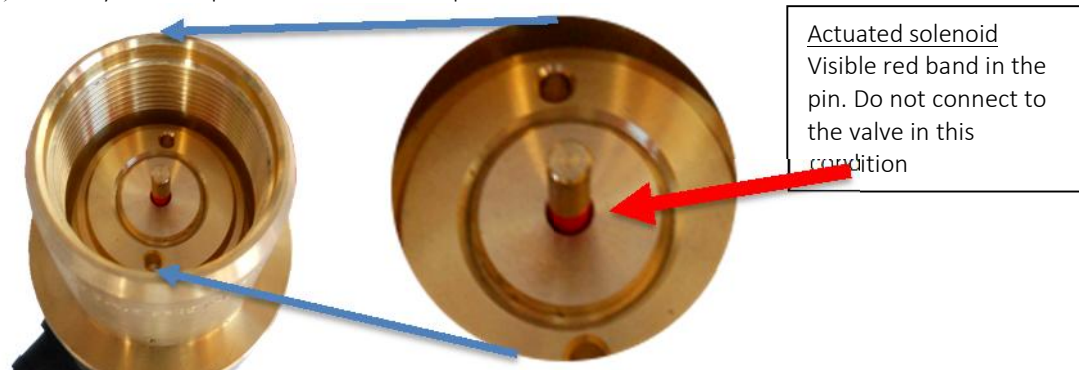
1. Wire release circuit to solenoid plug, before fitting plug to solenoid.
2. Fit back EMF diodes (not supplied) as required by the control panel manufacturer.
3. Check circuit
4. Unscrew 'solenoid securing nut' and slide 'solenoid' from spindle
5. Connect plug to solenoid
6. Insert steel rod/bolt through solenoid and note that it slides freely.
7. Activate the release circuit and note that the rod is magnetized to the solenoid.
8. Reset the control panel and note that the rod slides freely.
9. Slide the solenoid over the valve spindle and retain with the solenoid securing nut at 5Nm.
10. DO NOT over tighten or bend the valve spindle.



8.5.2. Optional detachable electrical actuator NF26010

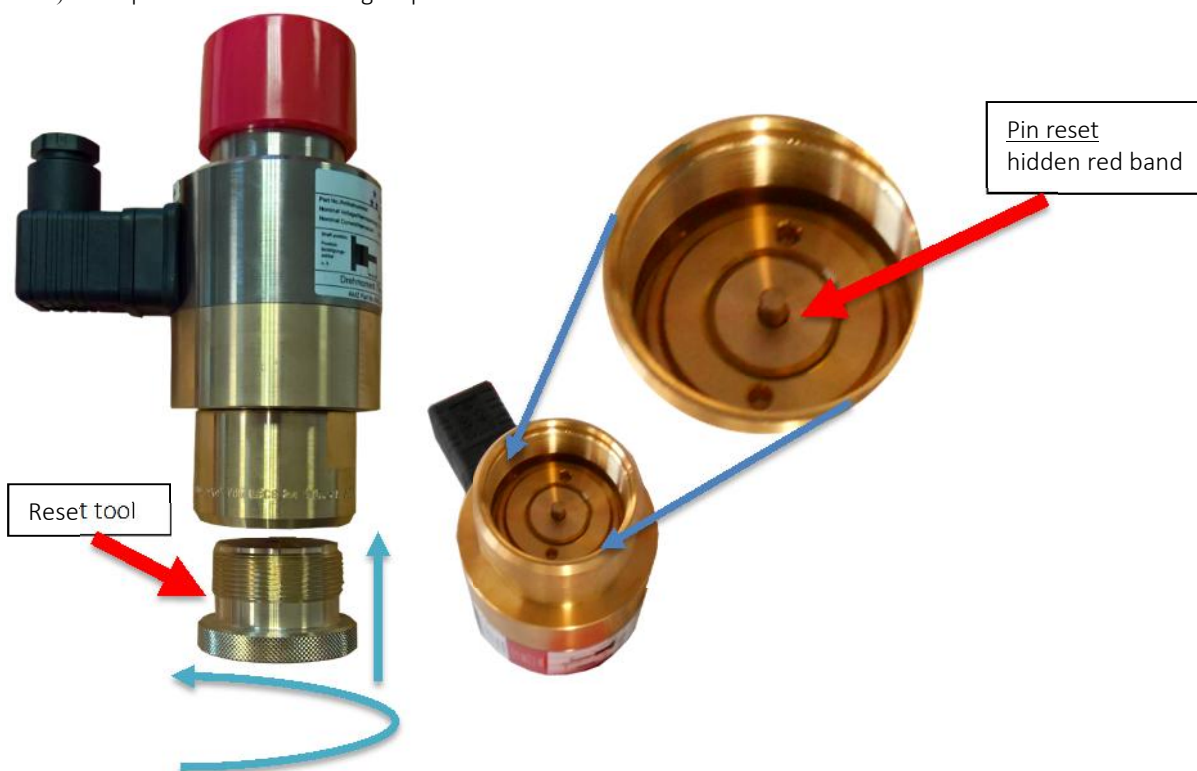
WARNING: This procedure must **NOT** be carried out on the Integrated Electric Actuator.

