2019-03

FIRE EATER A/S

Fire Eater
Control Inert Ci
UL Listed, FM approved Extinguishing System

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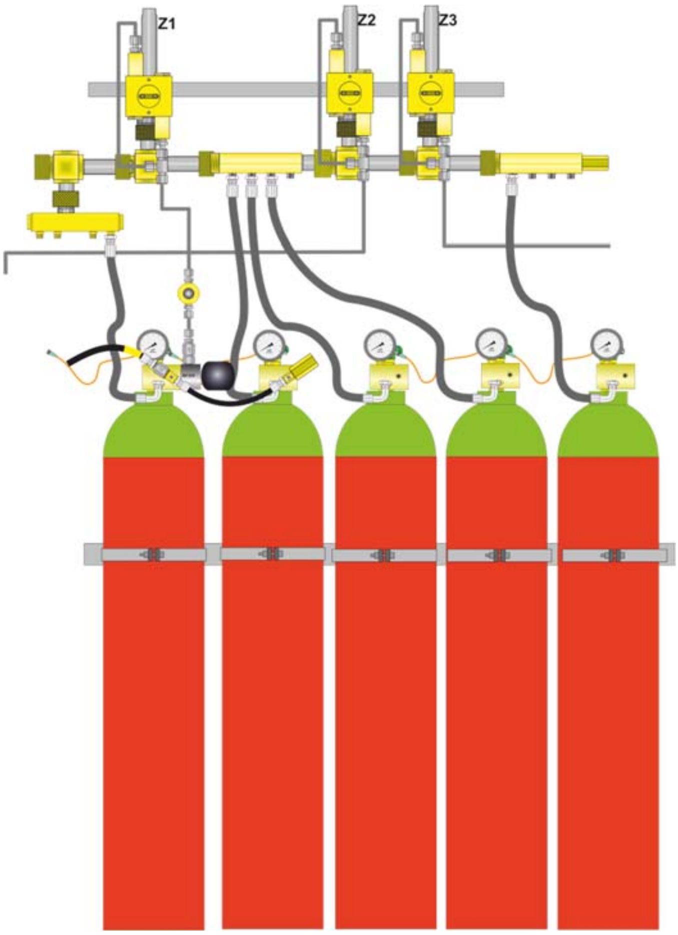

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Index

Chapter 0: Introduction

This manual is to be used for Designing, Installing, Operating and Servicing Fire Eater INERGEN fire suppression system: Ci INERGEN and SV (respectively Stand-alone system and Multi-zone system).

This manual is based on the various system requirements set forth by below standards and authorities:

IMO	International Marine Organization Classification societies	MS/Circ 848, 1267, ao FSS code
RMRS	Russian Maritime Register of Shipping	
DNV	Det Norske Veritas	
ABS	American Bureau of Shipping	
BV	Bureau Veritas	
UL	Underwriters Laboratories	UL 2127
FM	FM Global	FM 5600
LPCB	Loss Prevention Certification Board BRE Global	LPS 1230
CNPP	Center National Prevention et Protection	A2P
CNBOP	Centrum Naukowo Badawcze Ochrony	No 20(X 198 pos 4)
VNIIPO		
TFRI	Tanjin Fire Research Institute	GB25972
NFPA 2001		
EN15004		
ISO14520		

This manual replaces all previously issued manuals.

Units in the manual are SI units, if no other designation is given (other derived measures like Bar and mm are also used).

Fire Eater assumes no responsibility for applications of any system other than those addressed in this manual. The technical data in this manual is for information purpose only.

Fire Eater Ci INERGEN system is to be Designed, Installed and Serviced only by personnel who has been properly trained by Fire Eater and have obtained a Fire Eater Diploma passing the required test where applicable. Diplomas are valid for 3 years from date of issuing.

Only original Fire Eater parts should be used in the system. Replacing components with inferior parts can have fatal consequences.

Refilling of INERGEN cylinders are only to be made by a Fire Eater certified filling station.

Safety

INERGEN fire extinguishing systems uses equipment under high pressure (up to 400 bar / 40MPa / 5800 psi). Any person installing or servicing these systems must be aware of the safety issues in order to avoid any dangerous situation.

- Never handle, move or leave unfastened a cylinder without the valve protection cap.
- Never leave a cylinder standing unsecured from falling.
- Valve caps are not to be used as a lifting device.
- Secure cylinder properly for pressure bleed-off, Outlet force may exceed 2000N (500lbs f)
- Wear safety glasses and safety shoes.

When transporting

- Observe transportation rules (ADR and other).
- Cylinders next to driver cabin should be parallel with vehicle axels or standing up.
- Ensure proper shipping documents.

Environment & Exposure

INERGEN is a mix of normal atmospheric gasses (without Oxygen), and does not cause any decomposition product when exposed to temperatures of up to 2000 °C (3500 °F), neither will the gas have any negative influence on equipment or materials which can be operated in normal office environment.

As INERGEN only consist of atmospheric gasses, full-scale testing can be performed without concerns about environmental impact.

System limitations

This manual describes how to design, install and service a Fire Eater INERGEN system in a closed room with presence of the fuels described under chapter 4.
These are the INERGEN systems which rules are set out for what the system is tested, however this is not necessarily the limit of the system. If a system is to be used for another application or with limits outside what is described in this manual, special considerations should be made how to ensure a safe and effective system and which test should be made to prove the efficiency of the system. Below exclusions are only exclusions of the manual, but not exclusions for fire suppression by the INERGEN system.

This manual does not cover:
Extinguishing of metals or oxygenized material.
Design of explosion suppression INERGEN systems.

If the system is installed to protect a hazard that is already protected by another fire suppression system, special considerations must be made with regards to safe functioning of the system, (typical, but not limited to: Low oxygen concentration, high room pressure, decomposition products, interaction of agents, obscurity).

Chapter 1: System components

The system consists of (numbers are referring to cover page drawing):

01	Cylinder w INERGEN	Storage of INERGEN including hand wheel valve and INERGEN.
02	Cylinder rail & bracket	For fixing cylinders.
11	Discharge valve	A quick release valve fitted at installation site.
12	Discharge valve acc.	Cables electrical low pressure alarm. Tees
21	Actuator(s)	For actuating the quick release valve.
31	Discharge hoses	Leading INERGEN from disch. valve to manifold. DN 10 (3/8”)
32	Pilot hoses	For activating discharge valves. DN6 (1/4”)
41	Manifold	Gathering INERGEN from multiple cylinders.
42	Orifice	Reducing cylinder pressure to desired pipe pressure.
51	Pipes	Distributing the INERGEN to the nozzles.
52	Pipe fittings	
53	Brackets	
54	Fasteners	
61	Nozzles	Distributing INERGEN in a single enclosure.
71	Pressure Relief	To prevent over-pressurization during discharge
72	Signs & Labels	
73	Acc.	Accessories
81	Tools	
82	Service kit	
91	Remote Mech. actuation	Pneumatic Discharge Systems, Wire & Pull stations
92	Control panels	

Multizone system component

101	SV Zone kit	Selector valve with brackets, Inlet, Orifice and fittings
121	SV CiV	Control valve to open designated Selector valve
122	SV-Ci next kit Test port	Connectors for the Pneumatic Actuation system
131	SV Switch kit	Electrical monitoring of the SV position
141	SV MT kit	Manifolds w. Non-Return valve and outlet
142	SV End plug kit	Fittings and Burst disc for the distribution manifold
151	Brackets and accessories	
161	Fittings & Adapters	
181	Tools	Test and Resetting tools

General

Item numbers

The item numbers used, consists of 6-8 digits. Numbers after “-“ describes a variant. Variants can be special requirements, certificates or handling. Typical variants are (not limited to these):

-8: Customer specific versions Calibrated devices like nozzles etc.

-21: DNV

-23: EAC (GOST)

-44: AISI 316

-62: CCOE

-60: UL

-62: FM

-71: LPCB

Notice items with above extension are only available when required due to specific circumstances like special marking, certificate, datasheets and similar required by the authorities etc.

Basic components

INERGEN [00]:

INERGEN is a clear inert gas consisting of Nitrogen, Argon and CO2, which all are natural atmospheric gasses, stored in high pressure cylinders as permanent gas (no condensation).

Composition (% volume)

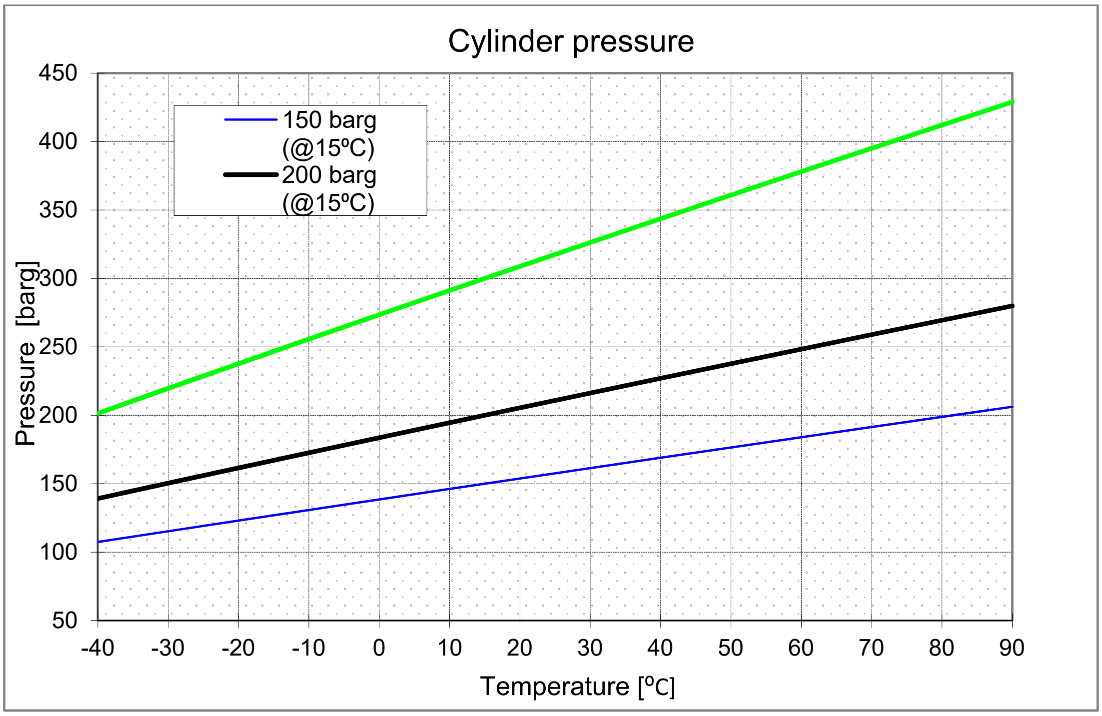
Nitrogen	52 %
Argon	40 %
Carbon dioxide	8%

Molar mass 34.08 g/mol

Specific vapor volume 0.706 m^3/kg (t = 20°C, p = 1.0132 bar)

INERGEN/Air (relative) $\rho r = 1.18$
(t = 20°C, p = 1.0132 bar)

Triple point of CO_2 at 5.2 atm and -56.4ºC



Directives, Standards, and conformity markings

INERGEN gas is covered by

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)

Conformity mark: na

Standards applied are:

EN15004
NFPA2001

Additional approvals:

TA	UL file Ex15566, vol4
TA	LPCB LPS1230
TA	FM

Cylinders [01]:

The cylinders are factory filled with INERGEN agent and fitted with a hand wheel valve.
Hand wheel valve outlet threads:
200 bar system W24.32 (Black hand wheel)
300 bar system M25×1.5 (Green hand wheel)
Each hand wheel valve is fitted with a burst disc to prevent cylinder explosion if the cylinder is left in a fire or exposed to elevated temperatures.
Hand wheel valves are installed in accordance with ISO 13341.

The cylinders are transported with a protective cap, which is not to be removed before installation.

Designation	Pressure		INERGEN	
	Fill	Operating	Volume	Mass
	MPa @ 15°C	MPa @ 21°C	M^3@21°C	Kg
30-300	30	31.0	8.7	12.4
50-300	30	31.0	14.6	20.7
80-300	30	31.0	23.3	33.1
140-300	30	31.0	40.8	58.0
30-200	20	20.6	6.3	8.9
50-200	20	20.6	10.5	14.9
80-200	20	20.6	16.8	23.8
140-200	20	20.6	29.4	41.7

Other sizes from 2 liter are also available, see datasheet Ci Cylinders

Item numbers

Below cylinders are available as -21 DNV &-71 LPCB
30, 50, 80 and140 liters cylinders are available as -60 UL & -62 FM
On request cylinders can be supplied as -23 CU-TR (former GOST), -25 BV, -26 CCOE, -27 Australian, and other.

200609	Cylinder 30-300 M25	Ci Cylinders (latest edition)
200615	Cylinder 50-300 bar M25	
200624	Cylinder 80-300 bar M25	
200642	Cylinder 140-300 bar M25 (per 2014 not yet available as DNV)	
200600	Cylinder 02-200 W24	
200601	Cylinder 05-200 W24	
200602	Cylinder 10-200 W24	
200604	Cylinder 20-200 W24	
200610	Cylinder 50-200 W24	
200616	Cylinder 80-200 W24	
200628	Cylinder 140-300 bar M25 (per 2014 not yet available as DNV)	
603xxx	Hand wheel valves	Ci HWV Hand wheel valve
105106	Cylinder cap E-type (open) 160kg	105106 Cylinder cap open
105130	Cylinder cap S-type EN962 160kg	105130 Cylinder cap S type
10513x	Cylinder cap S-type EN962 300kg	Cylinder cap S type

Installation

The cylinder is fixed to the cylinder rail by using the cylinder brackets.
For land systems, minimum 1 rail/bracket for each cylinder. For marine, 2 are required.
If nozzles are placed directly on the discharge valve, 2 brackets must be used.

Other types of fixations are acceptable under the condition that they can hold the forces from the cylinders.

Directives, Standards, and conformity markings

Cylinders are covered by

1999/36/EC	Transportable Pressure Equipment (TPED)
2010/35/EC	Update of above

Conformity mark: π

Standards applied are:

EN1964-1, EN1964-2
ISO9809-1, ISO9809-2

Hand wheel valves are covered by

EEC 99/36	Transportable Pressure Equipment (TPED)
2010/35/EC	Update of TPED
EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)

Conformity mark:

CE

Standards applied are

ISO5145 Cylinder valve outlets for gasses
ISO1117, ISO10297,
EN12094-4 Fixed firefighting systems valves

Cylinder rail & Brackets [02]:

For fixing the cylinder a rail and cylinder bracket are used.
The length of the rail is determined by the quantity of cylinders.
Cylinders are to be floor supported.

Wooden brackets are also available.

Item numbers (not limited to these numbers) **Data sheet**

Items available in aisi316 with item number -44

400108	Cylinder bracket 140l (ø360)	4001## Cylinder brackets 5-140l
400109	Cylinder bracket 80l (ø267)	
400110	Cylinder bracket 50/30l (ø229)	
400121	Cylinder rail end covers	400121 Cylinder rail end cover
400123	Elbow for cylinder in 2nd layer	400123 Bracket 2nd layer
400102	Cyl rail 3000	400x## Cylinder rail 50-80-140l
40020n	Cyl rail nx50l nx270 mm	
40030n	Cyl rail nx80l nx320 mm	
40040n	Cyl rail nx140l nx400+200 mm	
105100	Rack Top 50l U-profile	Rack U-profiles
105101	Rack Bottom 50l U-profile	Rack Beams
105102	Rack Cross beam 4x50l	
105103	Rack Outer beam 4x50l	
105104	Rack Cyl dummy 50l	Rack Cylinder dummy
105200	Rack Top 80l U-profile	Rack U-profiles
105201	Rack Bottom 80l U-profile	Rack Beams
105202	Rack Cross beam 4x80l	
105203	Rack Outer beam 4x80l	
105204	Rack Cyl dummy 80l	Rack Cylinder dummy
105107	Treaded Rod M12	105107
105108	Nut M12	screw nuts
105109	Washer M12	screw washers
105113	Washer M12 Split washer	screw washers

Installation

Cylinder rails are fixed to a construction using either screws, rivets or welding.
Fixing should be at intervals sufficient to carry the load from the cylinders.

Fasteners must be in accordance with section 54.

For marine installations, minimum 2 brackets are required per cylinder in order to prevent displacement of the cylinder when the ship is at sea.

For cylinders in multiple rows, there must be sufficient brackets (400123) to support the load from the cylinders. Typically 1 bracket per 2 cylinders + one at the end.

Directives, Standards, and conformity markings

NA

Discharge valve [11]:

The discharge valve is supplied (depending on type ordered) complete with a combined pressure gauge and pressure switch, the switches can be connected in a daisy chain.
It is a quick opening valve, which requires manual resetting.

The discharge valve is installed on site after the cylinder has been securely fixed.
The actuator is fitted to the discharge valve after installation and pressurization of the valve.

The valve has a built-in actuator that operates by back pressure. Valves connected to a Ci MT manifold will open once the master cylinder connected to the manifold is activated.

Item numbers (not limited to these numbers) **Datasheet No.**

The Ci IV8 valves are included in all system approvals (LPCB, CNPP, CNBOP, DNV, etc.)
Variants available: -60 UL, -62 FM

305410	Ci IV8-300 Manosw	Ci IV8 discharge valve
305411	Ci IV8-300 Basic	
305420	Ci IV8-200 Manosw	
305421	Ci IV8-200 Basic	

Installation

After the cylinder is fixed, the valve protection cap is removed and the discharge valve is screwed to the hand wheel valve.

After fitting the discharge valve, the hand wheel valve must be opened and sealed in open position.

Attention should be made to the system pressure, as different valve connection treads are used.

200 bar Black hand wheel	Chamfered hex union nut
300 bar Green hand wheel	Rounded hex union nut

Directives, Standards, and conformity markings

Discharge valves are covered by

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive

Conformity mark:
CE
Wheel mark

Standards applied are:
EN12094-4

Additional approvals:
TAC DNV P-14652

Discharge valve Accessories [12]:

Accessories for the discharge valves are Manoswitch start kits, the difference between the item numbers is the resistance of the end of line resistor, which has to match the control panel specification.

The DV7 is a Tee, which allows for 2 or 3 discharge valves to be fitted to one cylinder. This is used when multiple zones are protected by a common INERGEN cylinder. (It is used for the same purpose as the Selector valves, but is more feasible for small systems).

Item numbers (not limited to these numbers) **Data sheet**

The DV7 is included in all system approvals (LPCB, CNPP, CNBOP, DNV, etc.)
Variants available: -60 UL, -62 FM

303042	DV7a-2 W24 (200 bar)	DV7
303043	DV7a-3 W24 (200 bar)	
304042	DV7a -2 M25 (300 bar)	
304043	DV7a -3 M25 (300 bar)	

Electrical accessories

303020	Manoswitch cable 2m start kit	Manoswitch Start Kit
303019	Manoswitch 4K7 cable 2m start kit	
540360	Manoswitch 470-5K6 cable 2m start kit	54036# Manosw dual resist cable kit
540361	Manoswitch 680-3K3 cable 2m start kit	
540362	Manoswitch 470-10K0 cable 2m start kit	
540363	Manoswitch 100-200 Ohm cable 2m start kit	
303004	Cable 0.6m M8-3 (manoswitch extension cable)	Cable M8-3 extension (Manosw)
303005	Cable 1.0m M8-3 (manoswitch extension cable)	
303006	Cable 0.6m M8-3 (manoswitch extension cable)	
303007	Connector Female M8-3 Field attachable	Cable M8-3 accessories
303010	Connector Male M8-3 Field attachable	

Installation

The DV7 is fitted to the cylinder before the discharge valves are installed. Each outlet of the DV7 must have a discharge valve fitted.

The Manoswitch start kit is used for connecting the first manoswitch to the control panel and a terminator to use on the last manoswitch (ending the daisy chain).

Cables and connectors are standard industrial M8-3 connectors used for extending the reach of the M8 cable supplied with the manoswitch.

Directives, Standards, and conformity markings

Discharge valves are covered by
EEC /73/23 Low voltage directive

Conformity mark:
NA

Standards applied are:
NA

Actuators [21]:

Besides the built-in Pneumatic actuator a variety of actuators are available for the Ci system.

All actuators are screwed on to the actuator connection of the IV8 valve by hand (tightening torque of 10 Nm should not be exceeded).

The Pneumatic actuator has an actuator connection on the top allowing for stacking of another actuator.

Item numbers (not limited to these numbers) **Data sheet**

Solenoid actuators are available in -60 UL, -62 FM

305451	Ci IS8B w manual Electrical actuator	Ci IS8B
305450	Ci IS8B Solenoid only Electrical actuator	
305449	Ci IS8 NFPA switch	305449 Ci IS8 NFPA Switch
305442	Ci IM8 Manual actuator	305442 IM8 Manual Actuator
305448	Ci PA8 Pneumatic actuator (add on)	305448 PA8 Pneumatic Actuator
305454	MPW M20 (not CPR per 2014)	
305447	Ci PALP (not CPR per 2014)	
305621	Ci MT next kit (350mm)	305621 Ci MT next kit
54035x	Ci Junction box	54035x

Installation

Actuators should be fitted by hand (max 10Nm), Actuators may be screwed back max ½ turn to achieve correct position. Only one additional actuator may be fitted to the Ci PA8.

Before installing the electrical actuator the Ci IS8 NFPA switch must be fitted to the master cylinder/valve but slipping it onto the valve and tighten the screw to prevent it from coming loose.

Special tools are required to test and reset the actuators.

When a system consists of more than one manifold, the Ci MT next kit (305621) is used to feed pressure from a discharge valve to activate a discharge valve on the next manifold. This principle is continued for additional manifolds.
As each activated discharge valve supplies its own pressure, the number of cylinders activated this way is unlimited.

The Ci Junction box features duplicate terminals for wire connections, for connecting the solenoid, solenoid switch, low pressure switch and manifold pressure to the control panel.
If other arrangements are made they must have Duplicate terminals or leads, or an equivalent arrangement, shall be provided for circuits of products intended to be connected to initiating-device circuits of a releasing control unit; one for each incoming and one for each outgoing wire.

Directives, Standards, and conformity markings

Actuators are covered by

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive
EEC 73/23	Low voltage directive

Conformity mark:
CE

Standards applied are:
EN12094-4

Additional approvals:
TA UL file EX15566, vol 2

Discharge hoses [31]:

The discharge hose is a flexible connector between the discharge valve and the manifold. It has 2 functions, one is to lead INERGEN from the discharge valve to the manifold, the second one is to supply pressure from the manifold to activate the discharge valves.

A number of different lengths of the discharge hose is available as standard.

Item numbers (not limited to these numbers)		Data sheet
303102	Hose 0.5m Dn10-400	Ci Discharge hoses
303104	Hose 1.0m Dn10-400 elbow	
303106	Hose 1.5m Dn10-400 elbow	
303108	Hose 2.0m Dn10-400 elbow	
303109	Hose 2.5m Dn10-400 elbow	
303111	Hose 3.0m Dn10-400 elbow	
303113	Hose 4.0m Dn10-400 elbow	

<u>The 3031XX series has one 90° elbow connector and one straight connector</u>

303302	Hose 0.5m Dn10 -400 straight	Ci Discharge hoses
303304	Hose 1.0m Dn10 -400 straight	
303306	Hose 1.5m Dn10 -400 straight	
303308	Hose 2.0m Dn10 -400 straight	
303309	Hose 2.5m Dn10 -400 straight	
303311	Hose 3.0m Dn10 -400 straight	
303313	Hose 4.0m Dn10 -400 straight	

<u>The 3033XX series has two straight connectors</u>

Installation

Hoses are connected and tightened at the discharge valve first and then connected to the manifold.
The Hose must be tightened until metallic contact is achieved and then additional 15°.

Directives, Standards, and conformity markings

Hoses are covered by

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive
2009/26/EC	Marine Equipment Directive (MED

Conformity mark:

CE
Wheel mark

Standards applied are:

EN12094-8	Type 1 & 3 connector
ISO 15540	
ISO 15541	

Pilot hoses [32]:

The pilot hose is a flexible connector used for activating the discharge valve by pneumatic pressure. It is used when more than one manifold is used or when the back-pressure function is disabled, it may also be used when a remote pneumatic activation system is used.

A number of different lengths of the discharge hoses are available as standard.

Item numbers (not limited to these numbers)		Datasheet No.
303162	Hose 0.180m Dn6-400	Ci-Hoses PA
303166	Hose 0.220m Dn6-400	
303172	Hose 0.280m Dn6-400	
303174	Hose 0.330m Dn6-400	
303180	Hose 0.500m Dn6-400	
205064	Hose 0.400m Dn6-400	
205063	Hose 1.000m Dn6-400	
303182	Hose 1.000m 0+90° Dn6-400	Ci-Hoses PA2
303183	Hose 3.000m 0+90° DN6-400	
303184	Hose 0.400m 0+90° Dn6-400	
303155	Hose 0.350m 2×90° Dn6-400	Ci-Hoses PA3

Installation

The hose must be tightened until metallic contact is achieved and then additional 15°.

Directives, Standards, and conformity markings

Hoses are covered by

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive
2009/26/EC	Marine Equipment Directive (MED

Conformity mark:

CE
Wheel mark

Standards applied are:

EN12094-8	Type 1 & 3 connector
ISO 15540	
ISO 15541	

Manifold & Orifice & Acc [41 + 42 +43]:

The manifold features built-in check valves which are opened once the discharge hose is connected to ensure proper activation of all connected discharge valves.

The manifold is supplied complete with orifice and pipe system interface.
The pipe system interface is supplied as standard with ISO 7 -1”. Other threads are available on request.

The maximum orifice of the standard manifold is ø22mm. (Calculation software may limit the orifice size in order to calculate correctly, the calculated orifice will be in the print-out)
The maximum number of cylinder connections is 10.

If more than one manifold is used, the Ci MT Next kit (see actuators) must be used to connect from one discharge valve on one manifold to a discharge valve on the next manifold.

Item numbers (not limited to these numbers) **Datasheet No.**

Variants available: -8 Calibrated

305701	Ci MT1 Manifold	Ci MT Manifold 1-10
305702	Ci MT2 Manifold	
305703	Ci MT3 Manifold	
305704	Ci MT4 Manifold	
305705	Ci MT5 Manifold	
305706	Ci MT6 Manifold	
305707	Ci MT7 Manifold	
305708	Ci MT8 Manifold	
305709	Ci MT9 Manifold	
305710	Ci MT10 Manifold	
305730	Ci MT ISO Orific kit 1”	CM MT orifice kit
305731	Ci MT npt Orific kit 1”	
305732	Ci MT IV8 outlet	
302418	Cylinder orifice	302418 Orifice for cylinder
305623	Ci MT Pressure Switch kit	305623 Ci MT Pressure Switch kit
305741	Ci Manifold support bracket	
305304	Non Return valve 1”ISO Ext-In	305304
305305	Non Return valve 1”npt Ext-In	305305

Installation

The orifice with union is fitted to the pipe system, using thread sealant.
The manifold is fitted to the orifice using an O-ring seal. The union should be tightened to prevent it from coming loose.
The pipe system must be sufficiently supported to carry the load from the Ci manifold.

Directives, Standards, and conformity markings

Check valves in the manifold are covered by

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive

Conformity mark:
CE

Standards applied are:

EN12094-13	Check valve

Pipe system [51]:

The pipe system is used for distributing the INERGEN to the protected enclosures.

Typically the pipe is EN10220/10217 P235TR1, rated for the applicable working pressure (standard 80bar) and has material Charpy V test performed at -40°C.

Typically the fittings are EN 10242/ 10226/ 1562 with special requirement per VdS standard.
Fittings are type tested to 30MPa (300bar) and marked with a red dot and the letter “D” stamped into it. Fittings are suitable for use in installations with clean agent fire extinguishing systems and the low temperature generated during discharge of such system.

Pipes to ASTM Sch40, 80, 160 may also be used.
Fittings ASME 3000lb and above may also be used.

Pipes should be threaded and screwed or welded. If other type of assembly is used, the manufacturer of the pipe components must declare that it is suitable for use in fire suppression system using inert gas (here taken into consideration pressure and temperature during use and discharge).

Pipes and fittings may be Black, Galvanized or Stainless steel.

Item numbers (not limited to these numbers)	**Datasheet No.**
Not listed	
	Pipes
	Elbows
	Tees
	Reductions
	Unions

Installation

The pipe system must be installed in accordance with local authorities’ requirements.

See data sheet: Ci Galv pipe and fittings for details regarding item numbers etc.

Installation must be pressure tested in accordance with the requirements in EEC 97/23 (PED) or in accordance with the authority having jurisdiction.

Use FORMFE01210 Test report for pipe pressure testing

Directives, Standards, and conformity markings

The complete pipe system is covered by:

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
EEC 97/23	Pressure Equipment Directive (PED)

Conformity mark (only the complete pipe system, not the individual component):

Pipe-system Dn<32 should NOT be CE marked)
Pipe-system 32<Dn<100 must be CE marked by installation company
Pipe-system 100<Dn must be CE marked by third-party Notified Body

Standards applied are:

PED

Fasteners & Pipe hangers [54]:

All fasteners used must be of good quality and made from material suitable for the environment they are being used in. Installation hardware for the pipe system must be able to support the pipe system as well as the forces from nozzles during the discharge.

General requirements are:

Pipe must be allowed to move within the brackets due to length contraction during discharge due to the temperature change.
If the temperature rises from +20°C to +200°C, the ultimate tensile strength of the material used shall not be reduced by more than 25%. Combustible materials shall not be used.
Pipe supports shall be designed so that under extreme load there is no danger of the installation being damaged.
Pipe brackets shall completely surround the pipe and be closed.

The material from which a pipe support is manufactured shall be at least 3mm thick. If galvanized, a thickness of 2,5mm will suffice. This does not, however, apply to a pipe support made from hot-dip galvanized material, which may have a minimum size of 25mm x 1,5mm for pipes up to DN50 (12mm x 1,5mm, if type approved).

Pipe supports shall connect the pipe work directly to the building structure. Building members, to which primary supports are attached, shall be strong enough to carry the load. If not, additional links to load-bearing members shall be created.
All pipe runs longer than 1m shall be fixed with supports. The maximum distance between two supports along the pipe shall not exceed the values given below.

Pipe diameter (mm)	**Maximum distance between supports (m)**
< 25	**2**
> 25 < 50	**3**
> 50	**4**

The distance between a support and the last nozzle shall be as short as possible and shall not exceed:
> 0.1m for pipe with a diameter < DN25,
> 0.25m for pipe with a diameter >DN25.

Item numbers (not limited to these numbers)

8584226	Pipe clamp 1/2”
8584232	Pipe clamp 3/4”
8584239	Pipe clamp 1”
8584247	Pipe clamp 1 ¼”
8584254	Pipe clamp 1 ½”
8584261	Pipe clamp 2”
8584263	Pipe clamp 2 ½”
8584263	Pipe clamp 3”
8591004	Pipe base ø70mm
2040404	Nipple pipe ½” 40mm
2040406	Nipple pipe ½” 130mm

Datasheet No.
Pipe Brackets and accessories

401085	Through bolt expander M8-50	401085

Installation

The pipe-system must be installed in accordance with local authorities' requirements.

Directives, Standards, and conformity markings

NA

Nozzles mono-orifice [61a]:

The nozzles are calibrated individually by drilling the orifice fixed in the nozzle. A range of standard orifice nozzles are available.
The nominal diameter of the orifice must be marked on the outside of the nozzle.

IMPORTANT: When ordering a calibrated nozzle (orifice diameter of specific dimension), add “-8” to the part number and the diameter of the hole on the order form (example: 210206-8 orifice 5.6mm).

Item numbers (not limited to these numbers) **Datasheet No.**

Land applications, included in system approvals (LPCB, CNPP, CNBOP, UL, FM etc.)

Mono-orifice nozzles

210204	IN-15 ISO nozzle	
210206	IN-20 ISO nozzle	
210208	IN-25 ISO nozzle	
210210	IN-32 ISO nozzle	Mono-orifice nozzle
210224	IN-15 npt nozzle	
210226	IN-20 npt nozzle	
210228	IN-25 npt nozzle	
210230	IN-32 npt nozzle	
210202	IN-15 Ci IV8 w adapter	

Nozzle accessories (Aluminum parts currently not FM accepted)

210123	IN-1/2” Silencer 112
210125	IN-1/2” Silencer
210126	IN-3/4” Silencer
210128	IN-1” Silencer
210135	IN-1/2” Silencer TBD
210136	IN-3/4” Silencer TBD
303129	Nozzle with deflector for direct valve mounting
205149	Nozzle Deflector ½"
210334	Nozzle SS deflector (use item “-8” for size definition)

Installation

The nozzle is screwed on to the pipe system and tightened using a suitable draw bar.

Silencer base plate is screwed on the nozzle or pipe prior to fitting nozzle to the pipe work, the silencer body is then fitted to the base plate.

When nozzle is fitted directly to the discharge valve, the cylinder must be secured with 2 brackets to hold the forces from the nozzle.

Silencers are used in installations where sensitivity to high sound pressures is critical (hard discs etc.) or if reduced turbulence is desired.

Directives, Standards, and conformity markings

Nozzles are covered by:

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive

Conformity mark:
NA

Standards applied are:
Mono orifice: EN12094-07,

Notice:

Mono-orifice nozzles are per 2014-07 covered by UL, FM or LPCB, they are not covered by

and DNV.

Nozzles Marine [61b]:

The nozzles are calibrated individually by drilling the orifice fixed in the nozzle. A range of standard orifice nozzles is available. The nominal diameter of the orifice must be marked on the outside of the nozzle.

IMPORTANT: When ordering a calibrated nozzle (orifice diameter of specific dimension), add “-8” to the part number and the diameter of the hole on the order form (example: 210206-8 orifice 5.6mm).

Item numbers (not limited to these numbers)		Datasheet No.
Marine applications		
Included in system approvals (MED, DNV, RMRS, BV, ABS etc.)		
MED nozzles with 6 port orifice		
210404	IN-15 MED ISO nozzle SS	
210406	IN-20 MED ISO nozzle SS	
210408	IN-25 MED ISO nozzle SS	
210410	IN-32 MED ISO nozzle SS	
210424	IN-15 MED npt nozzle SS	
210426	IN-20 MED npt nozzle SS	
210428	IN-25 MED npt nozzle SS	
210430	IN-32 MED npt nozzle SS	
210504	IN-15 MED ISO nozzle Brass	
210506	IN-20 MED ISO nozzle Brass	
210508	IN-25 MED ISO nozzle Brass	
210510	IN-32 MED ISO nozzle Brass	
210524	IN-15 MED npt nozzle Brass	
210526	IN-20 MED npt nozzle Brass	
210528	IN-25 MED npt nozzle Brass	
210530	IN-32 MED npt nozzle Brass	
303129	Nozzle for IV8 direct w deflector MED	303129
Nozzle accessories (Aluminum parts currently not FM accepted)		
303129	Nozzle with deflector for direct valve mounting	
205149	Nozzle Deflector ½"	
210334	Nozzle SS deflector (use item “-8” for size definition)	

Installation

The nozzle is screwed on to the pipe system and tightened.
The MED nozzle is tightened with a wrench.
Nozzle material selection should be made with respect to pipe material.

When nozzles are fitted directly to the discharge valve, the cylinder must be secured with 2 brackets to hold the forces from the nozzle.

Directives, Standards, and conformity markings

Nozzles are covered by:

97/36/EC	Pressure Equipment Directive
2009/26/EC	Marine Equipment Directive (MED

Conformity mark:

wheel mark

Standards applied are:

MED nozzles: EU 1996/98, MSC 776, 848, 1267

Notice:

MED nozzles are per 2014-07 covered by IMO and DNV, they are not covered by UL, FM or LPCB

Pressure relief (Fire Dampers) [71]:

To ensure sufficient area of ventilation to the protected room, these pressure reliefs are ideal.

Item numbers (not limited to these numbers)		Datasheet No.
302720	Pressure relief A040	30272x Pressure relief
302721	Pressure relief A065	
302722	Pressure relief A095	
302723	Pressure relief A150	
302724	Pressure relief A250	
302725	Pressure relief A385	
302726	Pressure relief A615	
302728	Pressure relief A1000	
302762	Pressure relief EV300-EI60	30276x Pressure relief EV
302765	Pressure relief EV500-EI60	
302740	Cap for vent ø080mm	30274x Pressure relief cover
302741	Cap for vent ø100mm	
302742	Cap for vent ø125mm	
302743	Cap for vent ø160mm	
302744	Cap for vent ø200mm	
302745	Cap for vent ø250mm	
302746	Cap for vent ø315mm	
302748	Cap for vent ø400mm	

Installation

The pressure relief must be installed into the open or to a room significantly larger than the protected enclosure so that unintended pressure build-up is avoided and low oxygen concentration is avoided.
In general, a room to which pressure is relieved should be 10 times larger than the protected room.

Directives, Standards, and conformity markings

Pressure reliefs are covered by:

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)

Conformity mark:

NA

Standards applied are:

NA

Signs & Labels [72]

Signs should be placed outside the protected room to inform about the fire suppression system. Additional signs should also be placed on the entry door to the cylinder storage room.

Some authorities require a system identification sign, which must be placed on the cylinders.

Item numbers (not limited to these numbers)	Datasheet No.
Signs for local requirements are available	

Accessories [73]

Components used to complete the installation.
To seal actuators, use “fine” sealing wire; to seal hand wheel valves, use “coarse” sealing wire.

Item numbers (not limited to these numbers)		Datasheet No.
214009	Seal (plastic, red)	Seal
214010	Sealing wire (coarse)	
214011	Sealing wire (fine)	
102012	Stainless steel tube 6mm	102012 Stainless tube ø6
214025	Stainless ø6 pipe bracket	214025 Stainless bracket ø6
102021	Pipe retainer ø6 single	10202#
102022	Pipe retainer ø6 dual	
xxx	Compression ring fittings	Compression fittings 6mm
540351	Junction box	540351

Installation

The sealing wire must be installed so that it is not possible to change the position without breaking the wire. The seal is pressed on the sealing wire using special pliers with identity mark of the technician performing the operation.

Ø6 tube can be used for remote pneumatic actuation and other control functions.

Directives, Standards, and conformity markings

Accessories are covered by:

NA

Conformity mark:

NA

Standards applied are:

NA

Tools [81]

Tools for servicing the valves, actuators etc. should only be purchased at Fire Eater and are only sold to authorized installers where employees have received training and education in installation & maintenance of Fire Eater INERGEN systems.

Ordinary tools like wrenches and screwdrivers are also available in selected qualities for the installation.

Item numbers (not limited to these numbers) **Datasheet No.**

530509 Tool Cylinder Pressure gauge M25+W24
530810 Toolkit: Ci 2015
530820 Toolkit: FE SV 2015
530830 Toolkit: Ci SV 2015
530610 Tool kit: Tube Fitter ø6

305490 IV8 sep disc Used for resetting after discharge
305491 IV8 Act plug Used for resetting after discharge
For dismantling the valve for resetting after discharge
305495 Ci Actuator Reset Tool Used for service
For resetting the Ci Actuators after activation (whether or not the cylinder has been discharged)
530506 IS8B Electric Circ Tester Used for service
Verifies that sufficient power can be routed to the electrical actuator.
530502 Manoswitch tester Used for service
Verifies y the cylinder pressure monitoring circuitry
530520 Ci Force Act test Used for service
Measure the required force to operate the discharge valve and measure the force provided by the actuator (all actuators, electrical, manual, and pneumatic)
530525 Ci Outlet Damper Used for service
Testing the discharge valve
305149 SV22 Reset tool Used for service
To reset the SV selector valve
305148 APTB (Test port) Used for service
Measure the required pressure to activate the Selector valve
530530 Tool: NRV 1/4 Test Flow Used for service
Test the Non Return Valve for flow
530531 Tool: NRV 1/4 Test No Flow Used for service
Test the Non Return Valve for leaktightness
530540 Tool: Pressure switch setter Used for service
To verify the switchpoint for manifold and pipe pressure switches.

Installation

Directives, Standards, and conformity markings

Tools are covered by:
NA

Conformity mark:
NA

Standards applied are:
NA

Service kits [82]

After discharge the valve has to have the piston replaced before resetting in order to guarantee a leak-free service life.

Item numbers (not limited to these numbers)		Datasheet No.
305403	Ci IV8 Piston	
305404	Ci IV8 Service kit box	305404 Ci IV8 Service kit box

Installation

The individual parts of the service kit box are available separately for refilling the box.

Directives, Standards, and conformity markings

Service kits are covered by:

NA

Conformity mark:

NA

Standards applied are:

NA

Control panels [92]:

The Control Inert system may be used with any control panel capable of supplying sufficient activation current/voltage for the actuator and which complies with the requirements for which approval the system is used.
Eg. UL & FM: Standard for Control Units for Fire-Protective Signaling Systems, UL 864 and also must be UL Listed.

For control panels requiring EOL resistance which are differing from the standard EOL resistor interfaces are available to ensure a proper functioning system.

Item numbers (not limited to these numbers)		Datasheet No.	
563103-62	Sigma A-XT	563103	UL, FM
5400nn	Sigma XT		CE (LPCB)
560nnn	Sigma XT+		CE (LPCB)

Installation

After installation the correct function must be verified by measuring that there is sufficient power to actuate the actuator by using the Power meter.

Directives, Standards, and conformity markings

Control panels are covered by:

UL864	20110628-S8485B	issued 2011 June 28
EEC 89/106	Construction Product Directive (CPD)	
EEC 305/2011	Construction Product Regulation (CPR)	

Conformity mark:
CE

Standards applied are:
EN12094-1
EN 54
UL864

SV system components

SV Zone kit [101]:

The Zone kit consists of a Selector valve with Orifice, Pipe adapter, and Tee to create the distribution manifold.

Item numbers (not limited to these numbers)		Data sheet
305170	SV22 Zone kit ISO	30517# SV22 Zone kit iso-npt
305171	SV22 Zone kit npt	
304471	SV48 Zone kit NPT	304471
Included in above numbers		
305150	SV22 selector valve	305150 SV22 selector valve
305450	SV48 selector valve	305450 SV48 selector valve

Installation

For SV22 systems.
A cylinder rail is installed approx. 2.6 m above the cylinder foot.
Each zone kit is placed in this rail and the inlet tees are pushed together and tightened. Tees are identical for valves and manifolds, except the manifold has different pipe length (space between tees).

SV48
The valve and fitting is heavy and with tapered thread (sealing thread).
It is recommended to assemble the manifold on a strong support and use lifting devices to put it in place. Tees and fittings are identical for valves and manifolds.

Directives, Standards, and conformity markings

Discharge valves are covered by:

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive

Conformity mark:
CE

Standards applied are:
EN12094-5

Additional approvals:
TAC DNV P-14388

Notice:

The SV48 valve is per 2014-08.
CE approved and included in European approval.
Not included in UL listing neither is it included in FM approval or any marine approvals.

SV CiV & Test port [121]:

The SV CiV is a control valve which is used to control the selector valve at the same time as actuating the Ci IV8 valve. It uses pressure from the IV8 valve to operate the selector valve.
The kit, SV CiV kit, contains the valve and fitting necessary to connect the outlet to a ø6mm tube.
The SV CiV valve must be placed on a cylinder leading to the zone protected by the cylinder to which it is fitted.

The SV Test port is installed on the line from the SV CiV to the SV valve.
The APTB tool is used on the Test port to verify the SV22 opening pressure and verifying the zone connected. It is also used for bleeding the pressure of the activation circuitry after activation in order to reset the SV22.

Item numbers (not limited to these numbers)		**Data sheet**
305182	SV CiV start kit	305182 SV CiV start kit
305183	SV Test port kit	305183 SV Test port kit
Included in above numbers		
305440	SV CiV Control valve	305440 SV CiV Control valve
305302	Non-Return valve	305302 Non-Return valve

Installation

With the Ci discharge valve depressurized the actuator connector is removed and the SV CiV fitted in its place.

Ø6×1mm tube is fitted to the outlet and routed to the selector valve.

The SV Test port should be installed in close proximity of the SV CiV, and be easily accessible at service.

Directives, Standards, and conformity markings

Discharge valves are covered by:

EEC 89/106 Construction Product Directive (CPD)
EEC 305/2011 Construction Product Regulation (CPR)

Conformity mark:

CE

Standards applied are:

EN12094-4

Pneumatic activation kit [122]:

Hose and fitting to utilize the PA system of the discharge valve, as the backpressure activation system is disabled in Multi Zone systems.

Item numbers (not limited to these numbers)		Datasheet No.
305179	SV-Ci Next kit 0.4m straight	
305180	SV-Ci Next kit 0.7m elbow	
305193	SV-Ci Next kit 0.5m straight	
305197	SV-Ci Next kit 0.28m Straight	

Installation

The PA plug in the Ci IV8 is removed and the tee is fitted (PTFE tape must be applied to the 1/8” taper thread. Hoses are connected to the tee and between all cylinders to be activated.

It is of utmost importance that the Non-Return valves, which come with the SV CiV kit and are used to separate the zones with different cylinder quantities, are placed correctly.

Directives, Standards, and conformity markings

Hoses are covered by:

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive
2009/26/EC	Marine Equipment Directive (MED

Conformity mark:

CE
Wheel mark

Standards applied are:

EN12094-8	Type 1 & 3 connector
ISO 15540	
ISO 15541	

SV22 Switch kit [131]:

This accessory is only an option to use but can be installed to monitor the position of the Selector valve electrically.

All switches are change over switches, and the “Open” and “Closed” switch are available as a “-8” item with customer specific resistors fitted.

The “Open switch” operates when the valve is fully open.
The “Closed switch” operates when the valve starts to open.
The “Pipe pressure switch” operates when the outlet of the SV22 is pressurized.

Item numbers (not limited to these numbers)		Data sheet
305168	SV Switch adapter closed ATEX	305168
305186	SV Open Switch kit	305186 SV22 Open Switch kit
305190	SV Closed Switch kit	305190 SV22 Closed Switch kit
305184	SV22 Pipe pressure Switch kit	305184 SV22 Pipe pressure Switch kit
305181	SV22 Pipe pressure outlet	305181
304481	SV48 Pipe pressure outlet	304481

Installation

The “Closed switch” is installed in the 3/8” connection on the side of the SV actuator body by removing the plug covering the connection.

The “Open switch” is installed by removing the piston stop located in to of the SV actuator body.

The “Pipe pressure switch” is installed in the outlet of the SV valve and the pipe adapter is screwed into it.

305168 is a fail-safe construction designed to be used with an ATEX switch but supplied without this switch.

Directives, Standards, and conformity markings

NA

Manifold kit [141]:

SV-MT manifold kit is supplied with tee to form the distribution manifold when connected to zone kit and other manifold kits. The manifold contains non-return valve to limit the cylinders discharged to be controlled by the PA system.

SV-Ci MT manifold kit has adapters to fit it between tees from the zone kit or between other manifold kits.
The SV-Ci MT does not have non-return valve and hence all connected cylinders will be activated by back pressure, the manifold is similar to the one used on stand alone systems.

One zone kit should always be fitted between two MT kits to ensure sufficient distance between manifolds to make a proper installation.

Item numbers (not limited to these numbers)		Data sheet
30517n	SV22 MTn kit (n= 2-8)	20517x SV22 MTx kit
30576n	SV Ci MTn manifold (n= 2-10)	30576x SV Ci MTx manifold
30447n	SV MTn npt 2” KIT (n= 2-8)	30447x
30448n	SV Ci MTn npt 2” KIT (n= 2-10)	SV MT

Above numbers are based on
SV manifold (Back pressure disabled, PA required)
Ci MT Manifold (Back pressure activation active, all cylinders will activate)

Installation
Similar to the selector valves.

After the manifolds are installed hoses are connected, always start with the shorter hose.

Directives, Standards, and conformity markings
Check valves in the manifold are covered by:

EEC 89/106	Construction Product Directive (CPD)
EEC 305/2011	Construction Product Regulation (CPR)
97/36/EC	Pressure Equipment Directive

Conformity mark:
CE

Standards applied are:
EN12094-13 Check valve

SV22 End plug kit [142]:

Two plugs are used to complete the distribution manifold created by connecting the tees of the zone kit and MT kit.
One of the plugs has a built-in burst disc preventing over pressurization of the distribution manifold which is a closed pipe section (when all selector vales are closed).

The two bleed fittings are used to end the PA line at the beginning and at the end.
The bleed fitting is installed so that pressure build up anywhere in the PA line can easily bleed out without causing any undesired effects. The Bleed fitting will close once it is pressurized.

Item numbers (not limited to these numbers)		Data sheet
305164	SV22 End plug kit	305164 SV22 End plug kit
304454	SV48 End plug kit	304454
Included in above numbers		
305544	Burst disc 480 bar	Burst Discs

Installation

All plugs are tightened.

Directives, Standards, and conformity markings

NA

Brackets and accessories [151]:

To make installation easier, bracket kits can be used.

Item numbers (not limited to these numbers)		Datasheet No.
305166	SV Cable tray kit	305166 SV Cable tray kit
304455	Bracket kit 2” SV48	304455
400306	Cyl rail 1920 mm	Cylinder rail
102021	Pipe retainer ø6 Single	10202# Pipe reatiner
102022	Pipe retainer ø6 Dual	

Installation

The cable tray kit is used keeping pilot lines and cables organized when multiple zones are protected.

The Bracket kit 2” supports the 2” distribution manifold.

The cylinder rail is used for SV22 to support valves and manifold line.

Directives, Standards, and conformity markings

NA

Fittings, adapters and hoses [161]:

For more advanced installations, adapters for creating a high pressure distribution system are available.
This can be used when the Selector valves are to be spread out and not placed centrally.

Item numbers (not limited to these numbers)		Datasheet No.
305154	SV22 pipe kit 60mm	30515x SV22 pipekit
305155	SV22 pipe kit 85mm	
305156	SV22 pipe kit 125mm	
305157	SV22 pipe kit 160mm	
305159-8	Customer specific pipe length	
305750	SV Adapter 1”ISO – M40×1.5	305751 SV Adapters
305751	SV Adapter 1”npt – M40×1.5	
305730	Ci MT ISO orifice kit 1”	Ci_MT Orifice kit
305731	Ci MT npt orifice kit 1”	
305236	SV22 pipe adapter ISO 1”	
305237	SV22 pipe adapter npt 1”	
207060	Compensator hose DN25-400 0.5m	SV22 Compensation hoses
207061	Compensator hose DN25-400 1.0m	
207062	Compensator hose DN25-400 1.5m	
207070	Compensator hose DN32-400 0.5m	
207071	Compensator hose DN32-400 1.0m	
207072	Compensator hose DN32-400 1.5m	
303516	Nipple 1”-1”BSP-BSP 400bar (SV22 and hose)	
777056	Bonded seal 1”	
303508	Adapter 1” – 1“ ISO	
303517	Adapter 1” – 5/4” ISO	
303518	Adapter 1” – 1 1/2” ISO	
303519	Adapter 1” –2” ISO	
777122	Nipple 1”- ½” ISO-npt	
777124	Nipple 1”- ¾” ISO-npt	
777126	Nipple 1”- 1” ISO-npt	
777128	Nipple 1”- 1 ¼” ISO-npt	
777130	Nipple 1”- 1½” ISO-npt	
777132	Nipple 1”- 2” ISO-npt	
76090806	ASTM 6000 Elbow 1" npt galv	
76090809	ASTM 6000 Elbow 2" npt galv	
76130806	ASTM 6000 Tee 1" npt galv	
76130809	ASTM 6000 Tee 2" npt galv	
76241865	ASTM 6000 Reduce 1-2" npt galv	
76270806	ASTM 6000 Socket 1" npt galv	
76340809	ASTM 6000 Union 2" npt galv	
76610806	ASTM Sch160 1"npt 100mm galv	
76610809	ASTM Sch160 2"npt 100mm galv	

Installation

Above components are all suitable for use in Fire Eater INERGEN system with up to 40 MPa (400bar) working pressure.

Directives, Standards, and conformity markings

All pressure carrying parts
EEC 97/23 Pressure Equipment Directive

Conformity mark:
if exceeding Dn 32: CE

Tools [181]:

To ensure proper operation of the selector valve, a number of tools have been created.

Reset tool is used to reset the selector valve with after activation.

SV Test port is installed for each protected zone allowing for easy annual testing of the required operating pressure of the selector valve and at the same time eliminate the risk of faulty installation.

Item numbers (not limited to these numbers)		Datasheet No.
305187	Tool kit: SV	305187
305149	SV reset tool	305149
305183	APTB tool	305183
305147	ATPB CO2 adap kit	305147
305188	Tool: SV Switch installation	

Installation

The Tool kit: SV contains all tools necessary to operate, test and service the SV22 system.

Each tool is also available separately.

Before commissioning of the system the routing of the activation system must be verified and its integrity tested, for this the APTB tool is used, the same tool is used for bleeding the system after activation in order to reset the selector valve.

Directives, Standards, and conformity markings

NA

Equivalent length & Flow resistance

Component	Flow diameter	Equivalent Length	Loss Coefficient
	[mm]	[m] [ ]	
Ci IV8 Discharge valve	ø8	0.9963.09	
Hose end Straight	ø8	0.3501.06	
Hose end Elbow	ø8	0.1450.44	
Hose per meter	ø10	0.8232.06	
Ci MT check valve	ø8	0.9142.79	
SV MT	ø8	0.8992.67	
SV Tee	ø22	0.9801.09	
NRV 1”	ø22	3.8654.31	

For the hoses, please notice that the hose ends are the main contribution for the flow resistance as the diameter here is only ø8mm, whereas the hose has a flow diameter of 10mm.

Chapter 2: Specifications

INERGEN Agent

INERGEN agent is a plentiful, non-corrosive gas that does not support combustion nor react with most substances. INERGEN agent contains only naturally occurring gases which have no impact on the ozone layer or the environment in general. INERGEN agent is a mixture of three inerting (oxygen diluting) gases: 52% nitrogen, 40% argon, and 8% carbon dioxide. The INERGEN agent extinguishes fire by lowering the oxygen content below the level that supports combustion.

When the INERGEN agent is discharged into a room, it introduces the proper mixture of gases that still allow a person to breathe in a reduced oxygen atmosphere. It actually enhances the body's ability to assimilate oxygen. The normal atmosphere in a room contains approximately of 21% oxygen and less than 1% carbon dioxide. If the oxygen content is reduced below 15%, most ordinary combustibles will not burn. The INERGEN agent will reduce the oxygen concentration to approximately 12.5% while increasing the carbon dioxide content to about 3%. The increase in the carbon dioxide content increases a person's respiration rate and the body's ability to absorb oxygen. Simply stated, the human body is stimulated by the carbon dioxide to breathe deeper and more frequently to compensate for the lower oxygen content of the atmosphere.

Environmental impact

The INERGEN agent is a mixture of three naturally occurring gasses: Nitrogen, Argon, and Carbon dioxide.

As INERGEN is derived from gasses present in the earth’s atmosphere, it exhibits no ozone depleting potential, does not contribute to global warming, nor does it contribute unique chemical species with extended atmospheric lifetime. Because INERGEN is composed of atmospheric gasses, it does not pose the problems of toxicity associated with the chemically derived Clean Agent fire extinguishing.

INERGEN System

The Fire Eater INERGEN Fire Suppression System, is an engineered system utilizing a fixed nozzle agent distribution network. The system is designed and installed in accordance with the authorities having jurisdiction and NFPA 2001, "Clean Agent Fire Extinguishing Systems." When properly designed, the INERGEN system will extinguish fire in Class A, B, and C hazards by lowering the oxygen content below the level that supports combustion.
The system can be actuated by detection and control equipment for automatic system operation along with providing local and remote manual operation as needed. Accessories are used to provide alarms, ventilation control, door closures, or other auxiliary shutdown. When the INERGEN agent is discharged into a room, it introduces the proper mixture of gases that will allow a person to breathe in a reduced oxygen atmosphere. A system installation and maintenance manual is available and containing information on system components and procedures concerning design, operation, inspection, maintenance and recharge. The system is installed and serviced by authorized distributors that are trained by the Fire Eater.

The INERGEN system is particularly useful for suppressing fire in hazards where an electrically non-conductive medium is essential or desirable; where clean-up of other agents present a problem; or where the hazard is normally occupied and requires a non-toxic agent.

The following are typical hazards protected by INERGEN systems:

- Computer rooms with or without lowered ceiling and raised floors
- Telecommunication Switch gear rooms
- Vaults & Storage rooms
- Process equipment rooms
- Machinery spaces
- Historic buildings & museums
- All normally occupied or unoccupied electronic areas where equipment is either very sensitive or irreplaceable

Composition and materials

The basic system consists of extinguishing agent stored in high strength alloy steel cylinders. Discharge valve, hoses, manifolds and various types of actuators. The agent is distributed and discharged into the protected area through a network of piping and nozzles. Each nozzle is drilled with a fixed orifice designed to deliver a uniform discharge to the protected area.

Additional equipment includes - Control panels, releasing devices, remote manual pull stations, corner pulleys, door pumps, pressure trips, bells and alarms, and pneumatic switches.

Installation

All system components and accessories must be installed by personnel trained by the manufacturer. All installations must be performed according to the guidelines stated in the manufacturer's design, installation, operation, inspection, recharge and maintenance manual.

Availability

Availability - INERGEN Systems are sold and serviced through a network of independent distributors located in many countries.

On www.fire-eater.com a list of Fire Eater distributors and approved filling stations is available.

Maintenance

Maintenance is a vital step in the performance of a fire suppression system. As such it must be performed by an authorized Fire Eater distributor in accordance with NFPA 2001 and the manufacturer's design, installation, recharge and maintenance manual. When replacing components on the Fire Eater system, use only Fire Eater approved parts.

Technical services

For information on the proper design and installation, contact a local international authorized INERGEN System distributor. The Fire Eater applications engineering department is also available to answer design and installation questions. See www.fire-eater.com or call +45 7022 2769.

Inert gas history

The inert gases have been known to have fire extinguishing properties for many years. Before the early 19th century, the only fire extinguishing agent widely known and used was water. As today, it was commonly available, cheap and the inventors and other industrious people were working hard to improve supply techniques such as pumps, and means of transportation by vehicles.

The 17th and 18th centuries were challenging years where scientists struggled to discover the laws of physics and chemistry, and to investigate the surrounding world. The Swedish chemist Carl Wilhelm Scheele discovered in 1772 that air was a mix containing two principal substances: Oxygen and Nitrogen. (Also the French scientist A. Lavoisier, 1743-1794, was making similar observations, as he found that a combustion consumes Oxygen and leaves behind "the thing that has no life" Azote).

Some years later the Danish physicist H.C. Ørsted (1777-1851) studied the elements later to be classified in the periodical system. On the basis of the work done by Scheele he discovered that the components of air, Oxygen and Nitrogen, behaved very differently. He saw that Oxygen was taking actively part in a chemical process such as combustion and Nitrogen was not. On the contrary Nitrogen would actually suffocate a fire, and after this discovery he gave the element Nitrogen the Danish name "Kvælstof" which means the element that suffocates fire.