- J With all solenoids connected electrically operate the discharge circuit. All solenoids should operate.
- J Verify that the pin moves to released position.



Pin in released position: visible red band.

- J Reset all solenoid actuators by screwing reset tool in tight until a click is heard, keep screwing until fully tightened, check that pin is reset and band is no longer visible
- J Repeat for each initiating sequence.



Pin reset with specific tool.

- J On completion of all the testing and when the system is being restored to or placed in service, reset all solenoid actuators by screwing reset tool in tight until a click is heard, keep screwing until fully tightened, check that pin is reset and band is no longer visible.
- J Check that the solenoid has latched correctly by exerting light pressure the recessed pin (top of the actuator), the actuator should not operate under this pressure.
- J Reconnect the actuators to the container valves like indicated in 7.14.2.

9. Maintenance

The system shall be regularly inspected to ensure that it is fully operational. The interval between inspections and the scope are covered in NFPA 2001 (Chapter 7) and EN15004-1 (Section 9).

Before attempting any maintenance inform the system owners that the maintenance is about to be carried out to ensure that they have made other arrangements for the protection of the protected space during the period that the system will NOT be available.

Isolate the discharge circuit electrically at the control panel and for added safety remove the electrical connection to all solenoid actuators. Remove all actuators from the discharge valves.

The inspection shall include:

- J The protected space to ensure that there have NOT been any changes affecting the design or discharge retention.
- J Damage to any equipment or pipe work
- J The alarm and control system should also be inspected at the same time. Pay attention to the interface between the suppression system and the control system.
- J Auxiliary equipment such as pressure switches, door closures, dampers, air handling shutdown must be checked for correct operation.
- J Agent containers. These shall be check weighed or the contents checked with a liquid level device as well as the cylinder pressure. This needs to be compensated for temperature and the agent fill ratio. Guidance is given in NFPA 2001 and EN15004-1. Should the contents or pressure show a loss trend or more than 5% by weight or 10% by pressure then these must be withdrawn from service and recharged.
- J Pilot and discharge hoses are to be checked every 12 months for any signs of deterioration either in the metal fittings or hose. Hoses will deteriorate when subjected to continuous high temperatures, excessive bending or high ultra-violet light levels. The hoses should be replaced every 10 years or sooner if there any signs of deterioration.
- J Check valves are to be checked externally every 12 months for any signs of deterioration. The internal seals should be replaced every 10 years.

Recharge after discharge

- J Disconnect and remove all the actuators and cylinder pressure switches.
- J Fit anti recoil caps to all valves prior to removing them from their racking.
- J Only skilled and trained operatives shall recharge the cylinders while following the valve maintenance and recharge procedures.
- J Before returning to service all cylinders should be conditioned for at least 24 hours for the Nitrogen to be absorbed and the temperature stabilised. Check for leaks at all joints, check weigh the cylinder (note the extra weight of the nitrogen) and cylinder pressure.
- J Enter the details on the fill label.
- J Return to service.

10. Temperature/Pressure FK-5-1-12

If a loss in pressure (adjusted for temperature) of more 10%, the container shall be refilled or replaced.