Still later the periodical system was completed (Niels Bohr) and the real inert gases Helium, Neon, Argon, Krypton and Xenon were identified.

Nitrogen and Carbon Dioxide are not classified as true inert gases, since they can participate to some degree in chemical processes, but in a fire this ability is insignificant, and generally they are referred to as “inert gases” in the fire extinguishing systems industry.

One of the characteristics of the inert gases is that they do not take place in chemical processes, not even at high temperatures generated by combustion (Note: Krypton and Xenon are known to react with Fluorine at high temperature and pressure, but this is not relevant to fire extinguishing). So by introducing them into an enclosure at high concentrations, they dilute the Oxygen and extinguish the fire. The normal atmospheric Oxygen content is 20.95%, and by reducing that, to less than 15%, most commonly present combustibles, such as oil, gasoline, wood and plastics are extinguished.

The inert gas re-discovery

In the early 1980’s Fire Eater A/S was involved in a project, where it was obvious that Halon 1301 could not be used safely, due to the formation of seriously toxic thermal de-composition products.

It appeared obvious that the use of inert gases alone would lead to other safety problems, since the Oxygen concentration required for fire extinguishing, is very close to the minimum acceptable level for man. The idea of using a small amount of CO2, to compensate for the low Oxygen concentration required for fire extinguishing, was investigated. Experiments and search in scientific medical studies, discovered the amazing result, that CO2 used in a 3-6% concentration, is able to compensate the ill-effect of 8-12% Oxygen concentrations, and maintain consciousness and normal breathing.

The idea was filed as a patent application in 1987 and in 1991 commercialized based on a cooperation between Fire Eater A/S, Denmark (and its sister company Fire Research ApS) and Air Products & Chemicals, and Ecosystems, Pennsylvania, USA. The name of the process to compensate for Oxygen deficiency by Carbon Dioxide, in fire fighting, is INERGEN.

INERGEN is globally available through licensed suppliers. The INERGEN suppliers are not just high quality fire extinguishing systems suppliers, but furthermore they are specially trained in the use of INERGEN and the INERGEN system components, and through the organized license structure, experience and knowledge is distributed to all INERGEN suppliers. For the marine use of INERGEN this also means that the systems can be fully serviced where INERGEN is available, which in 2010 is worldwide.

Safety/toxic effect

Since the days of H. C. Ørsted it was commonly known that the reduction of Oxygen had some side effects: The suffocating effect of Nitrogen did certainly also apply for human beings, not only for the fire. This is true, but only in more severe cases of Oxygen deficiency.

Outside the fire extinguishing industry a need appeared, to know more about oxygen deficiency, the medical term being Hypoxia. Aviators were exposed to hypoxia during high un-pressurised flights, and from the 1930s physiologists were researching this field intensively. Also astronauts and mountain climbers are exposed to hypoxia, and that has provided a broad platform of scientific literature and data, to support the theoretical background of INERGEN and to some degree other inert gases or gas blends.

It is important to understand, that the Inert gases (He, Ne, Ar, etc.) and Nitrogen do not have any toxic effects at normal atmospheric pressures. It is even more important to understand that Carbon Dioxide does not have any toxic effects, but it has physiologic effects as a very important part of the human metabolism, and regulatory mechanisms in Oxygen supply.

When a Carbon Dioxide system is known to involve high personnel risks, it is due to the high concentrations used: More than 30% exceeds the human short term tolerance, and will result in unconsciousness in a matter of minutes.

Hypoxia

Hypoxia is the medical term for the lack of Oxygen in humans. The symptoms vary by the Oxygen concentration, and the exposure time. There are different reasons for hypoxia, but of course the most interesting one at this occasion, is the hypoxia caused by the use of fire extinguishing gases. Acute hypoxia occurs, when the Oxygen concentration is reduced in the matter of hours or less, as this does not allow for the natural compensation, having effect in a matter of days in prolonged gradual hypoxia.

When the inspired oxygen is reduced, it leads to a reduction in the blood-oxygen saturation. Initially this is detected by chemoreceptors in the major arteries, and automatically induces an increase in lung ventilation. Due to this, the equilibrium Carbon Dioxide partial pressure slightly decreases, and the initial respiration increase is outweighed. At 12% inspired Oxygen there is only little, or no change in ventilation. If the Oxygen concentration is further decreased, the lowered arterial Oxygen pressure will take effect, and ventilation will gradually increase, until about the 8-9-10% limit at which unconsciousness is often observed in young healthy males within a few minutes (2-4). There is a significant individual sensitivity to both the lowering of the arterial Oxygen, and Carbon Dioxide partial pressure.

Hypoxia is especially essential to the brain tissue, since the brain metabolism depends critically on the partial cerebral (brain cells) Oxygen pressure, blood-oxygen saturation and the acidity. If the partial Oxygen pressure drops below a certain limit, it results in immediate unconsciousness.

An unpublished paper by the Institute of aeronautical medicine, Copenhagen, suggests the following limits of consciousness, for male fighter pilots in good physical condition:

10.6%	30 minutes
8.0%	3-5 minutes
6.3%	1.5-2.5 minutes
5.2%	1 minute
3.8%	0.5 minute
2.4%	0.25 minute

The paper indicates that there are great individual differences, and that age, overweight, smoking, and a physical condition other than well trained, will decrease the tolerance to low Oxygen considerably.

In a broad population of "normal subjects" the first light symptoms of hypoxia can be observed at about 15.5% Oxygen. The symptoms such as impaired judgement, clumsiness, diminished visual acuity and increased response times are becoming more significant as the Oxygen concentration drops to 11-12%.

As the Arterial Oxygen level drops within 5 seconds, the symptoms starts with practically no delay. One of the very serious effects of severe acute hypoxia is that it is not identified by a large number of individuals. On the contrary they are experiencing a light intoxication or light-headedness, and will be likely to respond irrationally to warnings, or signs of danger.

Down to about 12% Oxygen, most physiologists agree, that short exposures do not cause any permanent injuries (exposures up to 30 minutes), and only in very few cases leads to unconsciousness.

At a flooding concentration chosen for the inert gas system of 50% (0.5m^3 gas per m^3 room), the average high (average of the upper 5% of measured discharges) Oxygen concentration is 12.9%. The average (of the 90% of the measured discharges) is 12.6%. The average low (average of the lower 5% of measured discharges) is 11.4%. The statistical basis of the above is 139 full-scale discharge tests under real life conditions. The enclosures ranged from 18m^3 to 690m^3 and were measured to an accuracy of +/- 3 cm. Cylinder pressure was gauged to a temperature compensated accuracy of +/- 2%, and room temperatures were within the range 19-24°C. these tolerances do not explain the otherwise satisfactory tolerance of +0.2%/-1.3% Oxygen concentrations measured, but enclosure tightness, actual cylinder temperature during test, and atmospheric pressure, possibly play the most significant role.

In fire situations, Oxygen concentrations have been experienced to drop to 8-10% after discharge of extinguishing gas, due to the Oxygen consumption of fire and the increased enclosure temperature.

The system design required to extinguishing fires, and the safety limits are obviously very close to each other for Inert gas systems. They can be used safely if all the design conditions are strictly held, and by very short exposures (less than 2 minutes) it is obvious that they do not represent an acute risk within reasonable tolerance limits and influences of the surroundings. However there is a simple, reliable and natural way to expand the exposure tolerance to low Oxygen: adding a small amount of Carbon Dioxide to the Inert gas mixture.

Acute adaptation to acute hypoxia

As earlier mentioned, Carbon Dioxide is a very important part of the human physiology. It is a product of metabolism, and the primary regulator of the acidity of blood and tissues, through its conversion to Carbonic acid and the hydrogen ion.

During exercise, the amount of Carbon Dioxide in the blood and in the expired air is increased and it represents the major drive to ventilation increase. Increasing the inspired Carbon Dioxide (hypercapnia), will like exercise, raise the acidity (lower pH) and increase the ventilation, depending on the inspired Carbon dioxide concentration.

As Carbon Dioxide above 8% concentration is clearly beginning to cause some problems at prolonged exposures, one could be tempted to make the following conclusions: Hypoxia is bad, Carbon dioxide is bad. Combined hypoxia and hypercapnia is twice as bad as the problems are adding up. 1 + 1 = 2. This is good arithmetic, but absolutely not true in this case: on the contrary. It should rather be viewed as 1 + -1 = status quo! This statement, not being scientifically correct, anyhow reflects the real effect.

In case of a lowered Carbon dioxide concentration the pH rises. This causes a vasoconstriction in the brain. In case of hypercapnia the result is a vasodilatation. In plain and simple words: The brain has a shunting valve mechanism that allows for an increased blood flow through the brain at high Carbon dioxide concentrations and decreases when the concentration is lowered. This is easily demonstrated: After hyperventilating for a minute or two, dizziness is felt strongly, and if continued it will lead to fainting. This is simply a result of the decreased Carbon Dioxide, and this little experiment clearly demonstrates the statement in ref. 1: "Carbon Dioxide is no less vital to life than Oxygen".

Some interesting effects of Carbon Dioxide are: During tests carried out by Gibbs and others (ref. 2), subjects were in four experiments breathing 6% Oxygen + 5% Carbon Dioxide for three minutes, then 4% Oxygen + 5% Carbon Dioxide for another three minutes. EEG remained normal and consciousness was fully maintained. Two subjects went even further: 2% Oxygen + 5% Carbon Dioxide for additionally two minutes. EEG remained normal and they were able to add and subtract, and obey demands.

Of course this experiment is way out in the extremes, but clearly indicates the beneficial effect of Carbon Dioxide.

Another interesting experiment, ref. 1, shows that a test individual unconscious due to a 5% Oxygen/95% Nitrogen atmosphere, recovered consciousness immediately after addition of 5% Carbon Dioxide (inspired gas 90% Nitrogen, 5% Oxygen, 5% Carbon Dioxide). Again a very clear indication that the Carbon Dioxide is the life insurance needed in the use of Inert gases and gas blends.

Carbon Dioxide is giving acute adaptation to acute hypoxia!

Hypoxia, hypercapnia and Carbon Monoxide

During a fire a lot of harmful smoke and decomposition products will be produced. The most significant one being Carbon Monoxide. Statistical information collected out of post mortems on human fire fatalities indicate that 70% had more than 30% Carboxyhaemoglobin (blood cells bound to Carbon Monoxide) which will have incapacitated the victim.

The mechanism of Carbon Monoxide is to bind to the blood cells with an affinity 200-250 times that of Oxygen and thereby reducing the blood Oxygen carrying capacity. This situation is physiologically similar to hypoxia.

What are the tolerable limits of Carboxyhaemoglobin? Basically, Carboxyhaemoglobin is not at all desirable, but to some people a part of their life: very heavy smokers and citizens of a large city. Heavy smokers may have a pre-load of Carboxyhaemoglobin of 10-15% as an extreme. And this is actually very close to “an acceptable level”.

As the inert gas blend, containing Carbon Dioxide, purposely increases the ventilation this will naturally lead to an additional Carbon Monoxide exposure: but there are 5 very important factors in effect:

- The Carboxyhaemoglobin pre-load
- The exposure time
- The Carbon Monoxide concentration
- The Oxyhaemoglobin saturation
- The rate of ventilation

The rate of ventilation is increased by 2.5 times at 5% Carbon Dioxide in 12.2% Oxygen, and the heart rate is increased by 10/min. (ref. 3)

The following example is based on breathing 20.9% Oxygen, and is giving an indication of the magnitude of the problem. The Carboxyhaemoglobin pre-load is 5%, and the exposure time is 10 minutes:

CO PPM	6 l/min.	18 l/min.	30 l/min.	40 l/min.
500	6.14%	8.42%	10.71%	12.68%
1000	7.28%	11.84%	16.42%	20.26%

These values may not at all be conservative due to the unknown factor of the Oxyhaemoglobin level, but are useful in relating to real life fire situations:

A gasoline 0.25 m^2 pan fire with 1 liter fuel, in an enclosure volume of 35 m^3 is giving the following results after total combustion:

- CO peaks at about 1100 PPM
- Oxygen low 17%
- Carbon Dioxide high 2.9%

Experiments with INERGEN extinguishing (50% vol. gas/vol. room) under the same basic circumstances prove that the Oxygen diluting effect of INERGEN, is at the same time CO-diluting:

- CO is reduced to approx. 700 PPM
- Oxygen low is 8%
- Carbon Dioxide high 5%
- Temperature peak 163°Celsius (325°F).

It is of course not recommendable to stay in room during such a fire and extinguishing (temperature 163°C!), but the gas situation in the enclosure will support consciousness for more than 10 minutes. Consciousness will not be supported for more than 1-2 minutes if the Carbon Dioxide level is not increased above 3%.

NOAEL/LOAEL

There is no NOAEL and LOAEL for inert gasses as there are no toxicological effects from exposure to low oxygen concentration.

NFPA 2001 defines NOAEL AND LOAEL "For halocarbons". The NOAEL and LOAEL are based on the toxicological effect known as cardiac sensitization. Cardiac sensitization occurs when a chemical causes an increased sensitivity of the heart to adrenaline, a naturally occurring substance produced by the body during times of stress, leading to the sudden onset of irregular heart beats and possibly heart attack. Cardiac sensitization is measured in dogs after they have been exposed to a halocarbon agent for 5 minutes. At the 5 minute time period, an external dose of adrenaline (epinephrine) is administered and an effect is recorded, if the dog experiences cardiac sensitization."

No Effect Level and Low Effect level for inert gas are in NFPA 2001 set to be respectively at concentration of 43% and 52% corresponding to an oxygen level of 12% and 10% (normal atmosphere is 21% oxygen).
These levels are based of physiological effects similar to the effects of doing exercise, and should hence not be mixed with toxicological effects caused by chemical agents.

Enclosure escape precautions

Even though the inert gas systems containing Carbon Dioxide offers a very high degree of safety to humans, it is under no circumstances recommended to stay in the enclosure during fire extinguishing or during fire extinguishing system discharge, if it can be avoided.

When inert gases and inert gas blends are used there are certain additional advantages: The gases are stored under high pressure, but always in the gaseous form. During discharge of the gas, there is no significant condensation of air moisture, and therefore escape route visibility, is not decreased by the fire-extinguishing agent.

During Hypoxia the physical performance will decrease slightly but at a 8-12% Oxygen concentration, there is only little change in a graded exercise performance measurement. This degree of hypoxia, when compensated with 3-5% CO2, will not be the reason for anybody to unsuccessful escape. Possibly the most important factor in successful escape out of the enclosure is: The preservation of consciousness and a normal response behavior. At this point, the INERGEN inert gas blend has an absolutely unique performance. Down to extreme degrees of hypoxia, the Carbon Dioxide provides extended consciousness and improved psychomotor abilities.

If the Carbon Dioxide concentration increases to a level at which it is uncomfortable, it is on the other hand giving a very fine warning against staying in the enclosure. By 5-6% Carbon Dioxide this becomes significant, and is providing an additional safety feature.

Exposure time to reduced oxygen atmosphere should be limited to:

Time	Agent conc.	% Oxygen
5 minutes	43%	12.0%
3 minutes	52%	10.0%
0.5 minutes	62%	8.0%

Above limitations are set out in NFPA 2001: 2012 (1.5.1.3)

Effect on machinery and equipment

Engines must be stopped before discharge of a fire extinguishing system, but If INERGEN is accidentally discharged before the engine is stopped, there will be no risk of damages to the engine. The diesel engines will continue running with no significant output changes (Study with Danish Navy 19. /4. - 1993), and no effect on lubricants, metal parts, electrical machines, and electrical and electronic parts.

After the discharge of INERGEN the air-quality will actually improve, due to the dilution of corrosive and toxic substances and due to the reduction of the relative humidity.

Extinguishing efficiency

The Inert gases require higher concentrations, and therefore they have often been looked upon as less efficient than the Halon type extinguishing agents.

From a mere cost/weight/space point of view, that is correct. This is the disadvantage of inert gas systems. High concentration requirement and gaseous storage require large storage volume and/or high pressure compared to both Halon 1301 and the new Halon type fire extinguishing agents.

From a fire extinguishing point of view however, the inert gases are no less efficient than the Halon type fire extinguishing agents, except for the speed of fire extinguishing. The Halon type compounds are usually discharged in 10 seconds or less. This is necessary in order to limit the formation of decomposition products of the Halo-Carbon itself. As the inert gases do not produce any decomposition products, the gas is discharged over longer time, but in such a way that the extinguishing concentration is reached within 60-120 seconds (according to the MSC Circ. 776, Appendix sect. 4.1: Max. 30 seconds after the agent discharge, the fire shall be extinguished. This means that the fire shall be extinguished max. 150 seconds after the discharge start). This may seem like a long time, but very shortly after the discharge start, the rate of combustion is significantly reduced, and the development of fire, and the fire damages are practically stopped instantly.

Efficiency also concerns the ability to extinguish class A fires (plastic and wood), and materials heated to very high temperatures, without contaminating the enclosure with toxic decomposition products. At this point the inert gases are also offering an improvement, compared to Halon and Halo-Carbons such as HCFC's, HFC's and PFC's.

Furthermore, the Inert gases are offering truly 3-dimensional extinguishing capability, since they blend perfectly with air (they are basically air themselves), and as the air/agent blend after discharge is just slightly heavier than normal air they are able to maintain an extinguishing concentration for a very long time.

Signs and warnings

A written operation instruction must be present at the control panel/manual discharge activators, that clearly indicate:

- Ventilation and engine(s) are stopped before INERGEN discharge
- Fire dampers and doors are closed before INERGEN discharge
- At the points of access to the enclosure, signs must be present that indicate:
- Evacuate the room in case of fire/fire alarm
- Operating instructions and valve identification

References:

1) Harvey, Raichle, Winterborn, Jensen, Lassen, Richardsson, Bradwell. The lancet 639-641, 1988
2) Gibbs, Lennox, Nims. Journ. Aviat. Medicine, 250-261, 1943
3) Consolazio, Fisher, Pace, Pecura, Pitts, Behnke. Am. Journal physiologi, 479-503, 1947
4) Nielsen, Smith. Acta Physiol. Scand., 293-313, 1943
5) Ketty, Scmidt. Journ. Clin. Invest., 27:4, 484-492, 1948
6) Slobodnick, Wallick, Chimiak. Rep. no. 04-91, Navy Exp. diving unit, Panama City, FL, 1991
7) Siesjo, Johannsson, Norberg, Salford. Brain Hypoxia, Academic press, New York, 1975
8) Lambertsen. Respiration, V.B. Mountcastle, Mosby, St. Louis, 1980

Material Safety Data Sheet

WARNING: Avoid exposure to vapors, fumes, and products of combustion.

INERGEN Safety Data Sheet

EU regulation 1907/2006, 1272/2008, 453/2010

Section 1: Identification

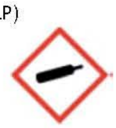
- Product — Gas mixture, 52% Nitrogen, 40% Argon, 8% CO_2
  IG541, INERGEN
- Supplier — Fire Eater
  Vølundsvej 17, 3400 Hillerød, Denmark
  www.fire-eater.com, email: info@fire-eater.com
- Emergency response — +45 7022 2769
- Product use — Fire Extinguishing Systems

Section 2: Hazard(s) Identification

- OSHA/HCS status — This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200)
- Classification of the substance or mixture
  GASES UNDER PRESSURE - Compressed gas
  H280, Full text of H-phrases: see section 16
- 67/548/EEC (DSD) or 1999/45/EC (DPD)
  Not classified
- Adverse physicochemical, human health and environmental effects
  No additional information available

GHS Label elements

- Hazard pictograms (CLP)



- Signal word — Warning
- Hazard statement — H280 - Contains gas under pressure; may explode if heated
  OSHA-H01 - May displace oxygen and cause rapid suffocation.

Precaution statements

- General — Read and follow all Safe Data Sheets (SDS's) before use.
- Storage — P403 - Store in a well-ventilated place.
  P410 - Protect from sunlight. Protect from sunlight when ambient temperature exceeds 52°C/125°F.
- Disposal — Not applicable

INERGEN Safety Data Sheet

EU regulation 1907/2006, 1272/2008, 453/2010

FIRE EATER

Section 3: Composition/Information on Ingredients

- Mixture

Name	Product identifier		%	Classification Directive 67/548/EC	Classification Regulation 1272/208 (CLP)
Nitrogen	CAS No EC No REACH No	7727-37-9 231-783-9 ANNEX IV	52	Not classified	H280: Contains gas under pressure; may explode if heated
Argon	CAS No EC No REACH-No	7440-37-1 231-147-0 ANNEX IV	40	Not classified	H280: Contains gas under pressure; may explode if heated
Carbon dioxide	CAS No EC No REACH No	124-38-9 204-696-9 ANNEX IV	8	Not classified	H280: Contains gas under pressure; may explode if heated

- REACH Registration: All components are listed in Annex IV of Regulation EC 1907/2006 (REACH) and are exempted from registration in accordance with article 2(7)(a).
  Contains no other components or impurities which will influence the classification of the product.

Section 4: First-Aid Measures

Description of necessary first-aid instructions

- Inhalation: Remove victim to uncontaminated area wearing self contained breathing apparatus.
  Keep victim warm and rested. Call a doctor.
  Apply artificial respiration if breathing stopped.
- Skin contact: Adverse effects not expected from this product.
- Eye contact: Adverse effects not expected from this product.
- Ingestion: As this product is a gas, refer to inhalation section.

Most important symptoms and effects, both acute and delayed

- No additional information available

Indication of any immediate medical attention and special treatment needed

- None.

INERGEN Safety Data Sheet

EU regulation 1907/2006, 1272/2008, 453/2010

FIRE EATER

Section 5: Fire-Fighting Measures

Extinguishing media

- Suitable extinguishing media:
  Use an extinguishing agent suitable for the surrounding fire.
- Unsuitable extinguishing media :
  Non known.

Special hazards arising from the substance or mixture

- No reactivity hazards other than the effects described below

Advice for firefighters

- Firefighting instructions:
  Depressurize the cylinders by releasing the fire extinguishing system if connected in this.
  Do not activate the release valve if cylinder is not securely fastened.
  Remove ignition source if safe to do so.
  Move containers from fire area if this can be done without risk.
  Use water spray to keep fire-exposed containers cool.
- Protection during firefighting:
  Compressed gas: asphyxiant, suffocation hazard by lack of oxygen.
- Special methods: Use fire control measures appropriate for the surrounding fire.
  Exposure to fire and heat radiation may cause gas receptacles to rupture. Cool endangered receptacles with water spray jet from a protected position.

Section 6: Accidental Release Measures

Personal precautions, protective equipment and emergency procedures

- Non-emergency personnel:
  No action shall be taken involving any personal risk or without suitable training.
  Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering.
  Avoid breathing gas.
  Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
  Stay upwind.
- Emergency responders:
  Monitor oxygen level to determine concentration of released product.
  Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe.
  Ensure adequate air ventilation.
  Act in accordance with local emergency plan.
- Environmental precautions:
  None

Methods and materials for containment and cleaning up

- Clean-up procedures: Ventilate with fresh air

INERGEN Safety Data Sheet

EU regulation 1907/2006, 1272/2008, 453/2010

FIRE EATER

Section 7: Handling and Storage

Precautions for safe handling

- General — Put on appropriate personal protective equipment (see Section 8).
  Contains gas under pressure. Do not puncture or incinerate container.
  Use equipment rated for cylinder pressure.
  Protect cylinders from physical damage; do not drag, roll, slide, or drop.
  Use a suitable hand truck for cylinder movement. Do not use valve cap for lifting.

Conditions for safe storage

- Storage — Store in accordance with local regulations.
  Store away from direct sunlight in a dry, cool and well-ventilated area. Keep container tightly closed and sealed until ready for use.
  Cylinders can be stored horizontal or vertical.
  Valve cap/guard must be fitted to the cylinder and only to be removed when the cylinder is securely fastened.
  Cylinders are always to be firmly secured to prevent falling or being knocked over.
  Cylinder temperatures should not exceed 65 °C (150 °F).

Section 8: Exposure Controls/Personal Protection

- General: — All components are exempted from REACH registration in accordance with article 2(7)(a). Annex IV of Regulation EC 1907/2006 (REACH)
  Contains no other components or impurities which will influence the classification of the product.

Occupational exposure limits

- General: — Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Nitrogen	52%	Oxygen Depletion [Asphyxiant]	
Argon	40%	Oxygen Depletion [Asphyxiant]	
Carbon dioxide	8%	OSHA PEL: 5.000 ppm ACGIH TLV (2012) TWA: 5.000 ppm STEL: 30.000 ppm	

- Appropriate engineering controls:
  Oxygen detectors should be used when asphyxiating gases may be released.
  Provide adequate general and local exhaust ventilation.
  Systems under pressure should be regularly checked for leakages. Ensure exposure is below occupational exposure limits (where available).

- Thermal hazard protection:
  None necessary.

- Environmental exposure controls :
  None necessary.

- Other information :
  Wear safety shoes while handling containers. Standard EN ISO 20345 - Personal protective equipment - Safety footwear.

INERGEN Safety Data Sheet

EU regulation 1907/2006, 1272/2008, 453/2010

FIRE EATER

Section 9: Physical and Chemical Properties

Appearance:

- Physical state: Gas
- Color: Colorless
- Odor: Odorless
- Flammability: Non flammable, does not sustain combustion
- Molar mass 34.08 g/mol
- Vapor density: 1.416 kg/ m^3 (t = 20°C, p = 1.0132 bar)
- Relative density: 1.18 (@t= 20°C, p = 1.0132 bar)

Section 10: Stability and Reactivity

- Reactivity: No specific test data related to reactivity available for this product or its ingredients.
- Chemical stability: The product is stable
- Possible hazardous reactions:
  Under normal conditions of storage and use, hazardous reactions will not occur.
- Hazardous decompositions products:
  None
- Hazardous polymerization:
  None

Section 11: Toxicological Information

- General: All components are exempted from REACH registration in accordance with article 2(7)(a). Annex IV of Regulation EC 1907/2006 (REACH)
  Contains no other components or impurities which will influence the classification of the product.
- Information on toxicological effects

Acute toxicity:	None
Irritation/corrosion:	None
Sensitization:	Stimulate the respiratory system to increase breathing
Mutagenicity:	None
Carcinogenicity:	None
Reproductive toxicity:	None
Teratogenicity:	None

- Specific target organ toxicity (single or repeated exposure) None
- Aspiration hazard: Stimulate the respiratory system to increase breathing
- Potential acute health effects

Eye contact:	None
Inhalation	Increased breathing
Skin contact	None
Ingestion	See Inhalation

Symptoms related to the physical, chemical and toxicological characteristics

- None

Delayed and immediate effects and also chronic effects from short and long term exposure Eye contact

- None

Long term exposure **None**

Potential chronic health effects **None**

Numerical measures of toxicity **None**

Section 12: Ecological Information

- Toxicity None
- Persistence and degradability Not relevant
- Bio accumulative potential: Not relevant
- Soil/water partition Coefficient): Not relevant
- Ecological effects: No known ecological damage caused by this product.

Section 13: Disposal Considerations (non-mandatory)

- Disposal methods: May be vented to atmosphere in a well ventilated place.
  Do not discharge into any place where its accumulation could be dangerous.
  Refer to the code of practice of EIGA (www.eiga.org).
  Container must be disposed of in a safe way.
  Do not puncture or incinerate container

Section 14: Transport Information (non-mandatory)

- UN number: UN 1956

Labeling

- ADR, IMDG, IATA, DOT, TDG.

2.2

INERGEN Safety Data Sheet

EU regulation 1907/2006, 1272/2008, 453/2010

FIRE EATER

ADR (road transport)

- Shipping Name: COMPRESSED GAS, N.O.S. (Nitrogen, Argon)
- H.I. nr: 20
- Transport hazard class: 2
- Classification code 1A
- Packing Instructions: P200
- Special provision: 274, 655
- Limited quantity: 120ml
- Exempted quantities: E1
- Transport category: 3
- Hazard identification (Kemler No)
  20
- Orange plates: 20 / 1956
- Tunnel Restriction: E: Passage forbidden through tunnels of category E
- EAC code: 2TE

ICAO-Ti/IATA-DGR

- Shipping Name: Compressed gas n.o.s. (Nitrogen, Argon)
- Class: 2.2
- Passenger and Cargo Aircraft
  Allowed
  Packing Instructions: P200
- Cargo Aircraft only
  Allowed
  Packing Instructions: P200

IMDG (Sea transport)

- Shipping Name: COMPRESSED GAS, N.O.S. (Nitrogen, Argon)
- Class: 2.2
- Emergency Schedule (EmS)
  Fire: F-C
  Spillage: S-V
- Packing Instructions: P200
- Special provisions: 274
- Limited quantites: 120 ml
- Excempted quantities: E1
- Stowahe category: A

INERGEN Safety Data Sheet

EU regulation 1907/2006, 1272/2008, 453/2010

FIRE EATER

Section 15: Regulatory Information (non-mandatory)

EU-Regulation

- REACH — All components are exempted from REACH registration in accordance with article 2(7)(a). Annex IV of Regulation EC 1907/2006 (REACH)
  Contains no other components or impurities which will influence the classification of the product.
- Contains no substances with Annex XVII restriction

Wassenaar Arrangement

- No ECCN number as all components are free to export without any restrictions.

Section 16: Other Information

- Training: INMON0001
- This Safety Data Sheet has been established in accordance with the applicable European Union legislation.
  Classification in accordance with calculation methods of regulation (EC) 1272/2008 CLP / (EC) 1999/45 DPD.
- This SDS is issued 2018-11 and replace revision 2016-11

END OF SAFETY DATASHEET

Chapter 3: General Information

System general

The Control Inert (Ci) system is a standalone system, for manual, pneumatic or electric activation.