FSL 1230™ 25 (25bar @ 20°C)			FSL 1230™ 42 (4bar @ 20°C)		
Temp. (°C)	Container pressure (bar)	Minimum pressure adjusted for temperature (bar)	Temp. (°C)	Container pressure (bar)	Minimum pressure adjusted for temperature (bar)
-20	19.7	17.7	-20	34.0	30.6
-19	19.8	17.8	-19	34.2	30.8
-18	19.9	17.9	-18	34.4	31.0
-17	20.1	18.1	-17	34.6	31.1
-16	20.2	18.2	-16	34.8	31.3
-15	20.3	18.3	-15	35.0	31.5
-14	20.5	18.4	-14	35.2	31.7
-13	20.6	18.5	-13	35.4	31.9
-12	20.7	18.7	-12	35.6	32.0
-11	20.9	18.8	-11	35.8	32.2
-10	21.0	18.9	-10	36.0	32.4
-9	21.1	19.0	-9	36.2	32.6
-8	21.3	19.1	-8	36.4	32.8
-7	21.4	19.3	-7	36.6	32.9
-6	21.5	19.4	-6	36.8	33.1
-5	21.7	19.5	-5	37.0	33.3
-4	21.8	19.6	-4	37.2	33.5
-3	21.9	19.7	-3	37.4	33.7
-2	22.1	19.9	-2	37.6	33.8
-1	22.2	20.0	-1	37.8	34.0
0	22.3	20.1	0	38.0	34.2
1	22.5	20.2	1	38.2	34.4
2	22.6	20.3	2	38.4	34.6
3	22.7	20.5	3	38.6	34.7
4	22.9	20.6	4	38.8	34.9
5	23.0	20.7	5	39.0	35.1
6	23.1	20.8	6	39.2	35.3
7	23.3	20.9	7	39.4	35.5
8	23.4	21.1	8	39.6	35.6
9	23.5	21.2	9	39.8	35.8
10	23.7	21.3	10	40.0	36.0
11	23.8	21.4	11	40.2	36.2
12	23.9	21.5	12	40.4	36.4
13	24.1	21.7	13	40.6	36.5
14	24.2	21.8	14	40.8	36.7
15	24.3	21.9	15	41.0	36.9
16	24.5	22.0	16	41.2	37.1
17	24.6	22.1	17	41.4	37.3
18	24.7	22.3	18	41.6	37.4
19	24.9	22.4	19	41.8	37.6
20	25.0	22.5	20	42.0	37.8
21	25.1	22.6	21	42.2	38.0
22	25.3	22.7	22	42.4	38.2
23	25.4	22.9	23	42.6	38.3
24	25.5	23.0	24	42.8	38.5
25	25.7	23.1	25	43.0	38.7
26	25.8	23.2	26	43.2	38.9
27	25.9	23.3	27	43.4	39.1
28	26.1	23.5	28	43.6	39.2
29	26.2	23.6	29	43.8	39.4
30	26.3	23.7	30	44.0	39.6
31	26.5	23.8	31	44.2	39.8
32	26.6	23.9	32	44.4	40.0
33	26.7	24.1	33	44.6	40.1
34	26.9	24.2	34	44.8	40.3
35	27.0	24.3	35	45.0	40.5
36	27.1	24.4	36	45.2	40.7
37	27.3	24.5	37	45.4	40.9
38	27.4	24.7	38	45.6	41.0
39	27.5	24.8	39	45.8	41.2
40	27.7	24.9	40	46.0	41.4
41	27.8	25.0	41	46.2	41.6
42	27.9	25.1	42	46.4	41.8
43	28.1	25.3	43	46.6	41.9
44	28.2	25.4	44	46.8	42.1
45	28.3	25.5	45	47.0	42.3
46	28.5	25.6	46	47.2	42.5
47	28.6	25.7	47	47.4	42.7
48	28.7	25.9	48	47.6	42.8
49	28.9	26.0	49	47.8	43.0
50	29.0	26.1	50	48.0	43.2

11. Appendix A – MSDS

3M MATERIAL SAFETY DATA SHEET 3M(TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12] 04/09/2007

Material Safety Data Sheet

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SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: 3M(TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]

MANUFACTURER: 3M

DIVISION: Electronics Markets Materials Division

ADDRESS: 3M Center

St. Paul, MN 55144-1000

EMERGENCY PHONE: 1-800-364-3577 or (651) 737-6501 (24 hours)

Issue Date: 04/09/2007

Supersedes Date: 09/11/2006

Document Group: 16-3425-2

Product Use:

Intended Use: STREAMING AND FLOODING FIRE PROTECTION

SECTION 2: INGREDIENTS

Ingredient

C.A.S. No. % by Wt 1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE 756-13-8 > 99.9

SECTION 3: HAZARDS IDENTIFICATION

3.1 EMERGENCY OVERVIEW

Specific Physical Form: Liquid

Odour, Color, Grade: clear colourless, low odour.

General Physical Form: Liquid

Immediate health, physical, and environmental hazards:

3.2 POTENTIAL HEALTH EFFECTS

Eye Contact:

Contact with the eyes during product use is not expected to result in significant irritation.

Skin Contact:

Contact with the skin during product use is not expected to result in significant irritation.

Inhalation:

If thermal decomposition occurs:

May be harmful if inhaled.

Ingestion:

No health effects are expected.

3.3 POTENTIAL ENVIRONMENTAL EFFECTS

This substance has a high Henry's Law constant and therefore will be primarily found in the atmosphere where photolysis will be the dominant reaction pathway. The ultimate degradation products of the photolysis reaction are HF, CO₂ and trifluoroacetic acid (TFA).

This substance does not contribute to ozone depletion; it has an atmospheric lifetime of approximately 5 days and a Global Warming Potential (GWP) of 1 (IPCC 2001 Method).

SECTION 4: FIRST AID MEASURES

4.1 FIRST AID PROCEDURES

The following first aid recommendations are based on an assumption that appropriate personal and industrial hygiene practices are followed.

Eye Contact: No need for first aid is anticipated.

Skin Contact: No need for first aid is anticipated.

Inhalation: If signs/symptoms develop, remove person to fresh air. If signs/symptoms persist, get medical attention.

If Swallowed: No need for first aid is anticipated.

SECTION 5: FIRE FIGHTING MEASURES

5.1 FLAMMABLE PROPERTIES

Autoignition temperature *Not Applicable*

Flash Point *Not Applicable*

Flammable Limits - LEL [*Details: Non-flammable*]

Flammable Limits - UEL [*Details: Non-flammable*]

5.2 EXTINGUISHING MEDIA

Product is a fire-extinguishing agent.

5.3 PROTECTION OF FIRE FIGHTERS

Special Fire Fighting Procedures: Wear full protective equipment (Bunker Gear) and a self-contained breathing apparatus (SCBA).

Unusual Fire and Explosion Hazards: Not applicable.

Note: See STABILITY AND REACTIVITY (SECTION 10) for hazardous combustion and thermal decomposition information.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Accidental Release Measures: Observe precautions from other sections. Call 3M- HELPS line (1-800-364-3577) for more information on handling and managing the spill. Ventilate the area with fresh air. Contain spill. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Collect as much of the spilled material as possible. Clean up residue. Place in a metal container approved for transportation by appropriate authorities. Seal the container. Dispose of collected material as soon as possible.

In the event of a release of this material, the user should determine if the release qualifies as reportable according to local, state, and federal regulations.

SECTION 7: HANDLING AND STORAGE

7.1 HANDLING

For industrial or professional use only. Contents may be under pressure, open carefully. Avoid breathing of vapours, mists or spray. Do not breathe thermal decomposition products.

7.2 STORAGE

Keep container in well-ventilated area. Store out of direct sunlight. Store away from heat. Store away from strong bases, amines, and alcohols.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 ENGINEERING CONTROLS

Provide appropriate local exhaust ventilation on open containers. Provide appropriate local exhaust when product is heated.

8.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.2.1 Eye/Face Protection

As a good industrial hygiene practice:

Avoid eye contact with vapours, mists, or spray.

8.2.2 Skin Protection

Gloves are not required.

8.2.3 Respiratory Protection

Under normal use conditions, airborne exposures are not expected to be significant enough to require respiratory protection.

As a good industrial hygiene practice: Avoid breathing of vapours, mists or spray.

If thermal decomposition occurs, wear supplied air respiratory protection.

8.2.4 Prevention of Swallowing

Not applicable.

8.3 EXPOSURE GUIDELINES

Ingredient Authority Type Limit Additional Information

1,1,1,2,2,4,5,5,5-NONAFLUORO-4- (TRIFLUOROMETHYL)-3-PENTANONE 3M TWA 150 ppm

SOURCE OF EXPOSURE LIMIT DATA:

ACGIH: American Conference of Governmental Industrial Hygienists

CMRG: Chemical Manufacturer Recommended Guideline

OSHA: Occupational Safety and Health Administration

AIHA: American Industrial Hygiene Association Workplace Environmental Exposure Level (WEEL)

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Specific Physical Form: Liquid

Odour, Colour, Grade: clear colourless, low odour.