The SV system is an add-on to the Ci system. Multiple zones can be protected by a shared INERGEN bank.

These additional systems are (not limited to but include)
SV22 and SV48 system (Multizone system by using Selector valve with 1” or 2” flow)

Periodical inspection and maintenance by qualified and trained personnel must be made minimum in accordance with the authority having jurisdiction.
Minimum inspection intervals

UL	Semi-annual (cylinder pressure must be verified)
FM	
LPCB	
CNPP	
CNBOP:	
NFPA:	At least annual: inspection and test; at least semiannually: pressure check
MED: IMO/MSC	

This system is made up of units tested within limitations contained in the detailed installation manual. The system designer must be consulted whenever changes are planned for the system or area of protection. An authorized installer or system designer must be consulted after the system has discharged.

For a list of authorized installers and service companies, please see www.fire-eater.com

The Ci and SV extinguishing system and components are designed for a minimum and maximum operation, transportation and storage temperature of -50 °C and +80°C, at temperatures above +70°C special consideration with regards to pressure developed in the cylinder must be made (burst disc pressure increased or pressure reduced).

Various authorities have witnessed different testing limitations based on their requirements.
The Ci and SV system have these authority limitations for operation, transportation and storage:
UL – FM 0 °C (32°F) and +65°C (150 °F).

Terms and definitions

Pilot cylinder

Cylinders which sole purpose is to activate the extinguishing system by supplying a pneumatic pressure.

PDS cylinders can be placed remotely and be of different types and styles.

Master cylinder

A cylinder which supplies pneumatic pressure for activating the extinguishing system as well as contributing to the extinguishing agent supply.

This cylinder will be fitted with an activator which can be either Electrical, Manual or Pneumatic, and supply gas to the protected hazard as well as pressure to the pneumatic activation line.

Slave cylinder

Cylinders which are activated by either a Pilot cylinder or a Master cylinder.
The gas from the cylinder is only used for extinguishing, not to activate other cylinders or equipment.

MDC

Minimum Design Concentration
The minimum design concentration used for calculating the minimum required INERGEN agent and the discharge time for a specific hazard.
MDC is based on the MEC multiplied by a safety factor (typically 1.3 or 1.2).

AMDC

Adjusted Minimum Design Concentration
The design concentration used to achieve 85% of the MDC at the end of the holding time.

FDC

Final Design Concentration
The concentration of INERGEN actually supplied to the hazard based on the actual cylinder quantity and filling.

MEC

Minimum Extinguishing Concentration is the actual extinguishing concentration measured for extinguishing the fuel.

Types of systems

Total flooding is the approved type of system available. A total flooding system normally consists of a fixed supply of INERGEN connected to piping with nozzles to direct the agent into an enclosed hazard space. In a total flooding system, the enclosure around the hazard must be tight enough to hold the required percentage of INERGEN concentration for a period of time to extinguish the fire.

Control Inert (Stand alone) Nozzle on cylinder

A system can consist of a single or multiple cylinders with nozzles directly attached to the cylinder. If multiple cylinders are used an activation line must be attached to each cylinder. One cylinder could be a master cylinder supplying pressure through the PA to the other cylinders or a separate actuator on each cylinder.

Control Inert (Stand alone) single manifold

The master cylinder will typically be placed at one end of the cylinders or on both (where redundancy is required), but it could be any of the cylinders of the system, it only depends on to which cylinder the actuator is placed as this will make it the master cylinder

Control Inert (Stand alone) multiple manifold

As the single manifold system, but for each manifold added to the system it is necessary to join the manifolds together at the valves, as pressure cannot move from one manifold to the next without using the Ci MT next kit.

The Ci MT next kit is connected on a valve from the manifold, which is pressurized during activation to a valve on a manifold not being pressurized.

An infinite number of manifolds may be linked as the pressure is generated by each cylinder. The quantity of manifolds is only limited by the allowable activation time as required authorities having jurisdiction.

Multi-zone systems SV22 and SV48 systems

A common bank of INERGEN can also be used to protect multiple rooms.

When using the SV system the SV manifold can be used as it disables the back pressure activation function due to the Non-Return Check valves integrated in the manifold. This way it is possible to control how many cylinder that will actually be activated. With the Back pressure activation function disabled it is necessary to use the Pneumatic activation (PA) ports on front of the valves to activate the required number of cylinders. The different numbers of cylinders that are to be activated are separated by Non return valves in the PA line.

When multiple cylinders are activated for all hazards, the SV Ci MT manifold can be used where the backpressure will activate all cylinders connected.

Type of Actuation

There are three basic types of actuation for the INERGEN systems: pneumatic, mechanical and electrical.

Electrical

Automatic electrical actuation of the cylinder valve, through an approved control panel, can be accomplished by using the Ci IS8 Solenoid actuator. The actuator is energized by an electric signal from the detection/control panel.

Mechanical

Mechanical actuation is accomplished by the Ci IM8 Actuator which is a hand operated Push-Button style actuator which is mounted the Ci IV8 discharge valve. By pushing the button, a spring is released. A wire rope mechanical actuator can also be used for “short distance” remote operation of the system.

Pneumatic

A Pneumatic actuator is available as well, this is the Ci PA8 which is a direct pneumatic actuator that can be attached to the discharge valve. When using external pressure sources this device should be used in order not to mix pressures through the PA In/Out on the discharge valve.

Control panels

Multiple control panels are available.

INERGEN FLOW

The flow of INERGEN in the system discharge piping is a compressible flow. The agent is a compressed gas, the temperature and density of which changes as the pressure in the pipe decreases. The flow calculation is based on classical energy conservation considerations.

For simple systems, an assumption of adiabatic expansion of the agent is sufficient. IMT (INERGEN Management Tool) flow calculation program, however, accounts for heat transfer from the pipe into the flowing agent. The consideration of heat input to the agent permits a greater degree of flexibility in system design. An orifice is placed in the manifold outlet for Ci systems and for SV systems the Orifice is placed just before or right after the Selector valve.

Discharge nozzles control the amount of INERGEN which flows into various portions of the protected space.

Personal Safety

Proper INERGEN system design requires that the design concentrations fall within the design window that limits the upper and lower requirements of both oxygen and carbon dioxide. INERGEN agent has acceptable toxicity for use in occupied spaces when used as specified in the United States Environmental Protection Agency (EPA) proposed Significant New Alternative Policy (SNAP) program rules and NFPA 2001, "Clean Agent Fire Extinguishing Systems." When design concentrations are inside this window, no adverse affects will take place on the human respiratory system. Any exposure outside of these limits requires the use of self-contained breathing apparatus. Respirators will not function in oxygen deficient atmospheres. Because of the decomposed products of combustion generated during an actual fire and extinguishment, it is a good safety rule to ventilate the hazard for at least 15 minutes before entering or if entry is required sooner, wear an approved self-contained breathing apparatus.

Avoid direct contact to the cold, high pressure discharge and avoid direct inhalation of undiluted gas.

Chapter 4: Planning

Fire classes

Attention must be paid to the fact that fire classes vary depending on location. Make sure that all documents used refer to the same classes or that the variations are taken into account.

NFPA	European	Fuel / Heat source
Class A	Class A	Ordinary combustible
Class B	Class B	Flammable liquids
	Class C	Flammable gases
Class C	Higher Hazard Class A (En15004) Not defined in EN2 2004	Electrical equipment
Class D	Class D	Combustible metals
Class K	Class F	Cooking oil or fat

In this manual Fire Classes will refer to the NFPA fire classes, unless specified otherwise.

Design concentration

Fore Fire Eater INERGEN systems below design concentrations are applicable.
To obtain the AMDC the Design factors are added for any special conditions which affect the system (Tee design factor, Atmospheric pressure, Room leakage)

	Class	MDC	Notes	Discharge time
IMO MSC/Circ848	Engine room	42.9	MEC: 35.6% (DBI 1998) SF: 1.2	85% < 120 sec
IMO MSC/Circ 1267	Engine room	46.2	MEC: 35.6 % (DBI 1998) SF: 1.3	85% < 120 sec
UL UL2127	A	39.3	MEC: 32.1 % (DBI 2012) SF: 1.2 +1.93% (distribution)	95% < 120 sec
UL UL2127	B	41.1	MEC: 31.6 % (DBI 2012) SF: 1.3	95% < 60 sec
UL UL2127	C	43.3	MEC: 32.1 % (DBI 2012) SF: 1.35	95% < 120 sec
FM Global FM5600	A	37.5	MEC: 31.2 % (FE 2013) SF: 1.2	95% < 120 sec
FM Global FM5600	B	41.6	MEC: 31.9 % (DBI 2012) SF: 1.3	95% < 60 sec
EN15004:2008	A	37.2	MEC: 28.6 % (BRE 2014) SF: 1.3	95% < 60 sec
EN15004:2008	B	43.7	MEC: 33.6 % (BRE 2014) SF: 1.3	95% < 60 sec
EN15004:2008	HH A	41.5	95% of Class B (min Class A)	95% < 60 sec
LPCB LPS1230:2005	A	37.2	MEC: 28.6 % (BRE 2014) SF: 1.3	95% < 60 sec
LPCB LPS1230:2005	B	43.7	MEC: 33.6 % (BRE 2014) SF: 1.3	95% < 60 sec
LPCB LPS1230:2005	Cable	42.6	MEC: 42.6 % (BRE 2014) SF: 1.0	95% < 60 sec
NFPA NFPA 2001:2012	A	34.2	Table value (Tabel A.5.4.2.2(b))	95% < 120 sec
NFPA NFPA 2001:2012	B	40.6	Table value (Tabel A.5.4.2.2(b))	95% < 60 sec
NFPA NFPA 2001:2012	C	38.5	28.5 x 1.35 (5.4.3.5)	95% of Class A < 120 sec
--	--	--	--	

*For class B the specified minimum design concentration is for heptane, if the hazard contains liquids with a cup burner value higher than that tested for heptane the design concentration has to be determined in accordance with the relevant standard (EN15004, FM5600, UL2127, NFPA 2001), as a guide for comparison of extinguishing concentration of ignitable liquids please see ISO 14520-15 to verify if the cup burner value exceeds that for heptane.

General

Planning for design and installation of an INERGEN system starts when the customer is first contacted with regards to protecting his hazard area with INERGEN. Most of the information necessary for the design of a system is collected during the first meeting with the customer. The information gathered at this point will determine the ease or difficulty of the rest of the project. One of the key elements for fire protection is to correctly define the hazard and conduct a complete survey to determine if the system will properly protect against the hazard. Coordination with all parties involved in the project will further improve the flow of the overall project. A thorough hazard analysis is required to determine the type of protection required. It is important to cover each element and accurately record the information. This information will be used to determine the size and location of the INERGEN system required and also to determine at a later date if any changes were made to the protected area after the system was installed.
Information necessary for design of an INERGEN system is listed in the following paragraphs.

Initial General Information:

- Which rules are to be applied?
- Who will approve the system? (any other regulatory or insurance agencies)
- Will any special requirements apply to the system design or installation?

Hazard area Information:

- Obtain the general arrangement drawings of the areas to be protected.
- If the general arrangement drawings do not include the following information then these must be obtained separately.
- Record all dimensions for the hazard areas such as length, width, ceiling height, angles of corners if not 90 degrees, false ceiling, raised floor etc.
- Draw a sketch including plan and elevation views of the hazard area if drawings are not available.
- Indicate the quantity and locations of all exits from the area on the sketches.
- Record all dimensions for any structural objects such as beams or columns, built in cabinets, ducts, etc. which may allow a reduction of the hazard volume.
- Identify anything unique about the area that would affect system design or installation.
- Identify the area’s normal, maximum, and minimum ambient temperatures.
- Is the area normally occupied?
- Identify any openings, or potential openings in the hazard enclosure that may cause loss of agent during or after discharge.
- If possible, determine the maximum strength of the weakest wall, floor, or ceiling. This information will be used to calculate venting requirements. If this information is not available, a conservative number will be used to calculate the required free venting area. This conservative number will probably increase the size of venting required.

INERGEN Supply Requirements:

- Will the cylinders be located in a dedicated space? If so, record dimensions of that space.
- Is the operating temperature (cylinders storage) range within the accepted limits ?
  Limit: -50°C to 65°C [-60ºF to 150ºF]
  UL & FM: -0°C to 65°C [32ºF to 150ºF]
- Determine if the floor will support the cylinders and bracketing.
  Assume cylinder weight of 1920kg/m^2 for an 80l-300bar system for this requirement.
- Will the cylinder bracketing be secured to a wall?
  If so, is the wall strong enough to support it and the cylinders?
- Will a reserve supply of agent be required?
  If so will it need to be connected to the manifold?
- Will a discharge test be required?
- If several areas are to be protected, will it be by a multi-zone system or several stand-alone systems?

For FM Global insured systems:

- Reserve supplies are necessary to permit prompt restoration of the system after a discharge, to minimize interruption of the process and the interval of impaired protection. The reserve should at least equal the minimum requirement for the in-service supply, unless available from an outside source within 24 hours.
- Where two or more hazard areas are protected by a single supply through selector valves, connect the reserve supply to the piping. Provide a switchover arrangement, if needed, to permit actuation by the normal means. A manually actuated main/reserve switch is normally provided at the control panel for this purpose.
- Provide a connected reserve where an INERGEN system is the sole protection for valuables and important occupancies unless protection can be fully restored within 24 hours, occupancies are constantly attended and written impairment procedures have been established.

Activation and Alarm Requirements:

- Will the system be activated automatically or/and manually?
- What type of manual actuation (direct mechanical, cable pull or pneumatic) is required?
- Identify the locations for all manual pull stations.
- If automatic detection is a part of the system?
- What types of alarm devices are required; audible and/or visible?
- Where will the system activation be signaled?
- Does the hazard area require explosion proof, weatherproof or fireproof wiring and devices?
- Devices requiring shut down or started up?

Piping and wiring Information:

- Determine the location of the cylinders.
- Identify the preferred supply piping routes.
- If the system includes selector valves, identify their location.

Ventilation and Leakage Concerns:

- Identify any un-closable openings regardless of their size.
- Advise the customer of the possible need to seal these openings to prevent agent loss.
- Advise the customer of the possible need to provide pressure venting during discharge.
- Determine the route venting will need to take to reach outside atmosphere. (clear description of how to reach outside atmosphere)
- Will the venting route involve venting through other enclosures or ducts? If so, provide details about the rooms or duct routing information. If the venting will be through other enclosures, will they be protected also? If so, will they be protected separately or simultaneously?
- Will dampers be required for inlet or exhaust ducts? If so, how will they be operated, electrically or pneumatically?
- Door fan test to NFPA 2001

CHAPTER 5 - Design

After completing the hazard analysis in Chapter 4 - Planning, proceed with the following elements to work up a complete design and bill of materials. An example is included with each step, to help the reader understand the procedure. The example uses a computer room and subfloor as shown below.

The IMT calculation software is self-explaining additional information may be found under "help".

The calculation from IMT will have to be printed to show all the information available for the system, not all information will be displayed directly in the program. This can be done by printing a PDF of the calculation where all output will be available, including the actual calculation limits.

Version number

These numbers are part of the calculation report printed on the last page of the output file.

IMT version:	3.0.x	2.2.xx
Flow design engine:	2018-08-01	2014-08-27
Room design engine:	2014-07-23	2014-07-23
Flow simulation engine:	2018-08-02	2014-08-08

Limitations on system design

The following are limitations to a Fire Eater INERGEN system that will ensure proper performance.

Max pipe length:	300 m (orifice to last nozzle)
Max pipe to cylinder volume ratio:	20%
Discharge time:	40 - 600 sec for 95% agent mass. 40-120 sec for 95% UL & FM approved systems
Re-number:	Minimum 0.4×10^6.
Minimum Manifold Orifice:	No limit
Manifold Orifice to Pipe ratio:	Max 0.64 (ø17.6/ø22.0 mm)
Nozzle Orifice:	Minimum ø1.0 with filter Nozzle Minimum ø3.0 for UL & FM approved systems
Nozzle to Pipe area ratio:	Max 0.7
Tee split: Bull head (min/max):	5/95 - 95/5
Tee split: Through/Side (min/max):	5/95 - 95/5
Nozzle pressure:	Min 20 bar
Nozzle pressure variance ratio:	Max 1.65 / 2.0
Max elevation change	Max 50 m
Mach-number:	Max 0.40
Minimum distance to first Tee:	0 m
Flow velocity:	Lower limit by Re-number and upper limit by Mach-number.
Pipe volume per nozzle:	Limited by nozzle orifice to pipe area ratio.
Nozzle agent arrival time:	Limited by max pipe length.
Pipe type:	Black, galvanized and stainless steel pipe. EN10220/10217 ASTM Sch 40, Sch80, Sch160
Pipe fittings:	Black, galvanized, stainless steel.
Cylinder pressure:	20 and 30 MPa @ 15°C.
Temperature:	-0°C to +65°C.
Nozzle quantity:	1 to 100

Activation limitations on one solenoid	
PA line (Pneumatic activation):	max 250 m (app. 750 cylinders)* UL/FM: max 50 m (app 150 cylinders)**
Number of manifolds:	max 80 (up to 750 cylinders)* UL/FM: max 50 (up to 500 cylinders)**

* This is the activation lines length/number of cylinders that can be activated within 2 sec.
** This is the activation lines length/number of cylinders that can be activated within 1 sec as per UL-FM requirement.
If longer activation lines or more manifolds are required, additional activators (Ci IS8B or Ci PA8) has to be added to the system and installed so above distances are not exceeded.

Guide to calculation software IMT3.0.x

IMT3 Main features

The IMT3 program allows the system designer to design an Inergen™ system using information about room size(s), authority requirements and pipe system layout. In addition, the performance of an "As built" (installed) system can be analyzed and verified against authority requirements.

For a normal design task, the following features are used (not necessarily in order of use):

- Creation of a new "system" based on a predefined template.
- Customer and project data input (project name, address, notes etc.).
- Revision control and revision notes.
- Design state used to manage the state of a design from "Work in progress" to "Installation approved".
- Selection of MDC for each room based on authority requirements and room (enclosure) hazard class.
- Selection of discharge time and target based on authority requirements and room (enclosure) protection class.
- Definition of an arbitrary number of rooms (enclosures) protected by a single pipe system, each room can have its own hazard class and design factor.
- Calculation of required number of cylinders based on room volumes, hazard class(es), design factors, cylinder volume and filling.
- Selection of manifold and orifice type, selection of pipe and nozzle families.
- Interactive 3D modelling of pipe system from orifice(s) to nozzles, defining the length of each pipe section.
- Interactive editing of 3D pipe system model, changing pipe section lengths, adding or deleting nodes etc. Changes are reflected in real time in the 3D model.
- Node, pipe, nozzle and orifice numbering can be set automatically, or user defined for some or all objects.
- Pipe table overview with real time update from 3D model, giving pipe system details in a table format.
- Calculation of pipe system using "Design", "Fixed pipe" or "As built" modes.
- Each successful calculation gets a unique Calc-ID upon completion, this is shown on all calculation print outs and pdf drawings generated by IMT3.
- A successful calculation is locked, preventing the user from changing anything influencing the calculation without invalidating and resetting the Calc-ID.
- Pipe table overview updates with calculation data when available.
- PDF calculation report of valid calculations, containing all parameters defining the system and all calculation results including any warnings and applied calculation limits.
- PDF drawings of system, containing an arbitrary number of drawing pages, each with user selected projection, zoom factor and pipe, nozzle, node and manifold data from a valid calculation.

IMT3 work flow

This is a brief overview of the typical workflow and the associated GUI views (menus, dialogs and tabs). To keep this short and manageable, we will not show every GUI view, as most are self-explanatory. For best results, you should work through an example in IMT3 while reading this.

Installing IMT3

IMT3 can be installed on Windows™ PC's using IMT3_installer.exe. This will guide you through the installation process and install the program in folder C:\fireeater\IMT3. Shortcuts will be created on the Desktop and in the Start menu.

In addition to the IMT3 calculation program, two separate programs "IMT3-partfinder" and "IMT3-parts-editor" are also installed. These are not used for IMT3 calculation, but rather for creating parts lists and making quotations etc. based on IMT3 calculations. IMT3-partfinder and IMT3-parts-editor will not be covered further in this manual.

Starting IMT3

IMT3 is started by clicking on one of the shortcuts named "IMT3". When IMT3 is started the first time on a new PC, you will be prompted to enter your personal user id and activation key, provided by Fire Eater. Afterwards IMT3 will check that you are a valid user using the IMT3 server, this means that when running IMT3 for the first time, your PC will need to be connected to the Internet.

After initial activation IMT3 can run without entering the user id and activation key for as long as IMT3 successfully connects to the IMT3 server at least every 60 days. This means that during normal usage IMT3 does not need to be continuously connected to the Internet.

Every time IMT3 is started, it will try to connect to the IMT3 server, checking for software updates and new parts data, used by the IMT3-partfinder (PF). You may minimize the update window without affecting normal IMT3 operation.

The activation menu can be found manually in: *Settings* >> *Activation settings*.

New system

In IMT3, each calculation with meta data is called a "system". A new calculation is started by using *File* >> *New system*, this will prompt you to select a template for your system. You can choose between default templates provided and maintained by FE or user templates created by each user. All template settings can be overridden by the user, they are just default settings for new systems.

You will then be prompted to select a file name for your system. IMT3 uses a Model View Controller (MVC) architecture, meaning that each system is represented by a data base stored in the "*.imt" file. Every change in the system is immediately stored in the "*.imt" file, thus making a "Save" button unnecessary.

System settings menu

The *Settings* >> *System settings* menu is used to change settings such as filling and storage temperatures and the default manifolds etc. used when inserting a new component in the pipe system.

The system settings menu is the place to check if you encounter something that cannot be changed otherwise.

Once a new system is opened you will be presented with number of tabs: "Project", "Inergen design", "Pipe drawing", "Pipe table" and "Calculation". In a nominal work flow you will probably use them in this order.

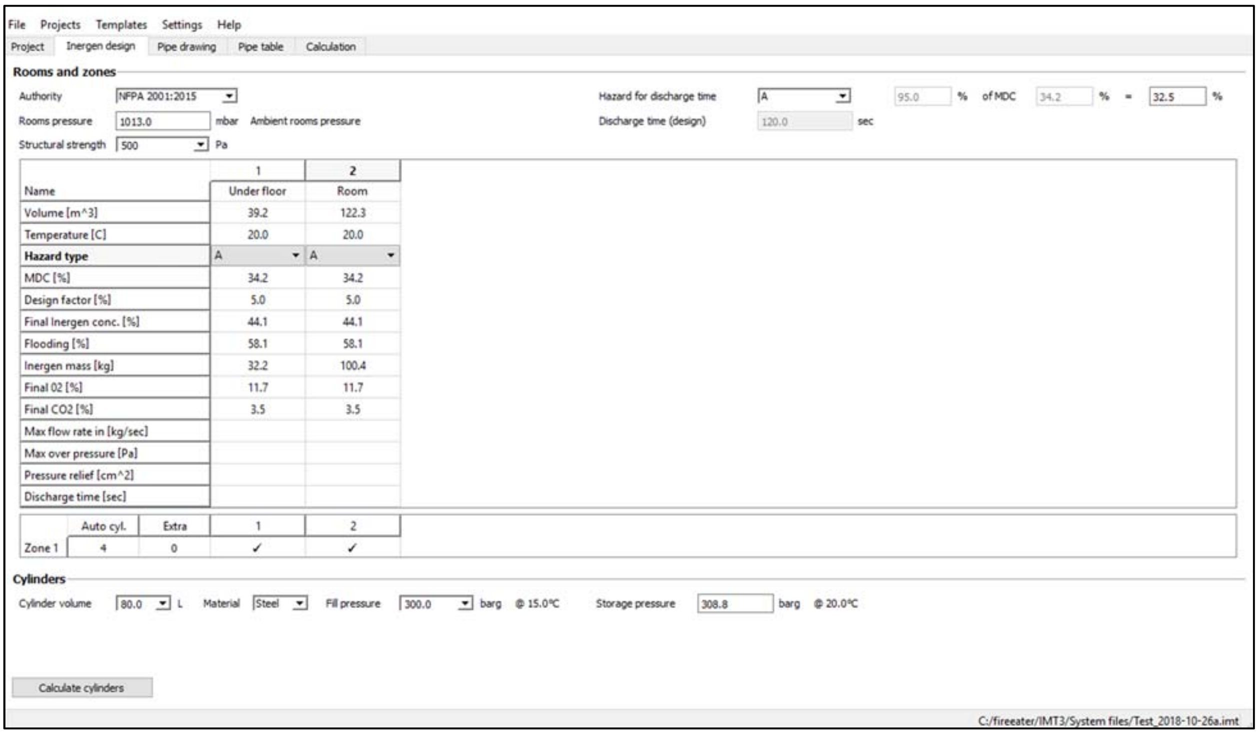
Project tab

The Project tab is used to manage system meta data. Meta data for the project and the customer can be managed, as well as revision version and design state.

None of the data in the Project tab is directly used in the calculation, thus you may skip this tab. After a successful calculation you will therefore still be able to edit the Project tab without doing a recalculation. Some of the data in the Project tab is used in the PDF calculation report and the PDF system drawings (in the title blocks).

Inergen design tab

This tab is used to determine the number of cylinders needed to protect the rooms (enclosures) by a single pipe system.



By selecting the appropriate “authority” you can choose which set of rules you wish to use for the system. For each room, you can choose the hazard class within that standard. The hazard for discharge time sets the discharge time and discharge time target for the system.

For physical reasons, it is impossible to set a different discharge time target for each room (since the nozzle areas control both the Inergen™ distribution **and** the discharge rate, they cannot independently control both distribution and discharge time for each room). Thus, the need for a single discharge time and discharge target for all rooms connected to the same pipe system.

The discharge time applies to the last room to reach the discharge time target Inergen™ concentration, regardless of the hazard class chosen for that room.

The *Design factor* can be used to set an additional safety factor above the MDC. This is applied by calculation the flooding mass for each room from the MDC and then adding the percentage *Design factor* to that flooding mass. It is thus perfectly acceptable to specify a *Design factor* of 500% if so desired.

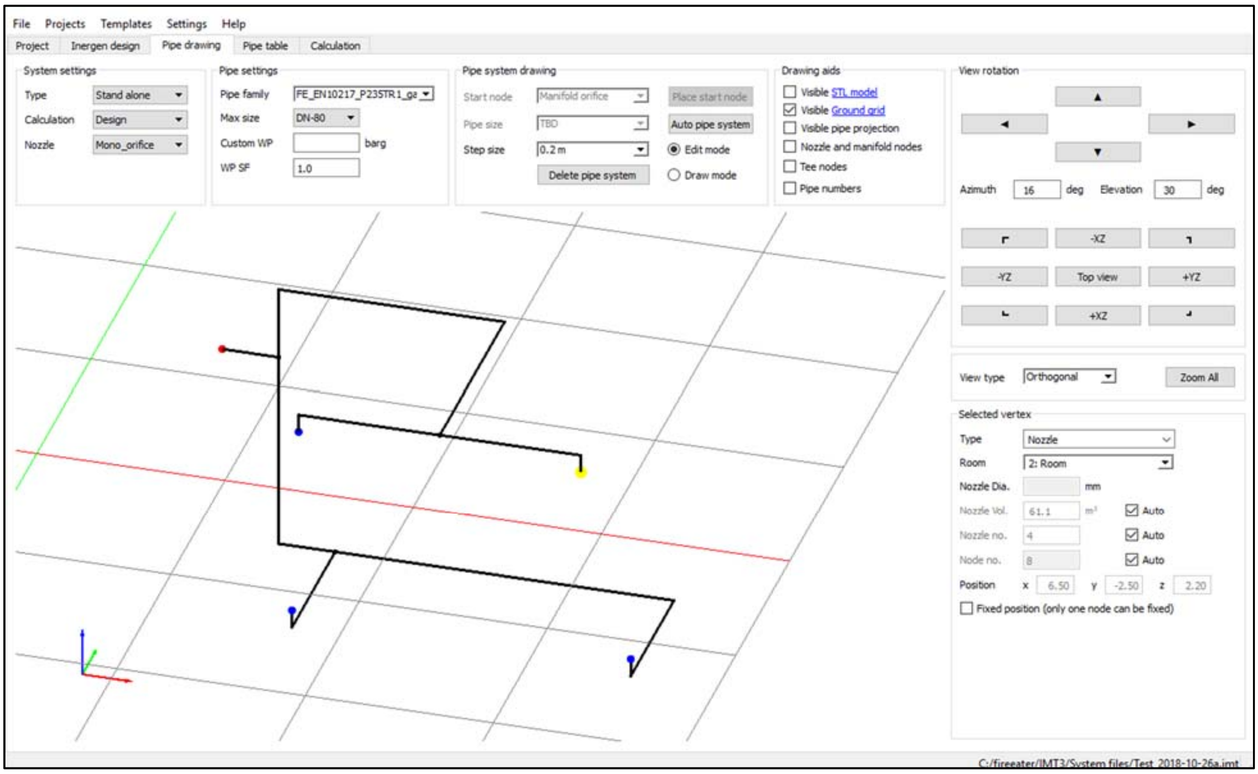
You can add and delete rooms by right clicking anywhere in a room column (**except in the header row**) and choosing “Add room” or “Delete room”.

After choosing the cylinder volume and filling pressure, the number of cylinders needed are calculated by pressing *Calculate cylinders*. This also finds the actual final Inergen™ concentrations etc, for each room (which is always at least as high as the MDC, because the total number of cylinders are rounded up).