General Physical Form: Liquid

Autoignition temperature *Not Applicable*

Flash Point *Not Applicable*

Flammable Limits - LEL [*Details: Non-flammable*]

Flammable Limits - UEL [*Details: Non-flammable*]

Boiling point 49 °C

Vapor Density 11.6 [*Ref Std: AIR=1*]

Vapor Pressure 244 mmHg [*@ 20 °C*]

Specific Gravity 1.6 [*Ref Std: WATER=1*]

pH *Not Applicable*

Melting point -108 °C

Solubility in Water Nil

Evaporation rate > 1 [*Ref Std: BUOAC=1*]

Volatile Organic Compounds 1600 g/l [*Test Method: calculated SCAQMD rule 443.1*]

Percent volatile 100 %

VOC Less H₂O & Exempt Solvents 1600 g/l [*Test Method: calculated SCAQMD rule 443.1*]

Viscosity 0.6 centipoise [*@ 25 °C*]

SECTION 10: STABILITY AND REACTIVITY

Stability: Stable.

Materials and Conditions to Avoid: Strong bases; Amines; Alcohols Additional Information: Listed materials to avoid should not be mixed with liquid Novec 1230 fluid. Avoid direct sunlight and ultraviolet light.

Hazardous Polymerization: Hazardous polymerization will not occur.

Hazardous Decomposition or By-Products

Substance Condition

Carbon monoxide During Combustion

Carbon dioxide During Combustion

Hydrogen Fluoride During Combustion

Hazardous Decomposition: Hydrogen fluoride has an ACGIH Threshold Limit Value of 3 parts per million (as fluoride) as a Ceiling

Limit and an OSHA PEL of 3 ppm of fluoride as an eight-hour Time-Weighted Average and 6 ppm of fluoride as a Short Term

Exposure Limit. The odor threshold for HF is 0.04 ppm, providing good warning properties for exposure.

SECTION 11: TOXICOLOGICAL INFORMATION

Please contact the address listed on the first page of the MSDS for Toxicological Information on this material and/or its components.

SECTION 12: ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION

Please refer to existing literature on TFA

CHEMICAL FATE INFORMATION

Photolytic half-life: 3-5 days.

Photolytic degradation products may include Trifluoroacetic acid (TFA)

NOTE: Hydrolysis is not expected to be a significant degradation pathway. Product is highly insoluble in water and volatile, and use as a clean extinguishing agent would not typically result in releases to aquatic environments.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Incinerate in an industrial or commercial facility in the presence of a combustible material. Combustion

products will include HF. Facility must be capable of handling halogenated materials.

As a disposal alternative, dispose of waste product in a facility permitted to accept chemical waste. Reclaim if feasible. For

information on product return, contact your distributor.

EPA Hazardous Waste Number (RCRA): Not regulated

Since regulations vary, consult applicable regulations or authorities before disposal.

SECTION 14: TRANSPORT INFORMATION

ID Number(s):

98-0212-3031-7, 98-0212-3201-6, 98-0212-3203-2, 98-0212-3217-2, 98-0212-3371-7, 98-0212-3414-5

Please contact the emergency numbers listed on the first page of the MSDS for Transportation Information for this material.

SECTION 15: REGULATORY INFORMATION

US FEDERAL REGULATIONS

Contact 3M for more information.

311/312 Hazard Categories:

Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No Immediate Hazard - No Delayed Hazard - No STATE REGULATIONS

Contact 3M for more information.

CHEMICAL INVENTORIES

The components of this product are in compliance with the chemical notification requirements of TSCA.

One or more of the components of this product have been notified to ELINCS (European List of Notified or New Chemical Substances). Certain restrictions apply. Contact the selling division for additional information. All the components of this product are listed on China's Inventory of Chemical Substances.

The components of this material are in compliance with the new chemical notification requirements for the Korean Existing Chemicals Inventory.

Contact 3M for more information.

Additional Information: The components of this product are in compliance with the chemical notification requirements of the

National Industrial Chemical Notification and Assessment Scheme (NICNAS) of Australia, the Canadian Environmental Protection

Act (CEPA) and the Ministry of Economy, Trade and Industry of Japan.

INTERNATIONAL REGULATIONS

Contact 3M for more information.

ADDITIONAL INFORMATION

U.S. EPA. Significant New Alternatives Policy Program (SNAP) approved for uses is streaming and flooding fire protection application.

This MSDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: OTHER INFORMATION

NFPA Hazard Classification

Health: 3 Flammability: 0 Reactivity: 1 Special Hazards: None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS Hazard Classification

Health: 0 Flammability: 0 Reactivity: 1 Protection: X - See PPE section.

Hazardous Material Identification System (HMIS(r)) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS(r) ratings are to be used with a fully implemented HMIS(r) program. HMIS(r) is a registered mark of the National Paint and Coatings Association (NPCA).

Revision Changes:

Section 1: Product use information was modified. Copyright was modified.

Section 14: ID Number(s) was modified.

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