In addition to the standard cylinder volumes shown in the list, it is also possible to write any custom cylinder volume.

Pipe drawing tab

This tab is used to model the pipe system in 3D, specify the system and calculation type and specify the nozzles and pipe families.



After selecting the appropriate system type (determines the available manifolds etc.), the calculation type can be selected from “Design”, “Fixed pipe” or “As built”:

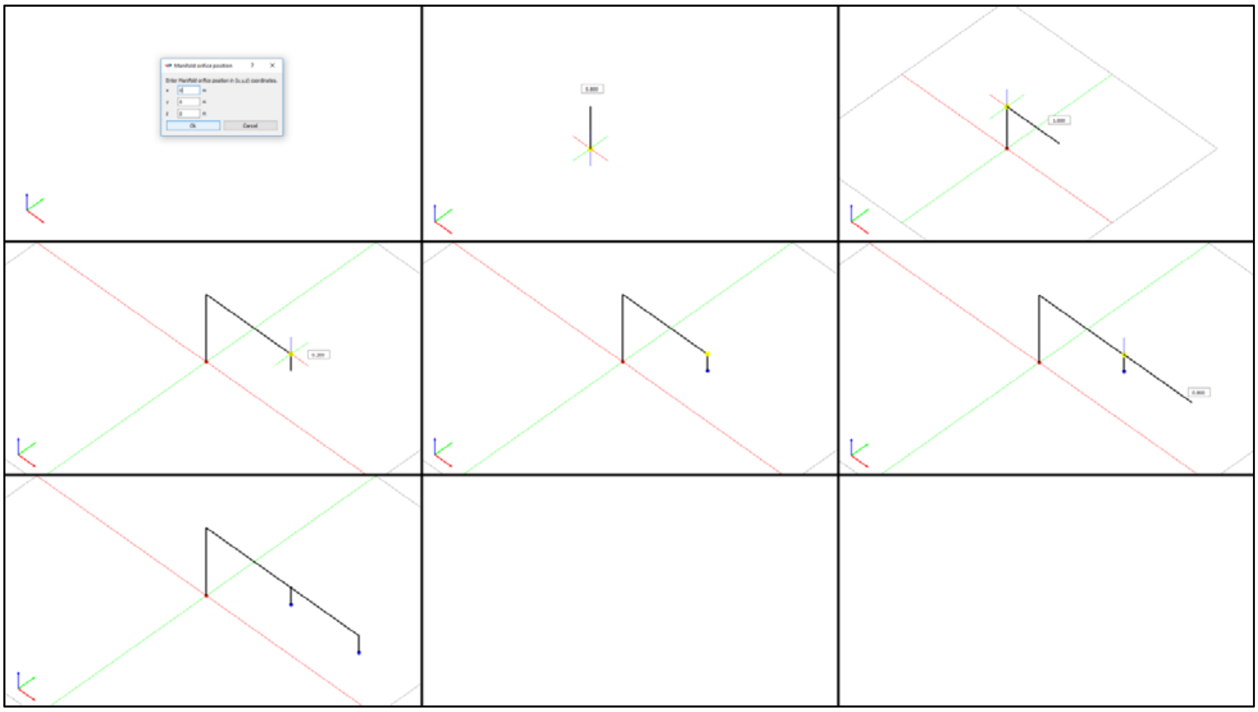
- Design: Calculate the manifold orifice(s), nozzles and pipe sizes to get the desired distribution and hit the discharge time target at the specified discharge time.
- Fixed pipe: Same as design but keep the pipe sizes fixed at the user selected values. Requires all pipe sizes to be specified by the user or a previous “Design” calculation.
- As built: Simulate the discharge using known manifold orifices, nozzles and pipe sizes.

The pipe system model is started by selecting the starting position (typically the manifold orifice position) using the *Place start node* button.

Then, while in *Draw mode*, use the left mouse button to select a vertex (this shows the allowed drawing directions, taking into account that only planar tee’s and 90 deg elbows are supported).

Dragging the mouse in one of the allowed drawing directions, draws a pipe section in increments of the selected *Step size*.

Each new pipe section always ends in a nozzle (shown with a blue dot). However, when you continue drawing from a pipe end, it automatically converts to an internal vertex. A vertex with 3 connections is automatically converted to a Tee.



Switching into *Edit mode* allows you to select and edit any element in the pipe system model. Thus, you can change pipe section lengths, edit the room number for nozzles etc., using the menu on the lower right or alternatively in the dialog box when double clicking a pipe section or node.

Notice that in **these** menus its necessary to confirm any numerical input (a pipe section length for example) with a press of the return key. This is because when return is pressed, the 3D pipe system model is updated to reflect changed pipe section lengths etc.

Pipe table tab

This tab gives an overview of the pipe system with the currently available data. It is updated from the pipe system model each time you switch to the tab. No user input is possible, but by clicking on the column headers, the rows may be sorted according to your preferences.

Calculation tab

This is used to start the calculation engine when *Calculate pipe system* is pressed. After the calculation is finished, any errors, warnings or cautions will be displayed.

If the calculation is successful the *Calculation valid* text is displayed in the left side of the bottom status bar, along with a unique *Calc-ID* composed of the user ID and the calculation date and time.

Updated pipe table tab

After a successful calculation, the pipe table tab will be automatically updated with the calculation results: Nozzle pressures, max flow rate, total nozzle flow etc. If it is a design calculation, the calculated nozzle orifice and nozzle dimension plus the calculated pipe dimensions will also be shown in the table.

File Projects Templates Settings Help

Project | Inergen design | Pipe drawing | Pipe table | Calculation

	Pipe	Elevation m	N1	N2	Start	End	Elbows	Con	Type	Nozzle	D orifice mm	Room	L m	Vol m^3	T %	N/P %	DN	P barg	Mach	Max flow rate kg/s	Total IG-541 kg	O2 %
1	1		1	2	Manifold orifice	Tee	0	0			5.5		0.600		100.0	28.6	DN-20		0.130			
2	2	-0.400	3	4	Tee	Nozzle	1	0		1	3.71	1	1.800	19.6	50.0	6.3	DN-15	75.5	0.031	0.18	16.1	11.7
3	3	-0.400	3	5	Tee	Nozzle	2	0		2	3.77	1	5.400	19.6	50.0	6.5	DN-15	75.2	0.032	0.19	16.1	11.7
4	4	2.200	6	7	Tee	Nozzle	1	0		3	6.73	2	1.700	61.2	50.0	20.8	DN-15	70.1	0.101	0.56	50.2	11.7
5	5		2	3	Tee	Tee	1	0					2.800		24.3	12.9	DN-15		0.062			
6	6	2.200	6	8	Tee	Nozzle	1	0		4	6.72	2	1.700	61.1	50.0	20.8	DN-15	70.2	0.101	0.55	50.2	11.7
7	7		2	6	Tee	Tee	2	0					5.600		75.7	21.9	DN-20		0.103			

Calculation report

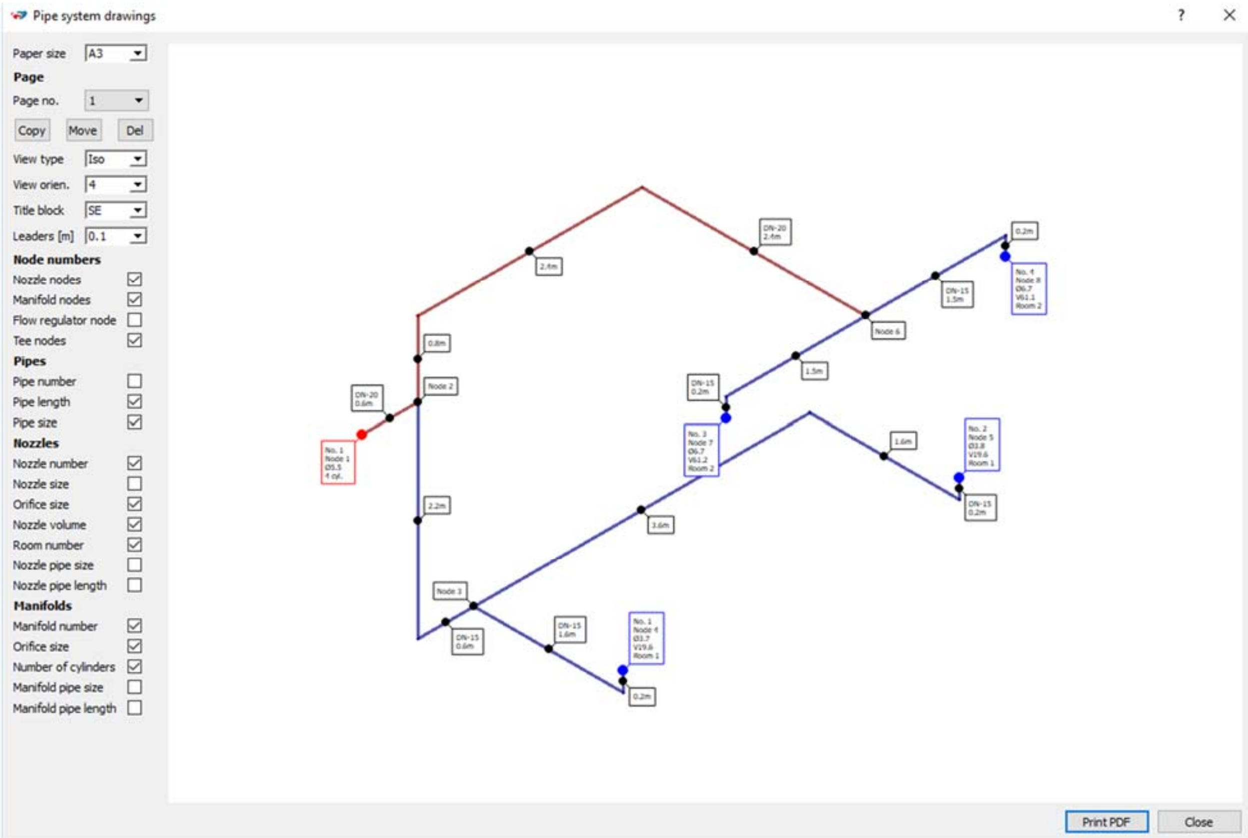
A complete calculation report can be printed as a pdf file by selecting *File* >> *Print pdf report*. This includes all data describing the system including the selected authority and associated “authority” calculation limits, plus the actual calculation limit for this calculation. The unique Calc-ID is shown on each page, along with the imt file name for reference.

Pipe system drawings

Selecting *File* >> *Print drawings* opens a dialog box to print pdf drawings of the pipe system complete with selected annotations for nozzles, pipes, etc. It is possible to define as many drawing pages as needed with different zoom level, projection and annotations for each drawing page.

The selected annotations are shown in boxes connected with leaders to the annotated object (nozzle, pipe section etc.). Each click on the object “dot”, rotates the annotation one quarter turn around the object “dot”, making it possible to optimize the annotation layout for best clarity.

The pipe sections are colour coded according to pipe size. Notice that all pipe sections belonging to a pipe branch always has the same pipe size. The pipe size is therefore only shown once for each pipe branch and not for each pipe section.



New drawing pages are added by copying an existing page using the *Copy* button. The new page is inserted immediately after the current one. Use the *Page no.* drop down to select the current page. *Move* and *Del* buttons are used to reorder or delete pages.

Notice that all page definitions are saved in the imt file, so your changes will be recalled if you close and reopen the drawing dialog box.

The *Print pdf* button prints the actual drawing pages as a single pdf file. The calculation time is printed on each page, corresponding to the Calc-ID time.

Meta-data in the title blocks is taken from the Project tab.

Troubleshooting

List of Errors, Warnings and Cautions with explanation and possible solutions.

Errors will indicate that the calculation failed.

Warnings are given when one of the limitations specified by the selected “Authority” has been exceeded.

Cautions indicate that special precautions are required during installation (Ex. DN-50 with a DN-15 Nozzle).

In the following XX, YY, ZZ and VV are variable according to the specific warning, error or caution.

Errors

Text	Explanation	Possible solution(s)
Desired room concentrations must be positive!	**Self-explanatory**	**Check MDC for each room**
Room: XX temperature: YY degC or room pressure: ZZ Pa (abs) exceeds NFPA2001 limits!	**Self-explanatory**	**Change room conditions**
Room XX volume must be positive!	**Self-explanatory**	**Check room volumes**
The cylinder volume must be positive for cylinder type: "Custom"	**Self-explanatory**	**Check custom cylinder volume**
Nozzle: XX room: YY not found in list of rooms!	**Nozzle XX not connected to a valid room**	**Check room number of nozzle**
Room: XX is not protected by any nozzles!	**No nozzle in room XX**	**Check that each room has at least one nozzle**
Nozzles in room: XX cannot protect a larger volume than the room volume!	**The sum of all nozzle volumes in room XX, is larger than the room volume**	**Check volumes of each nozzle in room XX or use *Auto* nozzle volume on one or more nozzles in the room**

Text	Explanation	Possible solution(s)
Nozzles in room: XX do not protect the entire room volume!	**The sum of all nozzle volumes in room XX, is smaller than the room volume**	**Check volumes of each nozzle in room XX or use *Auto* nozzle volume on one or more nozzles in the room**
Total number of cylinders is not the same as used in room design!	**The total number of cylinders used in the flow calculation is not the same as in the *Inergen design* calculation**	**Check the number of cylinders for each manifold or use *Auto* cylinders for one or more manifolds**
Flooding discharge time target must be larger than zero and less than the final actual flooding for the worst case room!	**The target for the discharge time is incorrect (below zero or too large compared to the actual final concentrations)**	**Check discharge time target or increase MDC or *Design factor* (to increase the number of cylinders)**
Flooding discharge time target larger than 95% of final flooding concentration in worst case room.	**The discharge time target, converted to a flooding target is larger than 95% of the final flooding concentration**	**Check discharge time target or increase MDC or Design factor (to increase the number of cylinders)**
Manifold XX of type YY has too many connected cylinders (maximum ZZ)!	**Too many cylinders connected to manifold**	**Increase the number of manifolds**
The tee at node XX is not defined correctly. A tee can not have two branch connections! Please correct the pipe(s) inlet/outlet connections!	**An non supported tee connection has been found (this is normally only possible if you**	**Check *Pipe drawing***

Text	Explanation	Possible solution(s)
	have deleted a pipe section and rejoined the "free" pipe system incorrectly)	
Maximum pipe size XX in selected pipe type YY is too small for the current design: Please select another pipe type, increase maximum pipe size or discharge time!	**The pipe family does not have a large enough pipe size for the required flow rate**	**Check pipe family and maximum pipe size or decrease maximum flow rate**
Flooding discharge time too short: Please increase flooding discharge time and/or decrease cylinder size.	**Impossible to discharge Inergen in required discharge time (the discharge valves etc. give too much resistance)**	**Decrease the required flow rate for each cylinder**
Flooding discharge time too short: Please increase flooding discharge time, decrease cylinder size or increase number of manifolds.	**As above, but it could also be the manifold which is causing problems**	**Decrease the required flow rate for each cylinder and/or manifold**
Fixed pipe sizes specified, but pipe: XX with size YY of type ZZ is not defined in pipe list!	**The selected pipe size does not exist in the current list of pipe sizes**	**Check selected pipe size, pipe family and maximum pipe size**
Fixed pipe solution error - one or more pipes are too small: Increase discharge time or pipe size.	**The fixed pipe size is too small for the required flow rate**	**Decrease flow rate in pipe or increase selected pipe size**

Text	Explanation	Possible solution(s)
Fixed pipe solution error - solution did not converge.	**Unspecified error. Probably caused by too small or too large pipes**	**Switch to *Design* to obtain reasonable pipe sizes**
Pipe: XX with size YY of type ZZ is not defined in pipe list!	**The selected pipe size does not exist in the current list of pipe sizes**	**Check selected pipe size, pipe family and maximum pipe size**
Nozzle XX orifice diameter YY mm is larger than orifice inlet diameter: ZZ mm.	**The nozzle orifice is too large compared to the physical nozzle size**	**Check specified nozzle orifice size, use two smaller nozzles instead of one large.**
Nozzle XX orifice diameter: YY mm is not smaller than the pipe diameter: ZZ mm!	**The nozzle orifice is too large compared to the physical nozzle size**	**Check specified nozzle orifice size, use two smaller nozzles instead of one large**
Nozzle XX orifice diameter must be larger than zero!	**Self-explanatory**	**Define a positive nozzle orifice diameter**
Nozzle XX with pipe size YY is not defined in nozzle family ZZ!	**Probably caused by fixing a nozzle to a too large diameter pipe**	**Use tees to split flow and add more smaller nozzles**
Nozzle XX is not connected to the pipe system!	**The pipe system is split into one or more sub systems**	**Reconnect sub systems**
The flow solution iteration did not converge to an accurate solution within the allowed number of iterations!	**The system may be too “extreme” in some way**	**Switch to *Design* to obtain reasonable pipe, nozzle and orifice sizes**

Warnings

Text	Explanation	Possible solution(s)
The system uses a custom cylinder size: The discharge time may be different than specified/calculated!	**Custom cylinders may give additional uncertainty in discharge time due to variations in thermodynamic properties**	**Use standard cylinder sizes to get best accuracy**
XX is not a valid YY approved cylinder type.	**Self-explanatory**	**Use an approved standard cylinder type/size**
Pipe XX inlet Tee split ratio YY is lower than the minimum limit ZZ for this standard and Tee connection type. Please change the system layout or the nozzle flows.	**The inlet tee split ratio is lower than the minimum value in the selected standard**	**Increase flow rate in the pipe (larger nozzles) or reconfigure the pipe system (ex. using two splits in series)**
Pipe XX inlet Tee split ratio YY is higher than the maximum limit ZZ for this standard and Tee connection type. Please change the system layout or the nozzle flows.	**The inlet tee split ratio is higher than the minimum value in the selected standard**	**Decrease flow rate in the pipe (smaller nozzles) or reconfigure the pipe system (ex. using two splits in series)**
Nozzle XX orifice diameter YY mm exceeds the maximum orifice diameter ZZ mm for nozzle family WW. Decrease nozzle flow or choose nozzle family with larger nozzles.	**Self-explanatory**	**Decrease the nozzle size (or decrease volume coverage for nozzle)**
Nozzle XX orifice diameter YY mm is	**Self-explanatory**	**Increase the nozzle size (or increase**

Text	Explanation	Possible solution(s)
smaller the minimum orifice diameter ZZ mm for nozzle family WW. Increase nozzle flow or choose nozzle family with smaller nozzles.		**volume coverage for nozzle). If possible replace two nozzles with one**
The system is designed/simulated with a pipe system working pressure safety factor of less than one! This may result in a dangerously high pipe pressure!	**Self-explanatory**	**Increase safety factor and/or switch to a pipe family with a higher working pressure**
The system is designed/simulated with a user defined pipe system working pressure equal to XX barg. The user is responsible for ensuring a safe pipe pressure!	**Self-explanatory**	**Switch to another pipe family, instead of using a user defined working pressure**
The 95% IG-541 discharge time: XX sec. is shorter than YY sec, allowed by the selected standard!	**The time to discharge of 95% of the** total **IG-541 mass, is shorter than allowed by the selected standard**	**Increase discharge time**
The 95% IG-541 discharge time: XX sec. is longer than YY sec, allowed by the selected standard!	**The time to discharge of 95% of the** total **IG-541 mass, is longer then allowed by the selected standard**	**Decrease discharge time**

Text	Explanation	Possible solution(s)
The discharge time: XX sec. is longer than YY sec, allowed by the selected standard!	**The discharge time to** target concentration **is longer than allowed by the selected standard**	**Decrease the discharge time to target. It may be necessary to increase the number of cylinders (higher Design factor)**
Manifold: XX orifice diameter YY mm exceeds the maximum orifice diameter ZZ mm for this manifold type. Increase the number of manifolds and/or the discharge time.	**The manifold orifice diameter has hit its upper limit**	**Decrease the maximum flow for the manifold. Increase number of manifolds or increase the discharge time**
Manifold: XX orifice diameter YY mm exceeds the maximum orifice diameter ZZ mm pr. inlet for this manifold type. Increase the discharge time, the actual IG-541 concentration or decrease the cylinder size.	**The manifold orifice diameter pr. cylinder has hit its upper limit**	**Decrease the maximum flow from the cylinders. Increase the discharge time, use smaller cylinders or use more cylinders (increase Design factor)**
Number of nozzles: XX exceeds the standard limit: YY	**The upper limit on the quantity of nozzles has been hit**	**Use fewer and larger nozzles**
Pipe XX nozzle/pipe area ratio: YY exceeds standard limit: ZZ	**The pipe size is too small for the total nozzle size(s) supplied by this pipe**	**Increase the pipe size or decrease the nozzle size(s). Increase discharge time if using Fixed pipe**
Nozzle XX orifice diameter YY mm is smaller than the	**The nozzle orifice diameter is too small**	**Increase nozzle diameter (increase the flow rate/decrease the**

Text	Explanation	Possible solution(s)
standard minimum limit: ZZ mm.		**discharge time). Use fewer larger nozzles**
Ratio of total pipe volume to total cylinder volume: XX exceeds the standard limit: YY	**The volume of the pipe system compared to the cylinders is too large**	**Decrease the pipe sizes or increase the number or size of cylinders. It may be necessary to increase the discharge time**
Total pipe length: XX m from distribution system inlet to nozzle YY exceeds the standard limit: ZZ m	**The distance from manifold orifice to farthest nozzle is too long**	**Move cylinders closer to nozzles, rearrange the pipe system**
Pipe XX Mach number YY exceeds the standard limit: ZZ	**The flow rate is to large in the pipe**	**Increase the pipe size or decrease the nozzle size(s). Increase discharge time if using Fixed pipe**
Nozzle XX pressure YY barg is lower than the standard limit: ZZ!	**The peak nozzle pressure is too small**	**Decrease the pipe flow losses: Bigger pipe(s) or smaller nozzle(s)**
Nozzle pressure variance XX between nozzle YY and ZZ exceeds the standard limit: VV	**The difference between the largest and smallest peak nozzle pressure is to large**	**Decrease the pipe flow losses to the nozzle with the smallest peak pressure: Bigger pipe(s) or smaller nozzle(s)**
Pipe XX Re-number: YY is less than the standard minimum limit: ZZ	**The pipe flow rate is too small**	**Increase the flow rate: Decrease the discharge time, decrease the pipe size or increase the nozzle size(s)**

Text	Explanation	Possible solution(s)
The required working pressure: XX barg exceeds the user defined working pressure (applying a safety factor of YY)! The pipe system may be unsafe!	**The simulated pressure is too high**	**Use higher WP pipes or decrease the pipe pressures (smaller manifold orifice or larger nozzles)**
The cylinder mass flow rates are not identical, the calculated discharge time may be inaccurate!	**The simulated cylinder flow rates are not identical (only possible if using more than one manifold)**	**Adjust the manifold orifice sizes**
Room XX maximum over pressure: YY Pa exceeds maximum limit: ZZ Pa	**The simulated room over pressure is larger than the limit**	**Increase the pressure relief area or decrease peak flow into room (longer discharge time)**
Room XX discharge time flooding target is higher than 95% of the actual final flooding: The calculated discharge time is not accurate!	**The discharge time target is too large compared to the final IG-541 concentration**	**Decrease the discharge time target or increase the final concentration in the room**

Cautions

Text	Explanation	Possible solution(s)
Using user defined custom cylinder volume: XX m^3, calculated cylinder empty and total mass not correct	**Only give correct cylinder empty mass for standard cylinders**	**Use standard cylinders**
Using user defined maximum nozzle to pipe area ratio: XX	**Self-explanatory**	**Use extra caution**

Nozzle XX interface size YY is smaller than pipe size ZZ.	**A reducer is necessary to mount the nozzle to the pipe system**	**Remember to include it in the part list**
One or more of the system orifices are not chocked. The nozzle pressure calculation accuracy may be degraded.	**The pipe system pressure is too high for chocked manifold orifice flow. (Only possible when using high pressure pipes!)**	**Peak pressure and discharge time may be inaccurate.** **Use standard FE pipes (that do not support this high a pressure)**

Pdf calculation report

If a valid calculation is available (a valid Calc-ID), the pdf calculation report can be printed. Any calculation error will invalidate the calculation.

A list of warnings and cautions if there are any will be printed at the end of the calculation report in the calculation summary.

The calculation summary contains:

- HWV type
- Discharge valve type
- Time to discharge of 95% of ALL Inergen™ in cylinders (this is not the discharge time to the discharge time target)
- IMT version number
- Flow sim engine or flow design engine revision date
- List of warnings
- List of cautions
- An optional list of “info”

All pages of the calculation report contain the imt file name and Calc-ID in the footer, along with the current page number and the total number of pages.

Application method

Total flooding is the only approved application method for INERGEN systems designed in accordance with this manual.

Caution:

All calculations are performed at the temperature stated in the IMT program (standard temperature is 21°C). If the temperature at the cylinder storage or the protected enclosure varies by more than ± 5.5°C from calculated, the calculated design quantity of extinguishing agent may be incorrect.

The calculation method has only been investigated for the pipes and fittings specified in chapter 1 of this manual.

If cautions or warning are printed on the software calculation print out, there is a risk that the system will not supply the designed quantity of extinguishing agent at the specific locations.

Design

The following steps must be followed, in the order they are presented, to properly design an INERGEN total flooding system. A simple design example will be used throughout the steps to help understand each step.

Please refer to the datasheet “IMT Software general” for more details on specific functions.

STEP NO.1 - Determine the hazard area volume(s)

The first step in the design of a system is to calculate the volume of each area to be protected.

Multiply the length by the width to determine the area, and then multiply the area by the height to determine the volume for each hazard area.

If any area is an odd shape, the designer may need to divide it up into regular shapes that will allow volume calculations, and then sum all the volumes to determine the actual volume of that area. If the irregular shape might affect distribution of the agent, it may be best to calculate sections of the hazard area as separate areas and include nozzles for each of these areas.

If the ceiling height exceeds the maximum allowable ceiling height as defined in the General Information Section of this manual, multiple levels of nozzles must be designed into the system.

Complete this step for each area protected by the system.

Example:

Server room:		$125m^3$
Length:	10.0m	
With:	5.0m	
Height:	2.5m	
Subfloor		$40m^3$
Length:	10.0m	
With:	5.0m	
Height:	0.8m	

STEP NO.2 - Determine volume reductions

The volume of solid objects in each hazard area that are not removable can be deducted from the volume of the hazard. This volume may include columns, beams, cut-out room sections, closets that will always be closed, ducts that pass completely through the area without any openings, and any other large, permanently fixed objects that cannot be removed from the hazard enclosure. Calculate the volume of all such objects and add them together to determine the amount of space to be deducted from the volume. Complete this step for each enclosure protected by the system.

Example:

Server room:
Columns: 0.6m x 0.6m x 2.5m x 3 columns = $2.7m^3$
Subfloor:
Columns: 0.6m x 0.6m x 0.8m x 3 columns = $0.8m^3$

STEP NO.3 - Calculate Reduced Volume

Subtract the volume of solid, permanent objects (Step No. 2) from each of the hazard areas' volumes (Step No.1). The result is the reduced volume for the enclosure.

Room volume - solid object volume = reduced volume

Complete this step for each area protected by the system.

Example:

Server room:
125m3 – 2.7m3 = 122.3m3
Subfloor:
40m3 – 0.8m3 = 39.2m3

STEP NO.4 - Determine minimum design concentration

The Minimum Design Concentration (MDC) is determined by the hazard being protected and applied rules. A list of MDC can be found in this manual ch4 under “Design Concentration”.

The Minimum Design Concentration is determined by the hazard present in the protected enclosure which requires the highest MDC.

Skip to the next step if using one of the built-in standards.

STEP NO.5 – Specify INERGEN concentrations

If using one of the built-in standards, the MDC will be automatically selected when the appropriate “Authority” and “Hazard type” is selected.

Alternatively, the minimum design concentration in accordance with Step No 4. can be entered if “Custom” *Hazard type* is selected.

If design safety factors other than temperature and room pressure are to be applied (Tee factor and others) these can be added as a *Design factor*.

STEP NO.6 – Specify room temperature and room pressure

Enter room temperature and room pressure.

The design quantity of agent shall be adjusted to compensate for ambient pressure that vary more than 11% (equivalent to approximately 915m [3000ft] of elevation change) from standard sea level pressures (760mm Hg at 0°C [29.92 in. Hg at 70°F])

STEP NO.7 – Specify cylinder type

Choose cylinder type, filling specification and storage conditions for the cylinders.

Standard filling pressure is 200 or 300 barg @ 15°C. typical storage temperature is 21°C.

STEP NO.8 – Calculate quantity of INERGEN

By pressing the button “Calculate cylinders” IMT3 will calculate, the required quantities of INERGEN cylinders, the total INERGEN mass, Flooding, Actual concentration, Oxygen conc and CO2 concentration.

STEP NO.9 – Verify actual concentration

Check that the Oxygen concentration is above NEL or LEL also at the minimum operating temperature.

Provisions to limit exposure to below specified must be provided.

The ΔT is giving the corresponding oxygen concentration with respectively 10 and 20 °C difference from the calculated.

Oxygen	Oxygen ΔT = 10°C	Oxygen ΔT = 20°C	Max exposure (minutes)
12.0%	12.2%	12.4%	5
10.1%	10.3%	10.5%	3
8.0%	8.3%	8.5%	0.5

STEP NO. 10 - Determine nozzle quantity

Nozzle quantity will be determined by many factors, such as size and shape of the hazard area, height of the ceiling, etc.
To determine the quantity of nozzles required.
Land systems:
divide the room length by 7.32m (max inter-nozzle distance) and round up to the next whole number.
Then divide the room width by 7.32m and round up to the next whole number.
Then multiply the two answers to determine the total nozzle quantity.
Marine systems:
Use 8.0m instead of 7.32m

Complete this step for each area protected by the system.

360° NOZZLE REQUIREMENTS:
Maximum coverage length per nozzle (radial distance): 5.18m.
Above distance should not be exceeded from the nozzle to the farthest point.

The radial distance is defined as the distance from the nozzle to the farthest point of the area protected. The nozzle should be placed as close to the center of the hazard area as possible. On multiple nozzle systems, the nozzles should be as equally spaced as possible.

Nozzle limitations

- Maximum nozzle height above floor level for a single row of nozzles
  Land systems (mono-orifice): 4.7m
  Marine systems (MED nozzle): 6.0m
  For ceiling heights over above limits, additional row(s) of nozzles is required.
- Minimum clearance in front of nozzle: 0.1m
  Minimum clearance behind nozzle: 0.0m
- Minimum protected area height is 0.3m
- For multiple level hazard areas, the intermediate levels of nozzles must be positioned at the top of the designed height for each intermediate level. Nozzles mounted at the ceiling must be within 1.0m of the ceiling.
- If noise level is a concern, additional nozzles may be used to reduce the noise level and a silencer should be installed, consult datasheet for recommendation regarding performance. The silencer is NOT FM approved (see section regarding Nozzle and silencer)
- If the room is an odd shape, the designer may wish to increase the nozzle quantity to provide a more even distribution of the agent.

STEP NO. 11 – Designing the pipe system

See IMT3 main features -> Pipe drawing tab. Only the flow path of INERGEN is included in the calculation. Dirt-traps may be placed at last nozzle without affecting the calculation, whether or not it is included in the design.

STEP NO. 12 - Determine nozzles locations

Using a plan view drawing of the protected areas, locate each nozzle and the cylinders. Then complete the 3D drawing using the IMT software as represented below, indicating the length of each pipe section.

NOTE:

- Nozzles should be placed as far from pressure vents as practically possible.
  Typically placed in the upper part of the hazard area, directed away from structures or object which could disturb the flow of INERGEN.
- Nozzles should be placed as evenly as possible within the protected area.

- A radial distance of minimum 0.5m from side of the nozzle must be clear to avoid damage to the structure.
  If placed closer, deflectors should be used.

STEP NO. 13 – Pipe system calculation

Go to the Calculation tab and use Calculate pipe system to start the pipe system calculation.

STEP NO. 14 – Calculate required area for pressure venting

Based on the discharge time and agent volume the mass flow is calculated by IMT and the required pressure relief area is calculated

The formula below is used to calculate the pressure relief opening area.
For more detail, consult CEA 4008.

$$A = \frac{M * V_g}{\sqrt{\Delta p * V_{bl}}} * \sqrt{\frac{C_1}{2}}$$

$$V_{bl} = (1 - x) * V_{air} + x * V_g$$

A: Pressure relief opening area; m^2
M: Mass flow of extinguishing agent; kg/s at t=0
(convert the flow from step 14, using the table below)
V_{bl}: Specific volume of blend; m^3/kg
(calculate using values from step 13 and table below)
V_g: Specific volume of extinguishing gas; m^3/kg
V_{air}: Specific volume of atmospheric air; m^3/kg
Δp: Allowed pressure rise in the protected area; Pa
(if Δp is unknown, use 500 Pa. This is considered a light construction and will generate a larger opening than might be required)
C_1: Resistance value for pressure relief opening
C_1=2 for openings with high flow resistance
x: Extinguishing concentration; m^3 agent/m^3 protected area

Temperature (°C)	V_{air}	$V_{g.\ INERGEN}$
-10	0.749	0.625
0	0.777	0.649
10	0.806	0.673
20	0.834	0.696
30	0.862	0.720
40	0.891	0.743

Specific volumes of air and Inergen at standard pressure

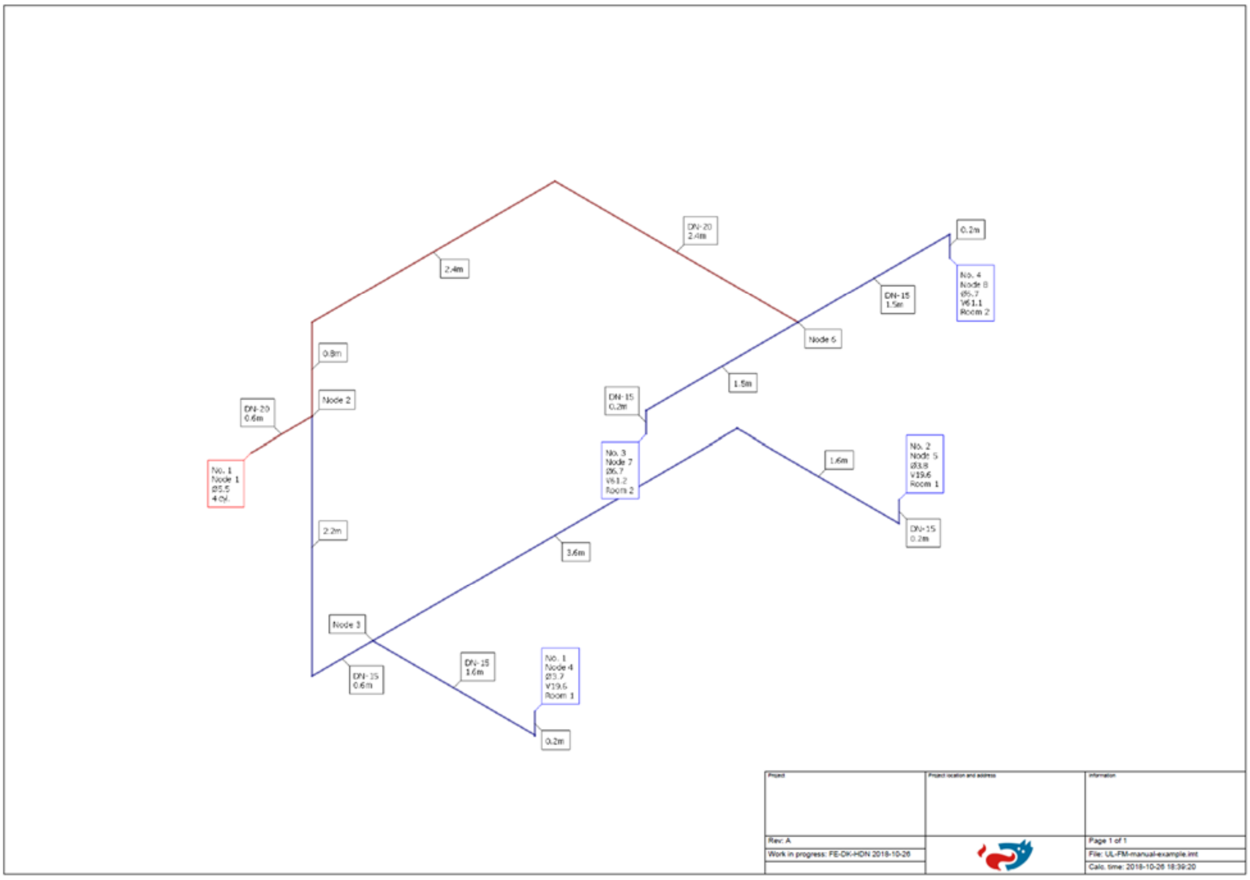
STEP NO. 15 - Create a bill of materials

Use the IMT “part finder” to generate a list of all materials and parts necessary to install the system.

STEP NO. 16 - Create installation drawings

The final step in the design of an INERGEN system is completion of installation drawings for submission to the appropriate authority and the customer. These drawings should include all details necessary for installation of this system.

File >> *Print drawings* may be used to generate these:



Alternatively, the pipe system can be exported as a DXF file using *File* >> *Export as dxf.*

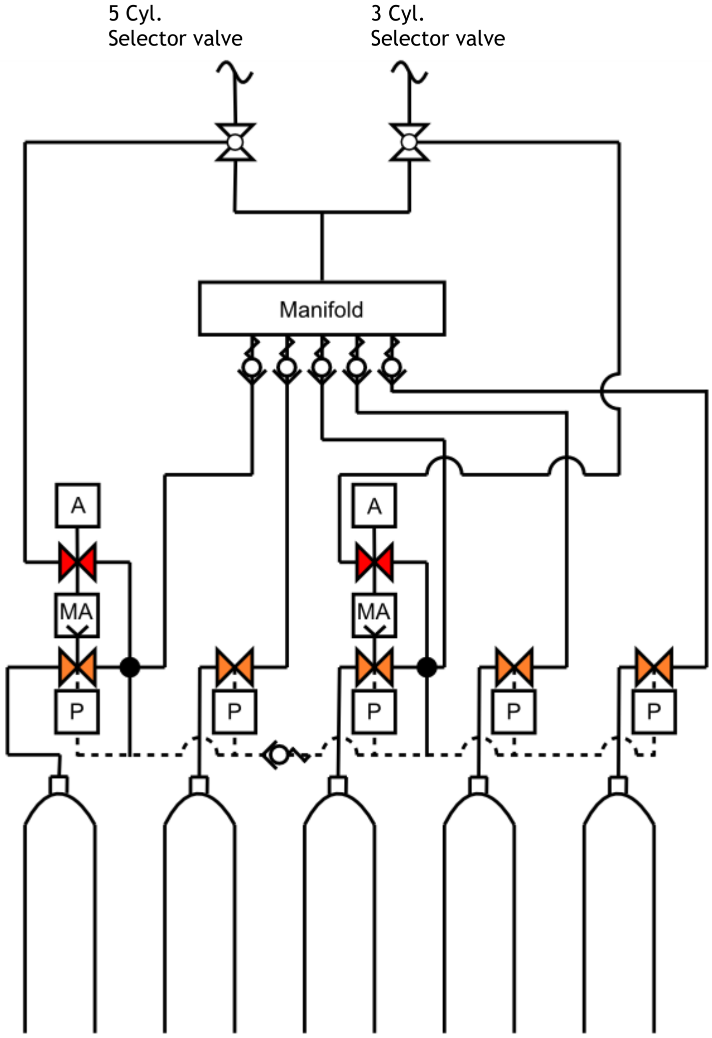
Multizone systems (DV7 and SV valves)

The following information must be considered when designing a selector valve system.

- Selector valve systems should only be used for multi areas where each area is a separate fire zone.
- Each hazard area must be calculated as a separate system design.
- Start with the largest system, in order to determine the quantity of cylinders required.
- After calculating the largest system, complete additional system calculations.
- Selector valves can be located either upstream or downstream of the pressure reducer.
- The piping located between the pressure reducer and the selector valve must be rated for the system (cylinder) working pressure, respectively 200 or 300 bar [4350 psi] or greater.

The following drawing is an example of a selector valve system.

161



A — Actuator; can be solenoid, push button or pneumatic

P — Pneumatic actuator

MA — One way mechanical link between SV CiV and IV8 valve

SV CiV

IV8 valve

SV22 selector valve

Non-return valve / check valve

Main and Reserve System

Normally the authority having jurisdiction will determine whether a hazard requires a reserve set of INERGEN cylinders, either connected or spare.

NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, states: "Where required, the reserve quantity shall be as many multiples of the primary supply as the authority having jurisdiction considers necessary". "Where uninterrupted protection is required, both primary and reserve supply shall be permanently connected to the distribution piping and arranged for easy changeover".

FM Global and IRI (Industrial Risk Insurers) require the following:

"In high pressure systems an extra full complement of charged cylinders (connected reserve) manifolded and piped to feed into the automatic system should be provided on all installations. The reserve supply is actuated by manual operation of the main/reserve switch on either electrically operated or pneumatically operated systems.

A connected reserve is desirable for several reasons:

- Protection, should reflash occur.

- Protection during impairment when main tanks are being replaced.

- Protection of other hazard areas if selector valves are involved and multiple hazard areas are protected by the same set of cylinders.

- If a full complement of charged cylinders cannot be obtained, or the empty cylinders recharged, delivered and reinstalled within 24 hours, a third complement of fully charged spare cylinders should be maintained on premises for emergency use.

The need for spare cylinders may depend upon whether or not the hazard is under protection of automatic sprinklers".

When designing a system, always determine if, and what kind of, reserve system is required.

NOTE: Usage of reserve systems with primary system may make hazard area unsafe for normal occupancy.

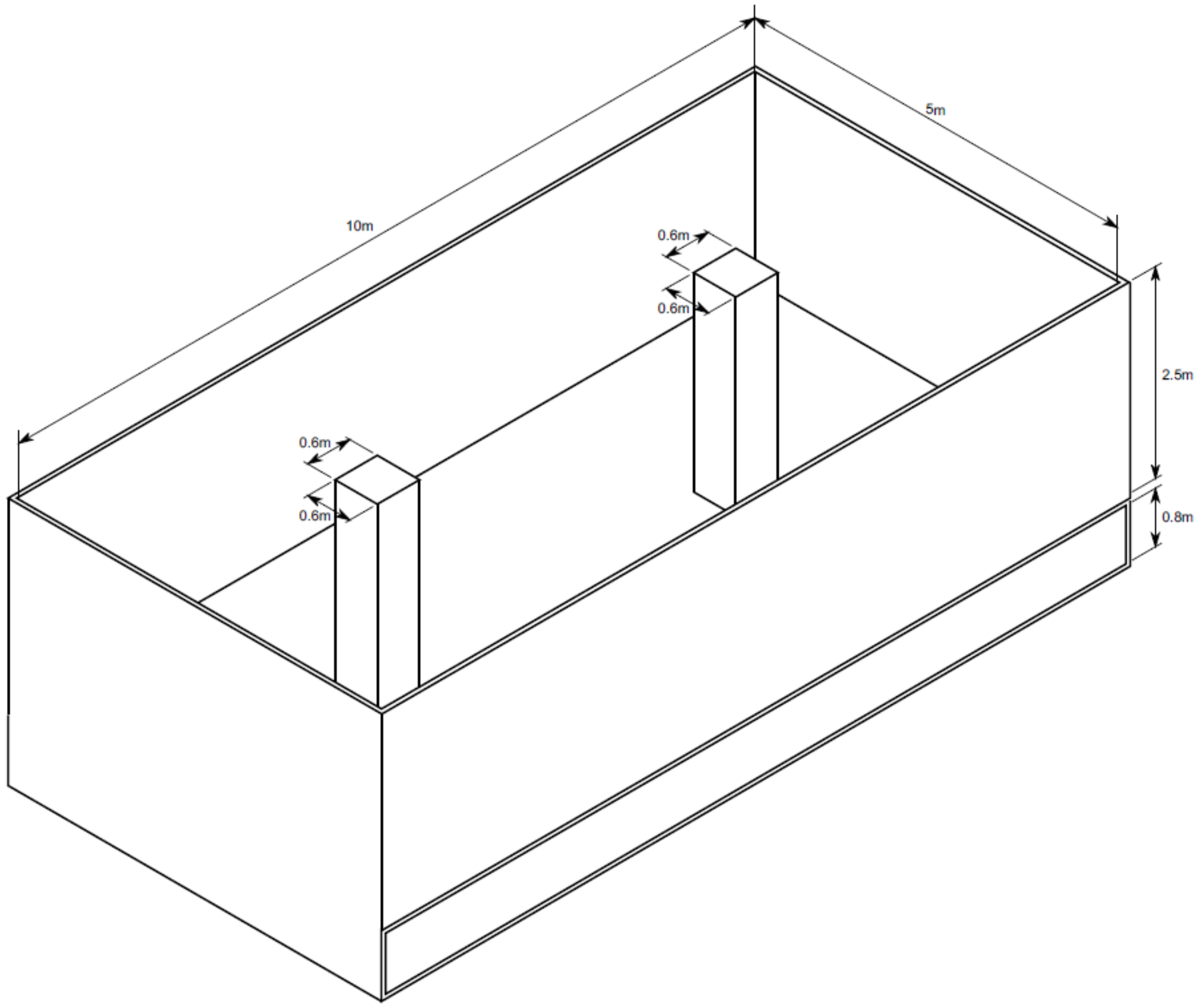
Typical application

A server room is here used as an example for a typical Fire Eater total flooding INERGEN system.

The area consists of the server room itself and a subfloor.

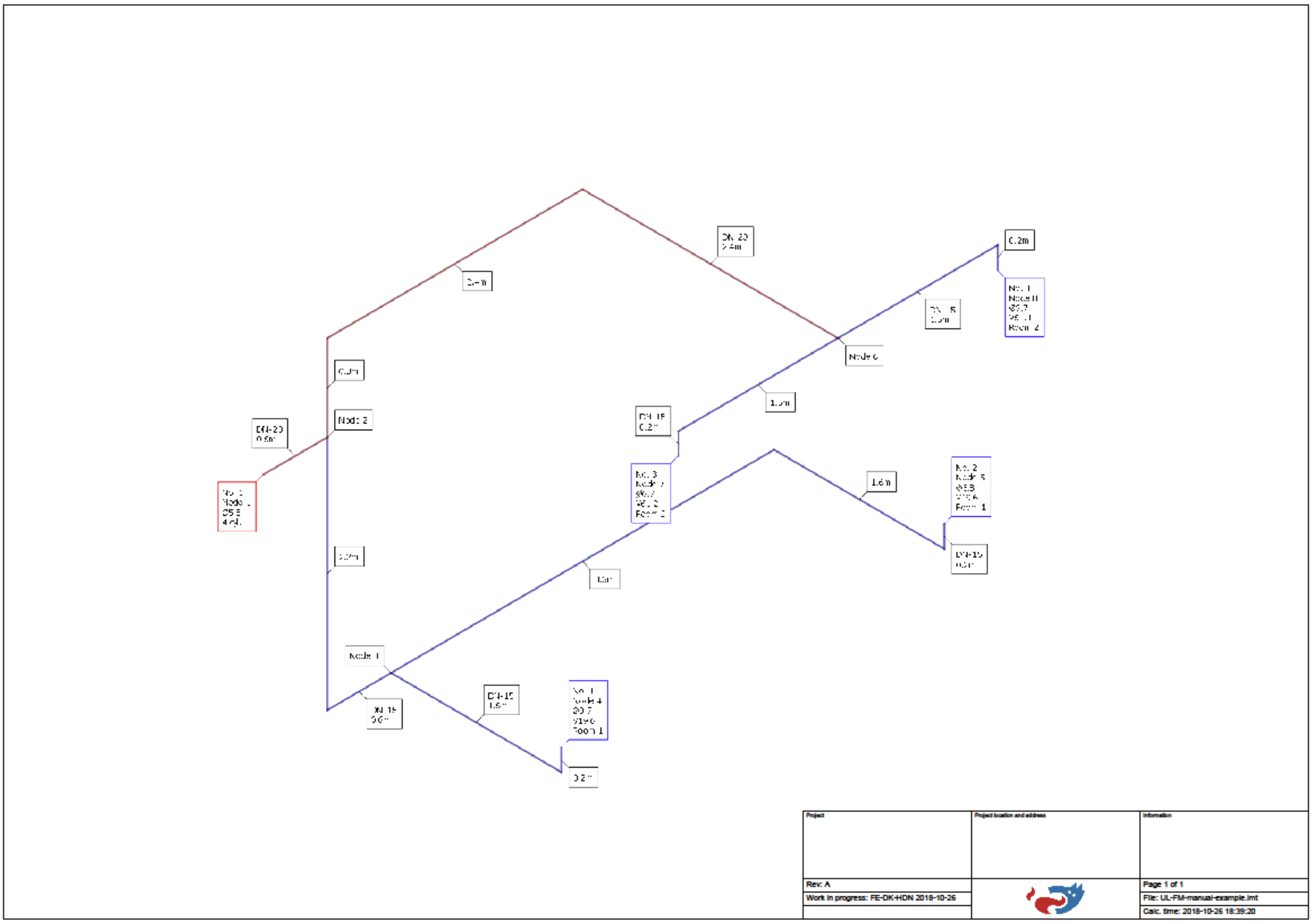
An Inergen system can be used – and the room protected – even when normally occupied. Alarms or warning devices must be located in the protected area and give occupants sufficient annunciation of imminent Inergen discharge.

Area to protect:



IMT3 output example:

IMT Isometric drawing



IMT Calculation

Printout shown on the next pages

IMT 3.0.x calculation report

Project

Name
Type
Application type
Location
Address 1
Address 2
Country
Contact name
Contact phone
Contact mail
Our reference Henrik Ditlev Nissen
Our reference mail hdn@fire-eater.dk
Purchase order no.
Information
Revision A
Rev. description
Design state Work in progress

Customer

Name
Number
E-mail
Address 1
Address 2
Country
Phone
Contact name
Contact phone
Contact mail

System data

Cylinder type	Inergen 80L steel cylinder	
Cylinder quantity	4	
Cylinder fill	15.0 °C	300.0 barg
Cylinder storage	20.0 °C	308.8 barg
Atmospheric pressure	1013.0 mbar	
Authority	NFPA 2001:2015	
Pressure relief resistance	1.0	

Rooms

Room	1	2	Total
Name	Under floor	Room	
Volume [m^3]	39.2	122.3	161.5
Temperature [°C]	20.0	20.0	
Hazard	A	A	
MDC [%]	34.2	34.2	
Design factor [%]	5.0	5.0	
Final Inergen [%]	44.1	44.1	
Flooding [%]	58.1	58.1	
Inergen mass [kg]	32.18	100.40	132.58
Final O2 [%]	11.7	11.7	
Final CO2 [%]	3.5	3.5	
Max flow rate [kg/s]	0.37	1.11	1.48
Max over pressure [Pa]	500	500	
Pressure relief [cm^2]	66	201	267

Discharge

Pipe family	FE galvanized welded steel pipe EN10220/10217-1 P235TR1.
Actual discharge time target	32.5% IG-541
Discharge time	120.0 sec

File: UL-FM-manual-example.imt 1/6 Calc-ID: FE-DK-HDN-20181026-183920

Pipe system

No.	N1	N2	Elv	Start	End	Elb	Con	Noz	Room	L	Vol	T	N/P	DN	Press	Dia	M
MT_no1															301.6	5.5	
Pipe															76.5		
1	1	2		Plain	T branch	0	0			0.6		100.0	28.6	DN-20			0.130
2	3	4	-0.4	T branch	Plain	1	0	IN-15	1	1.8	19.6	50.0	6.3	DN-15	75.48	3.71	0.031
3	3	5	-0.4	T run	Plain	2	0	IN-15	1	5.4	19.6	50.0	6.5	DN-15	75.19	3.77	0.032
4	6	7	2.2	T run	Plain	1	0	IN-15	2	1.7	61.2	50.0	20.8	DN-15	70.14	6.73	0.101
5	2	3		T run	T run	1	0			2.8		24.3	12.9	DN-15			0.062
6	6	8	2.2	T run	Plain	1	0	IN-15	2	1.7	61.1	50.0	20.8	DN-15	70.15	6.72	0.101
7	2	6		T run	T branch	2	0			5.6		75.7	21.9	DN-20			0.103

Volume of pipe system: 0.0043 m^3

Pipe to cylinder volume: 1.3 %

Minimum pipe working pressure: 76.0 barg

Description

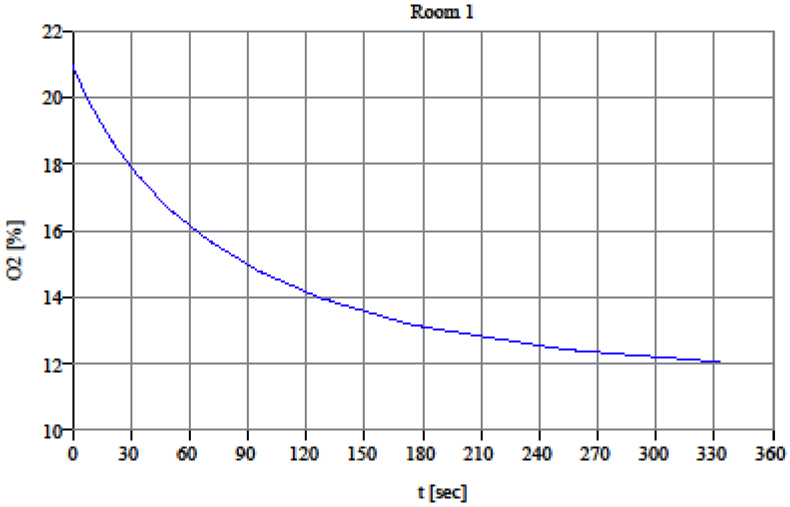
MT		Manifold with orifice
Pipe		Pipe system inlet (flow from all manifolds merged)
N1, N2		Inlet and outlet nodes
Elv	m	Elevation
Start		Connection at pipe inlet
End		Connection at pipe outlet
Elb		Number of 90 deg elbows
Con		Number of pipe connectors
Noz		Nozzle type
Room		Room number
L	m	Pipe length
Vol	m^3	Volume of room protected by this pipe
T	%	Tee split ratio
N/P	%	Nozzle to pipe area ratio
Press	barg	Max pressure in pipe at outlet
Dia	mm	Diameter of orifice (Nozzle or Manifold)
M		Mach number at pipe outlet

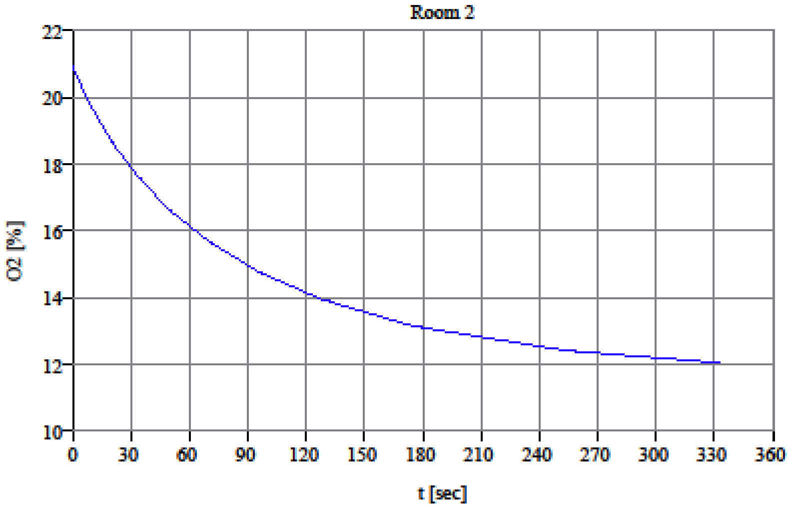
File: UL-FM-manual-example.imt 2/6 Calc-ID: FE-DK-HDN-20181026-183920

Oxygen and Inergen vs. time

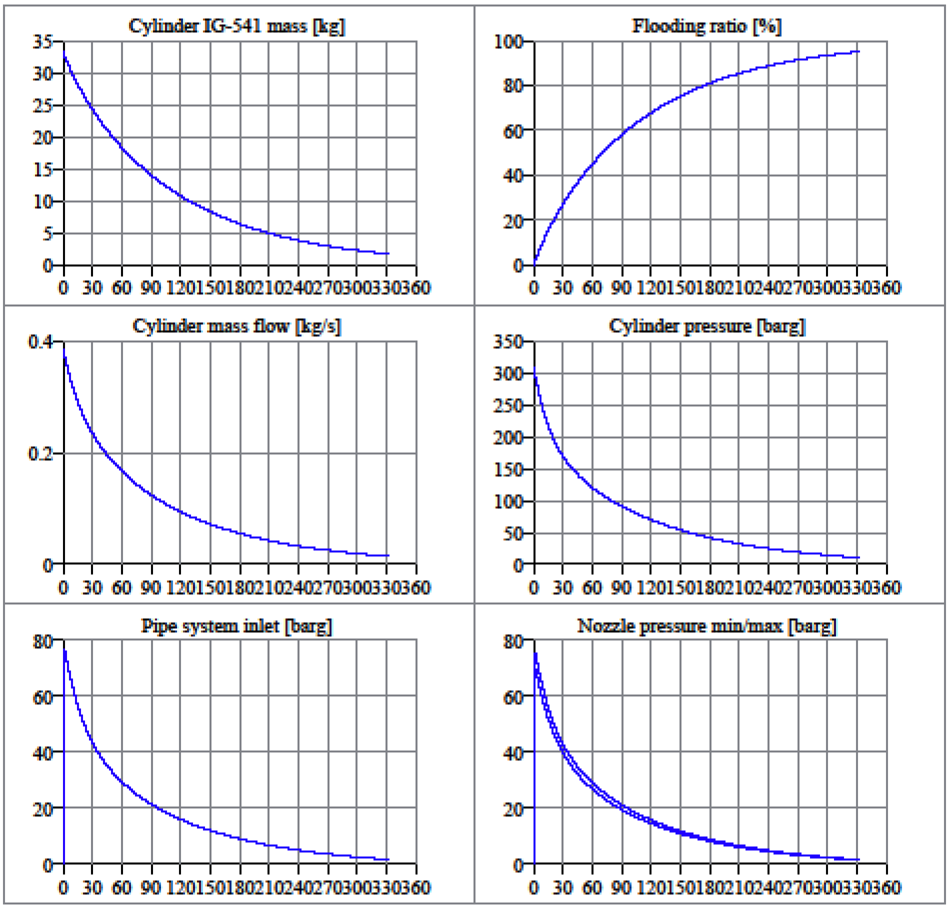
Time	9.6	20.9	34.6	51.1	71.1	96.1	120.0	128.8	175.2	254.3	332.3		sec
Room1	19.8	18.6	17.6	16.6	15.7	14.8	14.1	14.0	13.2	12.4	12.1	11.7	O2 %
Room1	16	32	47	61	74	86	95	98	109	119	124	129	% MDC
Room2	19.8	18.6	17.6	16.6	15.7	14.8	14.1	14.0	13.2	12.4	12.1	11.7	O2 %
Room2	16	32	47	61	74	86	95	98	109	119	124	129	% MDC

Room O2% plots





Discharge graphs



Calculation summary

HWV	HWV-8mm
Discharge valve	CI-IV8
Total Inergen	95% @ 332.3 sec
IMT vers.	IMT3.0.0
Flow design engine	2018-08-01
Info	No errors during calculation.
	No warnings during calculation.
	No cautions during calculation.

File: UL-FM-manual-example.imt 5/6 Calc-ID: FE-DK-HDN-20181026-183920

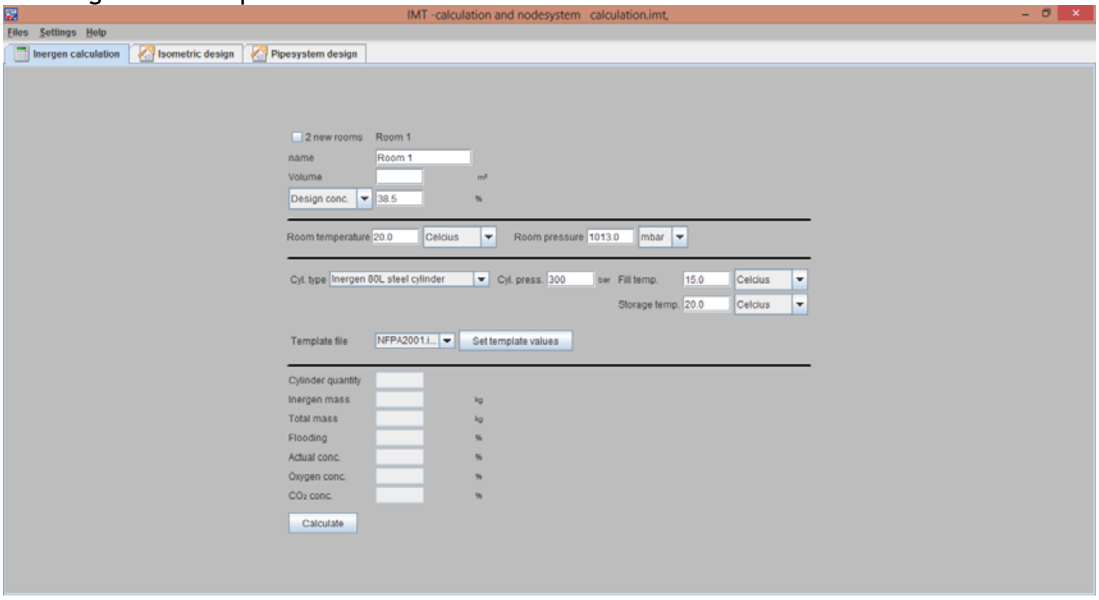
Calculation resume

Parameter	This calculation	Limit
Calculation time		
Rules applied	NFPA 2001:2015	NFPA 2001:2015
Cylinder pressure (fill) @ 15°C	300.0 barg	NA
Cylinder volume	80 L	NA
Number of cylinders	4	NA
Mass flow	1.48 kg/s	NA
Pipe length max	8.8 m	300 m (max)
Pipe to cylinder volume	1.3 %	20 % (max)
Discharge time to target	120 sec	120 sec (max)
Discharge time to 95% total IG-541	332.3 sec	30 - 600 sec
Max pipe pressure	76.5 barg	Defined by pipe
Re-number min	7.3E+05	4.0E+05 (min)
Mach number max	0.13	0.40 (max)
Max system orifice to pipe area ratio	6.3 %	64.0 % (max)
System orifice (all orifices)	23.9 mm^2	NA
Tee split bullhead	24% / 76%	5% / 95%
Tee split run/side	50% / 50% - 50% / 50%	5% / 95% - 95% / 5%
Nozzle orifice min	ø3.7 mm	ø3.0 mm (min)
Max nozzle orifice to pipe area ratio	29 %	70 % (max)
Nozzle pressure peak min	70 barg	20 barg (min)
Max nozzle pressure variance	1.08	2.00 (max)
Nozzle flow max/min	0.56 / 0.18 kg/s	NA
Elevation change	3 m	50 m (max)
Temperature (cyl. storage)	20.0 °C	NA
Nozzle quantity	4	100 (max)

File: UL-FM-manual-example.imt 6/6 Calc-ID: FE-DK-HDN-20181026-183920

Guide to calculation software IMT 2.2.x

On the initial page you will find the “Inergen calculation” tab open. There are two more tabs, “Isometric design” and “Pipe system design”. On the menu bar, you will find three items, “Files”, “Settings” and “Help”.



The menu layout is as per below:

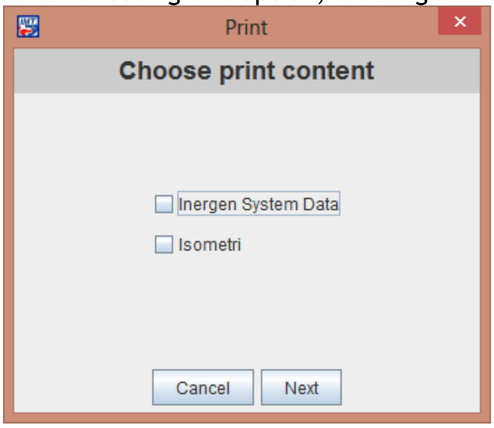
Files		
	New	Creates a new IMT calculation
	Open	Opens a saved calculation
	Save	Saves a previously saved calculation
	Save As	Saves a new calculation
	Print Free text	Opens a dialog box, for insertion of information that will be printed on the “Inergen System Data”

	Print	**Prints the System data or Isometric design**
	Open Part finder	**Opens the part finder**
	Exit	**Exits the program**
Settings		
	System Settings	**Opens the system settings**
	Template Values	**Opens the template values**
Help		
	About IMT	**Information about version number**

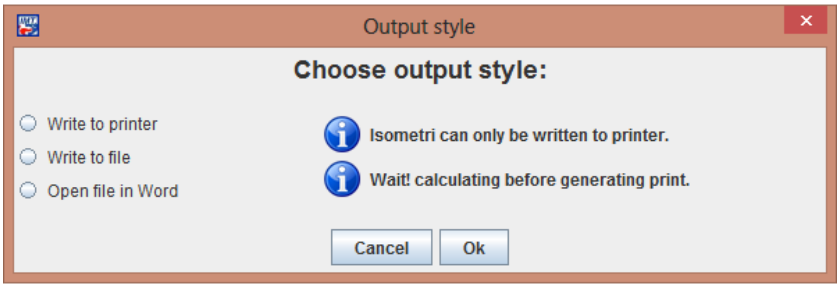
Below the “print”, “System Settings” and “Template Values” are to be explained more thoroughly.

Print

When choosing this option, a dialog box will be presented as below



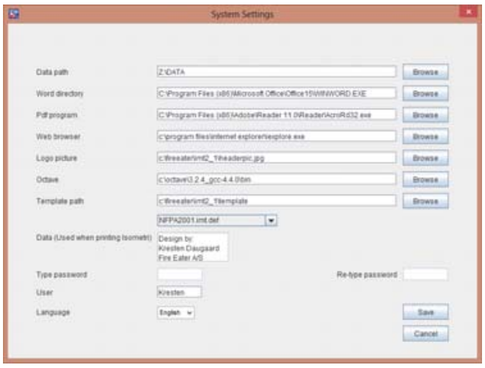
After choosing what information should be printed, click “next”. This will display a new dialog box



There is now three options. Choose to write to printer, write to a file or open the file in Microsoft Word.

System Settings

The System Settings is where all information regarding data paths and paths to programs used by the IMT.



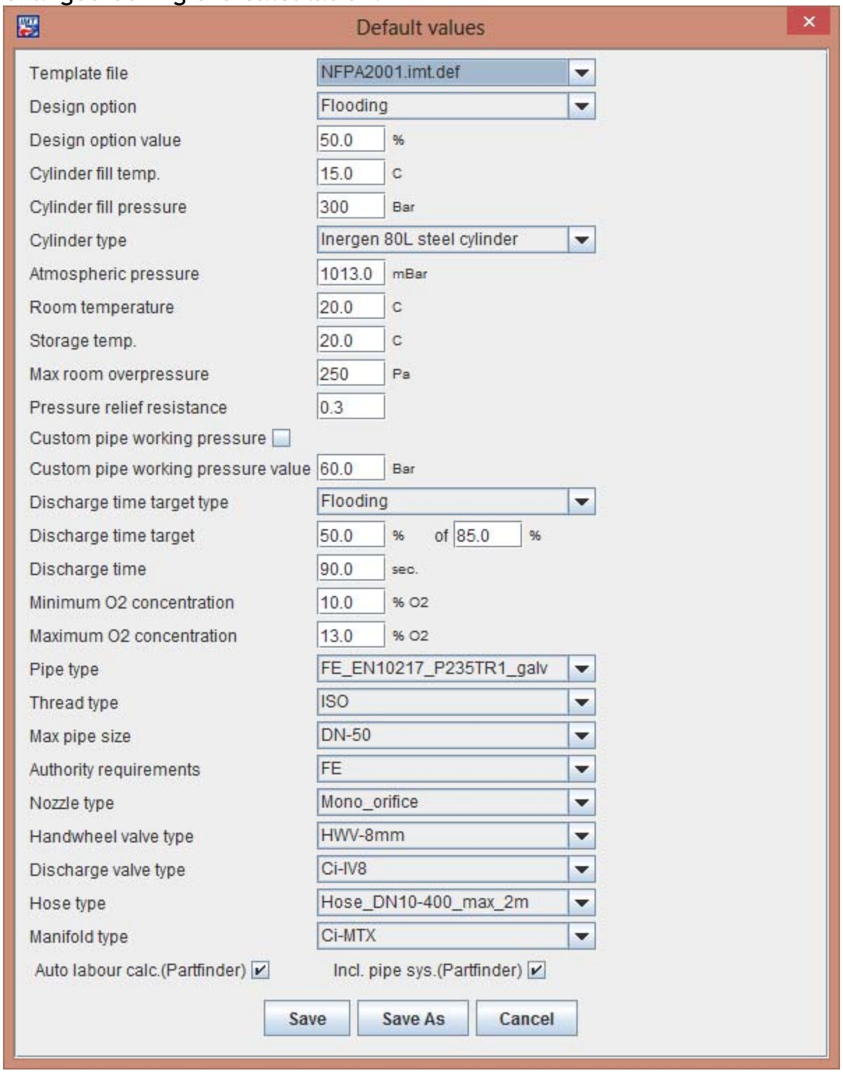
Data path	**Location of the saved files**
Word Directory	**Path to the winword.exe file, which will open the MS Word program**
Pdf program	**Path to the pdf reader program used on the computer**
Web browser	**Path to the Web browser used on the computer. E.g. FireFox, Chrome, Explorer**
Logo Picture	**Path to the image used on the header of the isometric drawing**
Octave	**Path to the Octave program. This will be installed along with the IMT software. This path should not be changed**
Template path	**Path to the user define templates. The drop down box below this, will state the default template that the IMT will start up with every time**
Data(Used when printing isometric)	**Insert name of company or designer of system**
Type password	**Used to change the password from the default "imt"**

User	**This is shown on the printed documentation**
Language	**Choose between Danish and English**

Template Values

The template feature is a possibility to have several standards defined in the program, and to be able to choose between these easily.

It is important to notice that the template is a way of defining default values. All of the values can be changed during the calculation.



Template file		**Name of the template. This will be defined when saving the template when all the values are set**
Design option	**Design conc**	**According to the standard Option: Flooding, Design or Oxygen**
Design option value	**38.5 %**	**According to the standard**

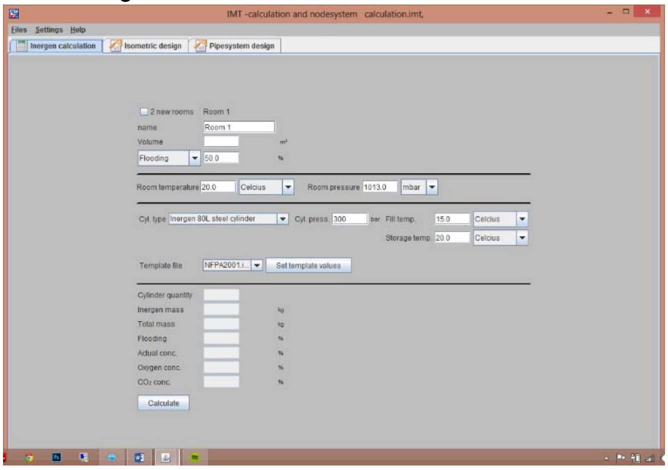
Cylinders fill. temp.	15°C	The filling temperature of filling from the cylinder/gas plant
Cylinder fill. pressure	300 bar	Typically 300 or 200 bar.
Cylinders type	80	Size of the cylinder used. Typical 80L, optional smaller cylinders or 140l.
Atmospheric pressure / Elevation	1013 mBar / m	Pressure or elevation of the room being protected. Atmospheric pressure at sea level is 1013mBar.
Room temperature	20 °C	The temperature in the protected room
Storage temp.	20 °C	The temperature of the cylinder storage.
Max room overpressure	500 Pa	The maximum allowed overpressure in the protected room.
Pressure relief resistance	0.3	Default for Fire Eater dampers is 0.3. If other dampers is used, the resistance for these must be used.
Custom pipe working pressure		When using a custom pipe working pressure, the value must be inserted here. This will overwrite the default value for the pipe chosen
Custom pipe working pressure value	bar	Check/uncheck if custom pipe working pressure is used.
Discharge time target type	Design conc	Choose between Flooding, Design or Oxygen% according to the standard.
Discharge time target	95% of 34.2	According to the standard

Discharge time	120 sec	According to the standard
Minimum O^2 concentration	10	LEL
Maximum O^2 concentration	14	Calculated on basis of MEC
Pipe type	FE_EN10220/10217_P235TR1_galv	Choose between different pipe. This includes values for pipe resistance, working pressure etc.
Thread type	ISO	Choose between NPT and ISO, other
Max pipe size	Dn50	Defines the maximum pipe size used in the calculation.
Authority requirements	NFPA	Choose the correct standard to the calculation. This ensures that the rules are obeyed according to the defined standard, throughout the calculation.
Nozzle type	Mono_Orifice	Choose between mono orifice for land based systems, and MED for marine and offshore systems
Hand wheel valve type	HWV-8mm	The hand wheel valve on the cylinders.
Discharge valve type	Ci IV8	Choose between IV7 and Ci-IV8. All new installations are to be with Ci-IV8.
Hose type	Max 2m	Defines if the IMT software will choose 0-2m or 2-4m hoses as default.
Manifold type	Ci-MTx	Choose between the Ci-MTx for stand-alone systems with 2-10 cylinders. Ci-MT1 for systems with only one cylinder. SV22-MTx for SV systems

Auto labour calc.(part finder)		**Check/uncheck if labour should be calculated on the complete part list**
Incl. pipe sys. (part finder)		**Check/uncheck if pipe system should be included in the part list.**

When all of these values have been set according to the standard in question, the template should be saved.
If it is the first time saving a new template, choose “Save As”, and give the template a name. When this is done, the IMT program must be restarted before the template is visible in the drop down box on the “Inergen Calculation” tab.

Tab: Inergen calculation



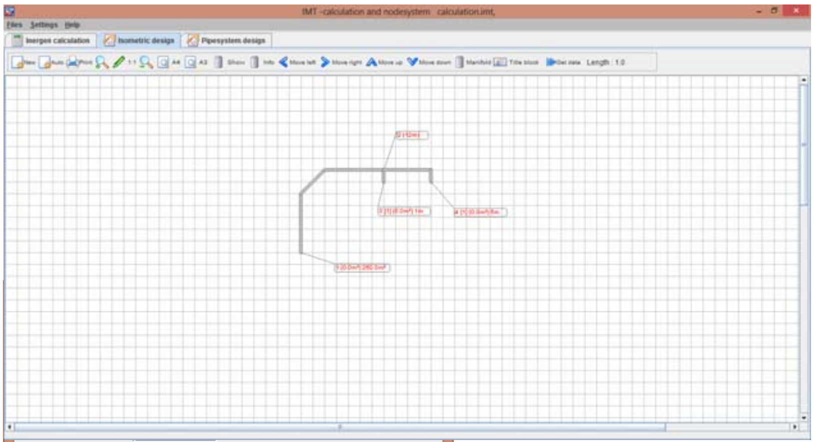
This initial tab, which is the default start-up screen, is where the number of cylinders, total mass, concentration, oxygen concentration etc. is calculated.
Most of the values can be changed on this initial calculation sheet. Please note that all these values can be set in the template file as well. For explanation of the values in the fields, please refer to the section regarding the template file.
The template file was explained in a previous section. This can be used now. When beginning a new calculation, choose the template file, and click “Set template values”.
Explained below is the new information on this tab.

2 new rooms	**If this box is checked, 3 rooms is shown, and each room should be given a name and volume. This can be used for floor void, room void and ceiling void.**
Design concentration	**This is the concentration in the room after the gas has been released.**
Cylinder quantity	**Quantity of cylinders needed for the calculated protected area**
Inergen mass	**Mass of the Inergen, excluding the cylinders**
Total mass	**Mass of the Inergen, including the cylinders**
Flooding	**This is, in short, the gas in the cylinders. Usually more gas than needed, because Fire Eater only operates with full cylinders.**

Actual conc.	**The design concentration that will actually be achieved, as we will input more gas than needed for the exact design concentration.**
Oxygen conc.	**Oxygen concentration in the protected area after the Inergen has been released. This must always be between 10-13% to ensure breathing is possible for humans. Most fires will be extinguished when the oxygen level is approx. 15%.**
CO_2 conc.	**The final CO_2 concentration in the protected area**

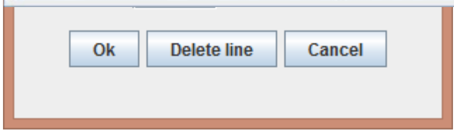
Tab: Isometric design

On the Isometric design tab, the pipe system must be laid out. This must include all pipes, both in the room, floor void and ceiling void. Furthermore, the nozzles must be defined. These are illustrated by the short ended pipes.



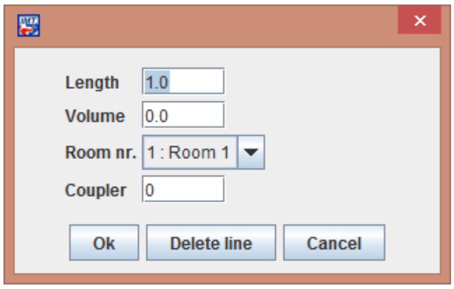
When the pipe system is laid out, the length of the pipes must be defined, as well as the volume covered by each nozzle. To define a pipe length, click on the line in question to open the dialog box, as seen below.

In this box, the length can be defined. This will not change the isometric illustration. The information will be used later in the part list, which will be explained later. The “Coupler” value can be defined, if not manually set, there will be one coupler added for each 6 meters of pipe.



When the values are set, click “Ok”.

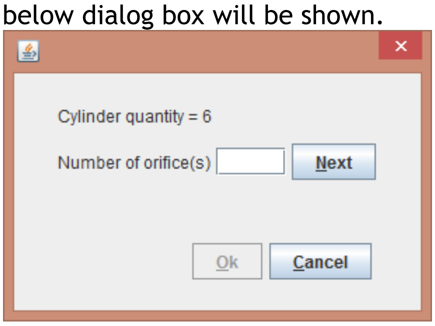
When defining the nozzles, click on the nozzle, and a dialog box will be shown. In this box the length of pipe from the tee to the nozzle must be defined. The volume covered by the nozzle must be defined. If the volume is set to “0” the IMT will automatically divide the complete volume with the quantity of nozzles, and set the volume. “Room nr.” is a drop down menu where the rooms defined in the “Inergen calculation” tab, if “2 new rooms” is checked. If using the feature with “2 new rooms”, the volume will only concern the room nr. chosen. When done, click Ok.



When all pipes, and nozzles are defined, the manifold must be inserted.

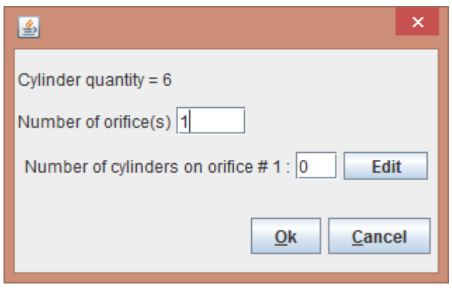
Click on the 

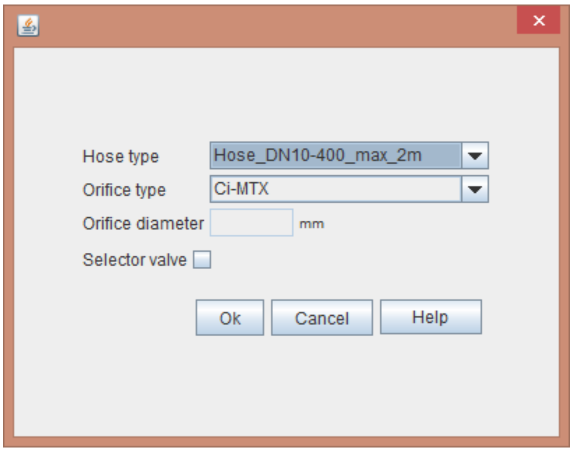
icon on the taskbar, and then click on the isometric area. When doing so, the below dialog box will be shown.



The value in this field must represent the amount of orifices for this specific calculation. If the system calculated is a stand-alone system, this will represent the amount of manifolds. If the system calculated is a SV22/SV48 system, the value must be the quantity of selector valves. This is because the orifice is located differently in the two system types. Note that a stand-alone manifold has 2-10 inlets. When the value is defined click “Next”.

On the next dialog box the number of cylinders on each orifice must be defined. When the value is set, click on “Edit”.





When clicking “Edit” a new dialog box will be shown. In this dialog box hose type and orifice type must be defined. In the hose type field two values can be chosen. 0-2 meter hoses or, 2-4 meter hoses. This will be an estimate, and can be changed later in the part list. Orifice type must reflect the type of system calculated. Choose between Ci-MTX, Ci-MT1, SV22-MTX and SV48-MTX.
If the system calculated is a SV22/SV48, the check box “Selector valve” must be checked.
When done, click “Ok”.
Now everything is set for the isometric design.

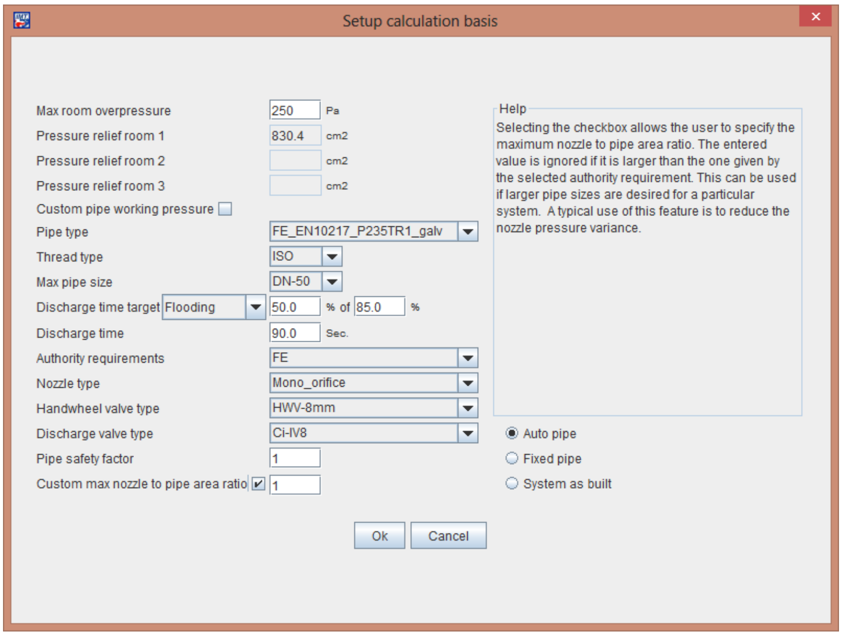
See the below table for the options in the taskbar

	**Create new isometric drawing**
	**Creates an auto isometric design. Only define the volume covered by each nozzle on average.**
	**Print the isometric**
	**Zoom in**
	**Show the design in 1:1**
	**Zoom out**
	**Show the outline of a A3 page, with page footer**
	**Show the outline of a A4 page, with page footer**
	**Show/hide the manifold and cylinders**
	**Info regarding orifice and other data of the isometric. This is only available after calculation system on the “pipe system design” tab**

	**Move the isometric design**
	**Move the isometric design**
	**Insert manifold**
	**Show the information for the title block/footer.**
	**Get the data from the “pipe system design”, when this is calculated.**

Tab: Pipe system design

The initial screen presented when choosing the “Pipe system design” tab is the “Setup calculation basis” as shown below.



All of the values in this box has already been set in the template file, and the explanation for these fields and values is defined in the “Template values” section of this guide. However there are five values new to this dialog box, which will be explained in the table below.

Pipe safety factor	
Custom max nozzle to pipe area ratio	
Auto pipe	**Default setting. This will automatically calculate the best-suited pipe for the system.**
Fixed pipe	**If choosing this option, it is possible to define the pipe size for each branch manually. If a pipe chosen manually will not fit the calculation an error will occur.**
System as built	**When the calculation is done, and the physical installation is done, the “System as built” can be checked. This will be shown on the final print, which in many cases will be used as documentation for the complete system. Note that this can only be done after doing “Auto pipe” calculation**

When all values are set in the “Setup calculation basis”, click “Ok”.
Click on “Isometri” to import information from the isometric design, to the pipe system design.
Click on “Calculate system”.

Troubleshooting

List of Errors, Warnings and Cautions with explanation and possible solutions.

Errors will indicate that the calculation failed.
Warnings are given when one of the limitations given on the previous page has been exceeded.
Cautions indicate that special precautions are required during installation (Pipe Dn50 to Nozzle Dn15).

List of Errors, Warnings and Cautions

Errors:		
	Explanation	Possible solution
Room temperature or pressure exceeds NFPA2001 limit.	**Self-explanatory**	**Increase room temperature and/or room pressure**
Room volume is negative.	**Self-explanatory**	**Define a positive room volume**
Room missing nozzles.	**Self-explanatory**	**Add at least one nozzle to the isometric design**
Discharge Concentration/time/target is negative or larger than final concentration.		
Oxygen target for discharge time concentration exceed 20.95 or design O2 conc.	**Self-explanatory**	
Nozzle incorrect room designation.	**Nozzle does not correspond to the**	**Re-draw isometric drawing**

	designated room.	
Nozzle volume in room do not add up correctly.	Total volume of gas on all nozzles does not add up to the defined volume	Check the volumes on the nozzles and correct to get a total volume as defined.
Manifold connection do not match requirement.	Self-explanatory	Redefine the manifold type in isometric design
Pipe size missing or not defined in pipe table (only in “fixed pipe” or “as built” calculation).		Change the pipe size, or allow larger pipes for the calculation in “Setup calculation basis”
Pipe size too small (only fixed pipe calculation).	An invalid pipe size has been chosen.	Pipe below DN10(3/8”) has been defined. Change this to be larger diameter
Pipe size exceeding limits applied.	Self-explanatory	Tree solutions are possible. Increase the discharge time, increase the allowed pipe size or divide the pipe system up, into two or more calculations.
Relative flooding discharge target level exceeded.		
Unable to Calculation.	Self-explanatory	Most likely a problem with the Octave calculations program. Contact Fire Eater A/S, Denmark

Warnings:		
Cylinder mass flow rates are not identical.	**Only applicable in "as-built" systems. All cylinders are defined to be emptied in same period. If orifices for e.g. two MT5s are set to be different, this warning will occur.**	**Change to "Auto pipe" and re-calculate.**
Components: Non standard, Cylinder, HWV, Discharge valve, Discharge hose, Manifold, Nozzle Pipe not connected to Nozzle or Manifold	**A connection is missing somewhere in the isometric.**	**Re-draw the isometric.**
Discharge time: Exceed min or max discharge time	**Self-explanatory**	**IMT UL2 is not able to calculation the system data in the defined discharge time. Redesign the pipe system or try to design with two or more pipe systems.**
Discharge time: Exceed max discharge time for standard	**Self-explanatory**	**IMT UL2 is not able to calculation the system data in the defined discharge time. Redesign the pipe system or try to design with two or more pipe systems.**

Discharge time target: Higher than 95% of the actual conc	A fixed level of 95% is set in the IMT program.	Lower the discharge time target to 95% or less.
Manifold orifice: Exceed max per manifold, per cylinder	The manifold orifice can be drilled to a size of 17.9mm	Add more manifolds
Pipe working pressure: Safety factor less than 1, exceeding standard working pressure, using customized fittings	Information regarding the system is using a customized working pressure.	Change custom working pressure in the “Setup calculation basis”.
Pipe volume: Exceed cylinder to pipe volume ratio.	Self-explanatory	The total pipe volume must not excess the total cylinder volume by more than 10%. Decrease the pipe length or add cylinders to the system.
Pipe length: Exceed max length.	Self-explanatory	Decrease the total pipe length to less than 300m
Pipe Mach number: Exceed.	Only applicable in “as-built” systems. The maximum Mach is 0.40	Re-calculate the system in “Auto”.
Pipe Tee split ratio: Exceed 10/90-90/10-10/90.	Minimum 10% of gas must leave one	Re-draw the isometric.

	output from a tee.	
Pipe RE-number: Too low.	Reynolds Number has to do with flow of gas in pipes	Decrease the discharge time, to increase the flow-to-time ratio.
Nozzle orifice: Exceed limits (smaller or larger per nozzle).	Self-explanatory.	Add more nozzles to the pipe system.
Nozzle: Exceed max number of nozzles.	The maximum is 100.	Reduce the number of nozzles
Nozzle pressure variance: Exceed.	Maximum difference from nozzle with lowest pressure to highest must not exceed 100%.	Add one or more nozzles to the pipe system.
Nozzle pressure: Too low.	The pressure at the nozzle must be at least 20 barg.	Remove nozzles from the pipe system, or add more gas, to obtain a higher pressure.
Nozzle missing room designation.	Self-explanatory.	Re-draw isometric system
Nozzle/pipe area ration: Exceeded.	Only applicable in “as-built”. Pipe is too big for designated nozzle.	Change to “Auto”.

Nozzle-pipe undefined nozzle type.	Not applicable	Not applicable
Room missing nozzles.	Self-explanatory.	Ensure that all rooms is covered by nozzles.
Room pressure relief is too small / pressure too high.	Not applicable	Not applicable
Room discharge time exceeds max/min.	According to standard	Make sure the discharge time is according to standard. Usually between 60 and 120 secs.
Cautions:		
Nozzle to pipe area ratio are user defined	Information	Information
Nozzle is smaller than pipe (a reduction will be required)	Self-explanatory	Add a reduction in the part list manually.

Critical output

At the end of the IMT calculation a Calculation report is printed if an error occur that prevents the calculation from being completed it will not be possible to make a print of the calculation.
A list of errors, warnings and cautions if there are any will be printed at the end of the Calculation report.

SW version and Component:

- Hand wheel valve type: HWV Ø8mm type
  Discharge valve type: Ci-IV8 type
- Calculation method: Calculated pipe & orifices
  Calculation time: 12-08-2014 09:50:20
- Vendor: Fire Eater A/S
  Program: IMT 2011 UL
  IMT version: 2.2.0
  Flow design engine: 2014-08-27
  Room design engine: 2014-07-23
- All components used in calculation are UL-FM Class A (or B) approved.
  No errors during calculation.
  No warnings during calculation.
  No cautions during calculation.

Explanations

Errors will indicate that the calculation failed.

Warnings are given when one of the limitations given on the previous page has been exceeded.

Cautions indicate that special precautions are required during installation (Pipe Dn50 to Nozzle Dn15).

Application method

Total flooding is the only approved application method for INERGEN systems designed in accordance with this manual.

Caution:

All calculations are performed at the temperature stated in the IMT program (standard temperature is 21°C). If the temperature at the cylinder storage or the protected enclosure should varies by ± 5.5°C from calculated the calculated design quantity of extinguishing agent may be incorrect.

Calculation method has only been investigated for the pipes and fittings specified in chapter 1 of this manual.

If cautions or warning are printed on the software calculation print out there is a risk that the system will not supply the designed quantity of extinguishing agent at the specific locations.

Design

The following steps must be followed, in the order they are presented, to properly design an INERGEN total flooding system. A simple design example will be used throughout the steps to help understand each step.

Please refer to the datasheet "IMT Software general" for more details on specific functions.

STEP NO.1 - Determine the hazard area volume(s)

The first step in the design of a system is to calculate the volume of each area to be protected.

Multiply the length by the width to determine the area, and then multiply the area by the height to determine the volume for each hazard area.

If any area is an odd shape, the designer may need to divide it up into regular shapes that will allow volume calculations, and then sum all the volumes to determine the actual volume of that area. If the irregular shape might affect distribution of the agent, it may be best to calculate sections of the hazard area as separate areas and include nozzles for each of these areas.

If the ceiling height exceeds the maximum allowable ceiling height as defined in the General Information Section of this manual, multiple levels of nozzles must be designed into the system.

Complete this step for each area protected by the system.

Example:

Server room:	125m^3
Length:	10.0m
With:	5.0m
Height:	2.5m
Subfloor	40.0m^3
Length:	10.0m
With:	5.0m
Height:	0.8m

STEP NO.2 - Determine volume reductions

The volume of solid objects in each hazard area that are not removable can be deducted from the volume of the hazard. This volume may include columns, beams, cut-out room sections, closets that will always be closed, ducts that pass completely through the area without any openings, and any other large, permanently fixed objects that cannot be removed from the hazard enclosure. Calculate the volume of all such objects and add them together to determine the amount of space to be deducted from the volume. Complete this step for each enclosure protected by the system.

Example:

Server room:

Columns: 0.6m x 0.6m x 2.5m x 3 columns = 2.7m^3

Subfloor:

Columns: 0.6m x 0.6m x 0.8m x 3 columns = 0.8m^3

STEP NO.3 - Calculate Reduced Volume

Subtract the volume of solid, permanent objects (Step No. 2) from each of the hazard areas' volumes (Step No.1). The result is considered to be the reduced volume for the enclosure.

Room volume - solid object volume = reduced volume

Complete this step for each area protected by the system.

Example:

Server room:

125m^3 – 2.7m^3 = 122.3m^3

Subfloor:

40m^3 – 0.8m^3 = 39.2m^3

STEP NO.4 - Determine minimum design concentration

The Minimum Design Concentration (MDC) is determined by which hazard being protected and which rules applies. A list of MDC can be found in this manual ch4 under “Design Concentration”.

The Minimum Design Concentration is determined by the hazard present in the protected enclosure which requires the highest MDC.

STEP NO.5 – Specify INERGEN concentrations

Choosing the INERGEN quantity method:

Design Concentration: Enter the minimum design concentration in accordance with Step No 4.

As an alternative the concentration can also be given as Flooding or Oxygen Concentration

If design safety factors other than temperature and room pressure are to be applied (Tee factor and others) these must be included in above specified concentration.

STEP NO.6 – Specify room temperature and room pressure

Enter Room temperature and room pressure (choose appropriate unit)

The design quantity of agent shall be adjusted to compensate for ambient pressure that vary more than 11% (equivalent to approximately 915m [3000ft] of elevation change) from standard sea level pressures (760mm Hg at 0°C [29.92 in. Hg at 70°F])

STEP NO.7 – Specify cylinder type

Choose cylinder type, filling specification and storage conditions for the cylinders.

Standard filling pressure is 200 or 300 bar @ 15°C. typical storage temperature is 21°C.

STEP NO.8 – Calculate quantity of INERGEN

By pressing the button “Calculate” IMT will calculate, the required quantities of INERGEN cylinders, the total INERGEN mass, Flooding, Actual concentration, Oxygen conc and CO2 concentration.

STEP NO.9 – Verify Actual concentration

Check that the Oxygen concentration is above NEL or LEL also at the minimum operating temperature.

Provisions to limit exposure to below specified must be provided.

The ΔT is giving the corresponding oxygen concentration with respectively 10 and 20 °C difference from the calculated.

Oxygen	Oxygen ΔT = 10°C	Oxygen ΔT = 20°C	Max exposure (minutes)
12.0%	12.2%	12.4%	5
10.1%	10.3%	10.5%	3
8.0%	8.3%	8.5%	0.5

STEP NO. 10 - Determine nozzle quantity

Nozzle quantity will be determined by many factors, such as size and shape of the hazard area, height of the ceiling, etc.
To determine the quantity of nozzles required.
Land systems:
divide the room length by 7.32m (max inter-nozzle distance) and round up to the next whole number.
Then divide the room width by 7.32m and round up to the next whole number.
Then, multiply the two answers to determine the total nozzle quantity.
Marine systems:
Use 8.0m instead of 7.32m

Complete this step for each area protected by the system.

360° NOZZLE REQUIREMENTS:

Maximum coverage length per nozzle (radial distance): 5.18m.
Above distance should not be exceeded from the nozzle to the farthest point.

The radial distance is defined as the distance from the nozzle to the farthest point of the area protected. Nozzle should be placed as close to the center of the hazard area as possible. On multiple nozzle systems, the nozzles should be as equally spaced as possible.

Nozzle limitations

- Maximum nozzle height above floor level for a single row of nozzles
  Land systems (Mono-orifice): 4.7m.
  Marine systems (MED nozzle): 6.0m
  For ceiling heights over above limits, additional row (s) of nozzles is required.
- Minimum clearance in front of nozzle: 0.1m.
  Minimum clearance behind nozzle: 0.0m.
- Minimum protected area height is 0.3m.
- For multiple level hazard areas, the intermediate levels of nozzles must be positioned at the top of the designed height for each intermediate level. Nozzles mounted at the ceiling must be within 1.0m of the ceiling.
- If noise level is a concern additional nozzles may be used to reduce the noise level and the Silencer should be installed, consult datasheet for recommendation regarding performance. The Silencer is NOT FM approved (see section regarding Nozzle and silencer)
- If the room is an odd shape, the designer may wish to increase the nozzle quantity to provide a more even distribution of the agent.

STEP NO. 11 – Designing the pipe system

Draw the pipe system in the “Isometric design”

Add manifold quantities and specifications.

Pipe ends are always in a nozzle, covered room volume for each nozzle is entered.

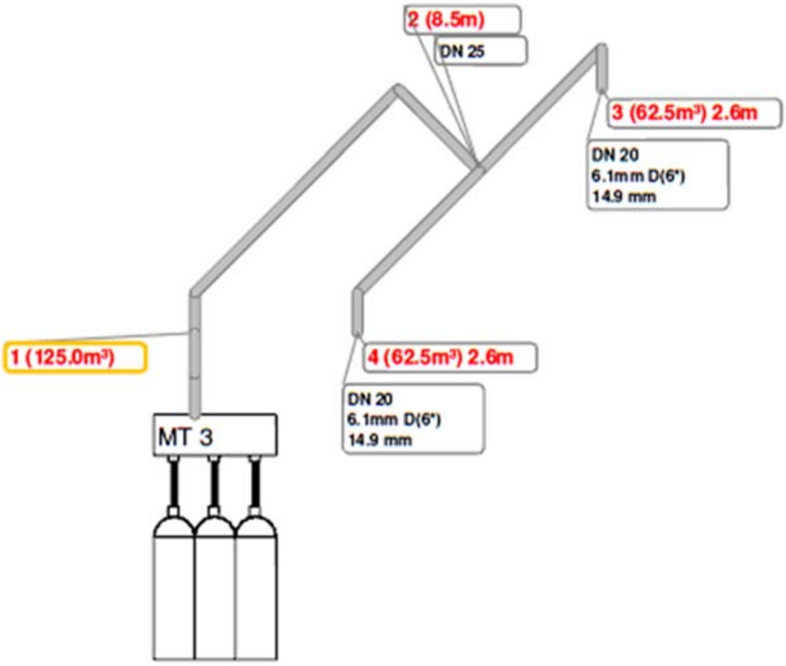
Only the flow path of INERGEN is included in the calculation, dirt-traps may be placed at last nozzle without affecting the calculation weather or not it is included in the design.

STEP NO. 12 - Determine nozzles locations

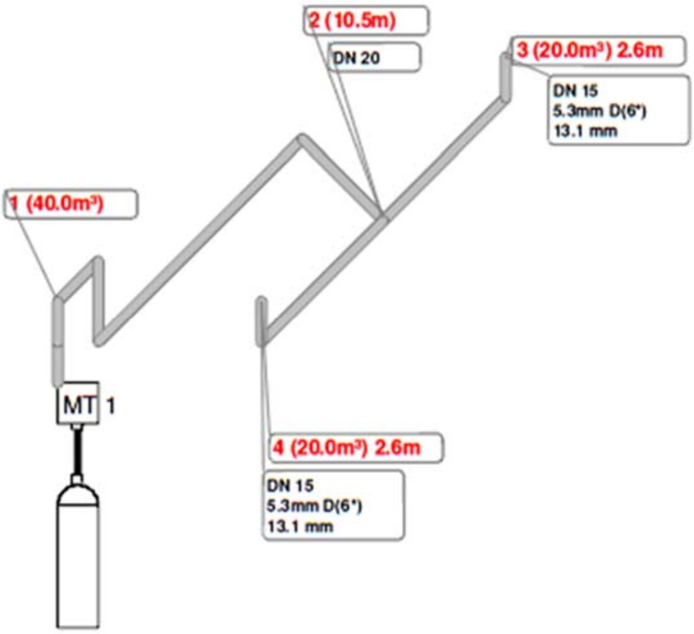
Using a plan view drawing of the protected areas, locate each nozzle and the cylinders. Then complete an isometric sketch using the IMT software as represented below, indicating the length of each pipe section.

NOTE:

- Nozzles should be placed as far from pressure vents as practically possible.
  Typically placed in the upper part of the hazard area, directed away from structures or object which could disturb the flow of INERGEN.
- Nozzles should be placed as evenly as possible within the protected area.
- A radial distance of minimum 0.5m from side of the nozzle must be clear to avoid damage to the structure.
  If placed closer deflectors should be used.



Computer room



Sub floor

STEP NO. 13 – Pipe system calculation
Go to the "Pipesystem" design" and choose the setup calculations Basics

Preferences like max pipe size are entered.

Discharge goal should be 95% of the minimum design concentration, and the time should be 120sec.

Authority can be UL or FM.

Import the pipe system by pushing the button "Isometri"
The table contain the pipe system parameters are filled

STEP NO. 14 – Calculate required area for pressure venting
Based on the discharge time and agent volume the mass flow is calculated by IMT and the required pressure relief area is calculated

The formula below are used to calculate the pressure relief opening area.
For more detail, consult CEA 4008.

$$A = \frac{M * V_g}{\sqrt{\Delta p * V_{bl}}} * \sqrt{\frac{C_1}{2}}$$

$$V_{bl} = (1-x) * V_{air} + x * V_g$$

A: Pressure relief opening area; m^2
M: Mass flow of extinguishing agent; kg/s at t=0
(convert the flow from step 14, using the table below)
V_{bl}: Specific volume of blend; m^3/kg
(calculate using values from step 13 and table below)
V_g: Specific volume of extinguishing gas; m^3/kg
V_{air}: Specific volume of atmospheric air; m^3/kg
Δp: Allowed pressure rise in the protected area; Pa
(if Δp is unknown, use 500 Pa. This is considered a light construction and will generate a larger opening than might be required)
C_1: Resistance value for pressure relief opening
C_1=2 for openings with high flow resistance
x: Extinguishing concentration; m^3 agent/m^3 protected area

Temperature (°C)	V_{air}	$V_{g.\ INERGEN}$
-10	0.749	0.625
0	0.777	0.649
10	0.806	0.673
20	0.834	0.696
30	0.862	0.720
40	0.891	0.743

Specific volumes of air and Inergen at standard pressure

STEP NO. 15 - Create a bill of materials
Use the IMT program to generate a list of all materials and parts necessary to install the system.

STEP NO. 16 - Create installation drawings
The final step in the design of an INERGEN system is completion of installation drawings for submission to the appropriate authority and the customer. These drawings should include all details necessary for installation of this system.

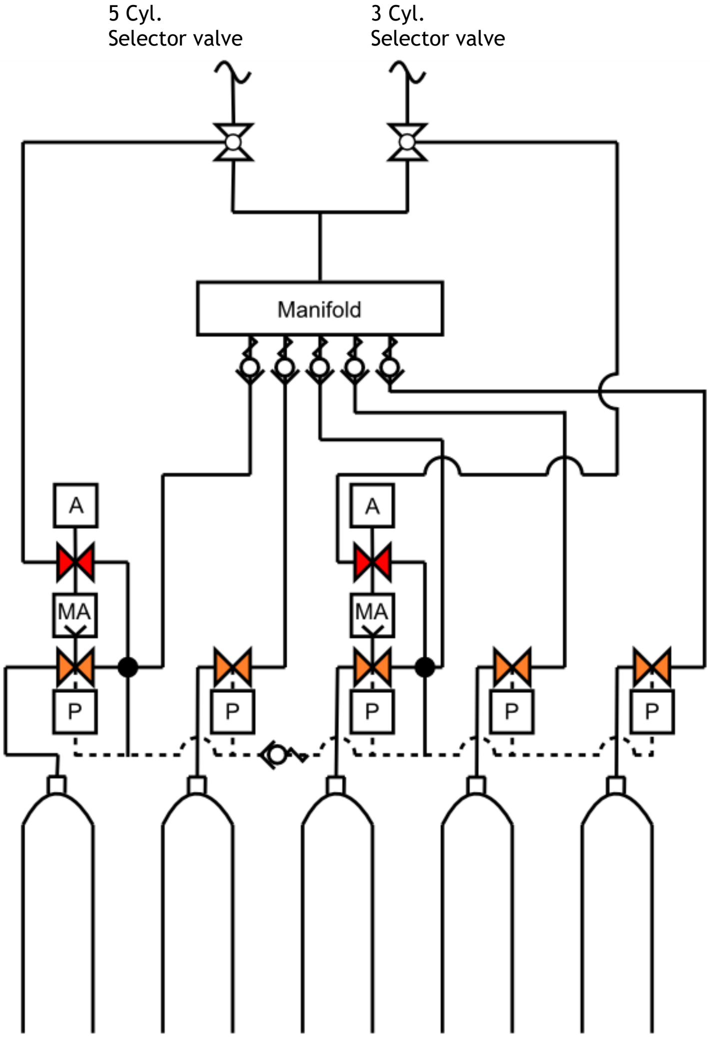
Multizone systems (DV7 and SV valves)

The following information must be considered when designing a selector valve system.

- Selector valve systems should only be used for multi areas where each area is separate fire zone.
- Each hazard area must be calculated as a separate system design.
- Start with the largest system in order to determine the quantity of cylinders required.
- After calculating the largest system, complete additional system calculations.
- Selector valves can be located either upstream or downstream of the pressure reducer.
- The piping located between the pressure reducer and the selector valve must be rated for the system (cylinder) working pressure, respectively 200 or 300 bar [4350 psi] or greater.

The following drawing is an example of a selector valve system.

161



Actuator; can be solenoid, push button or pneumatic

Pneumatic actuator

One way mechanical link between SV CiV and IV8 valve

SV CiV

IV8 valve

SV22 selector valve

Non-return valve / check valve

RESERVE SYSTEM

Normally the authority having jurisdiction will determine whether a hazard requires a reserve set of INERGEN cylinders, either connected or spare.

NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, states: "Where required, the reserve quantity shall be as many multiples of the primary supply as the authority having jurisdiction considers necessary". "Where uninterrupted protection is required, both primary and reserve supply shall be permanently connected to the distribution piping and arranged for easy changeover".

FM Global and IRI (Industrial Risk Insurers) requires the following:

"In high pressure systems an extra full complement of charged cylinders (connected reserve) manifolded and piped to feed into the automatic system should be provided on all installations. The reserve supply is actuated by manual operation of the main/reserve switch on either electrically operated or pneumatically operated systems.

A connected reserve is desirable for several reasons:

- Protection, should reflash occur.

- Protection during impairment when main tanks are being replaced.

- Protection of other hazard areas if selector valves are involved and multiple hazard areas are protected by the same set of cylinders.

- If a full complement of charged cylinders cannot be obtained, or the empty cylinders recharged, delivered and reinstalled within 24 hours, a third complement of fully charged spare cylinders should be maintained on premises for emergency use.
The need for spare cylinders may depend upon whether or not the hazard is under protection of automatic sprinklers".

When designing a system, always determine if, and what kind of, reserve system is required.

NOTE: Usage of reserve systems with primary system may make hazard area unsafe for normal occupancy.

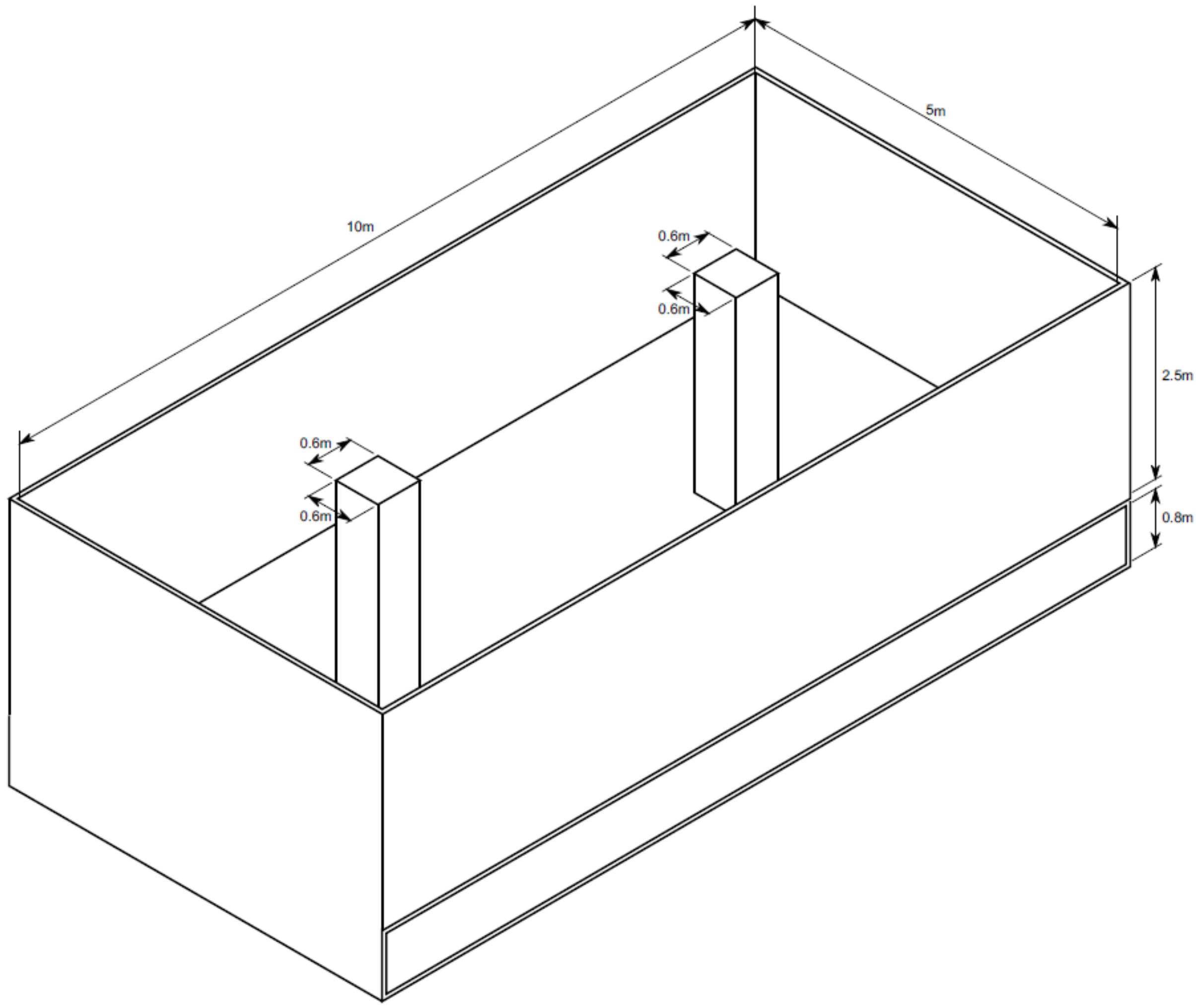
TYPICAL APPLICATION

A server room is here taken as an example for a typical Fire Eater total flooding INERGEN system.

The area consists in the server room itself and a subfloor.

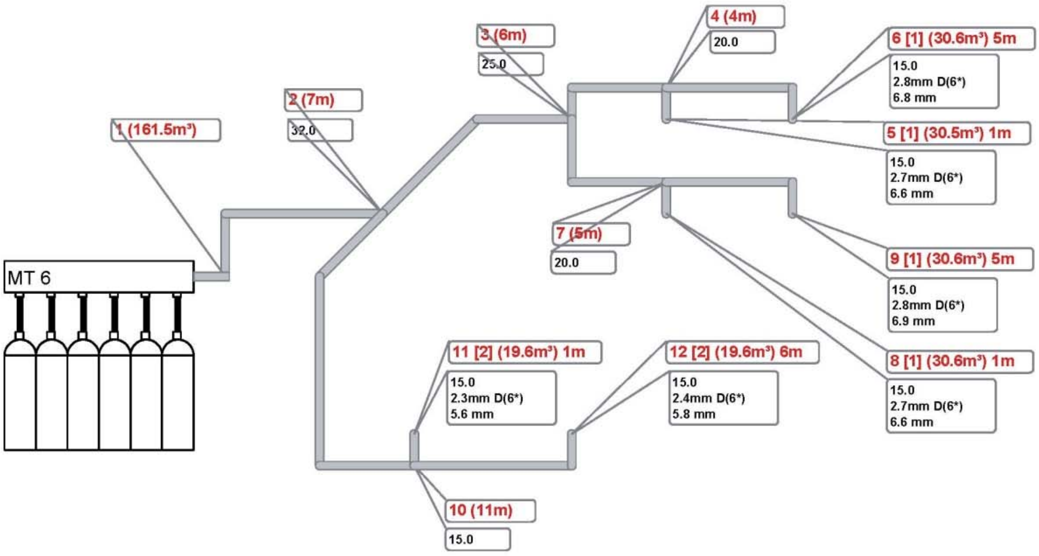
An Inergen system can be used – and the room protected – even when normally occupied. Alarms or warning devices must be located in the protected area and give occupant sufficient annunciation of imminent Inergen discharge.

Area to protect:



IMT output for example:

IMT Isometric drawing



Rev.	Date.	Desciption	Sign.

Project:	Location:	System:
Address:		

	Date	Sign.		
Constr.				Comments:
Approved				
As built				Drawing no.:
Scale			FIRE EATER	Filename:

IMT Calculation
Printout shown on the next pages

IMT V.2.2.0

User	M Kroneder
Printed	12. august 2014 10:30:53 CEST
Filename	CI Manual 2014-08.imt
Company	
Address	
ZIP & City	
Your ref.	
Telephone No.	
Our reference	M Kroneder
Information	

Inergen System Data

Fire Hazard		Flame ext	
Tee Design factor			
Safety factor applied		UL-FM Class A	
Minimum design conc.	40.0 %		

Cylinder Type	Inergen 50L steel cylinder	
Cylinder fill	15.0 C°	300.0 bar
Cylinder Storage	20.0 C°	308.7 bar
Temperature (Room)	20.0 C°	
Atmospheric pressure (Room)	1013.0 mbar	
Pressure relief resistance	2.0	

Room	1	2	3	Total
Name	Room A	Room B		
Volume of room [m^3]	122.3	39.2		161.5
Actual conc. [%]	42.0	42.0		
Flooding [%]	54.5	54.5		
INERGEN [kg]	94.13	30.17		124.30
Final O_2 [%]	12.1	12.1		
Final CO_2 [%]	3.4	3.4		
Max flowrate [kg/sec]	1.9	0.62		2.52
Structural strength [Pa]	1000	1000		
Pressure relief [cm^2]	333.2	108.9		442.1

Cylinder quantity	6	pcs.
Pipe to Cylinder volume	5.6	%

Discharge time	120.0	Sec. to target
Target type	Inergen conc.	
Target	38.0 %	
Pipe type	FE galvanized welded steel pipe EN10220/10217-1 P235TR1.	

User	M Kroneder
Printed	12. august 2014 10:30:53 CEST
Filename	CI Manual 2014-08.imt
Information	

Pipe system

No	N1	N2	Elv	Start	End	Elb	Con	Usr	Noz	Room	L	vol	T	N/P	DN	Pres	Dia	M
MT_no1															32	296.3	7.5	
Pipe																72.2		
1	1	2	2.0	pP	pB	1					7.0	161.5	100.0	22.2	32			0.091
2	2	3		pR	pB	1					6.0		75.7	27.7	25			0.124
3	3	4	1.0	pR	pR	1					4.0		50.0	21.7	20			0.101
4	4	5	-1.0	pB	pP				IN-15	1	1.0	30.5	49.9	19.9	15	62.6	6.6	0.097
5	4	6	-1.0	pR	pP	1			IN-15	1	5.0	30.6	50.1	21.4	15	59.9	6.8	0.104
6	3	7	-2.0	pR	pR	1					5.0		50.0	22.0	20			0.103
7	7	8	-1.0	pB	pP				IN-15	1	1.0	30.6	50.0	20.2	15	62.1	6.6	0.098
8	7	9	-1.0	pR	pP	1			IN-15	1	5.0	30.6	50.0	21.6	15	59.4	6.9	0.105
9	2	10	-6.0	pR	pR	2	1				11.0		24.3	29.7	15			0.142
10	10	11	1.0	pB	pP				IN-15	2	1.0	19.6	50.0	14.4	15	56.6	5.6	0.07
11	10	12	1.0	pR	pP	1			IN-15	2	6.0	19.6	50.0	15.3	15	55.1	5.8	0.074

Volume of pipe system 0.0172 m^3
Min. Pipe working pressure. 76.0 bar

Description

MT: Manifold	
Pipe: Pipe system inlet	
N1, N2 : Nodes start & end	
Elv: Elevation	m
Start: Which kind of fitting is the pipe START connected to	
End: Which kind of fitting is the pipe END connected to	
pP: Plain pipe	
pB: Branch Tee	
pR: Run Tee	
Elb: Fitting Elbow	Qty
Con: Fitting Connector	Qty
Usr: Fitting user defined	Qty
Noz: Nozzle type (IN-15, IN-20, ...)	
Room: Room number 1-3	
L: Length of pipe in meters	m
Vol: Volume of room protected by this pipe.	m^3
T: Tee split rato (pipe inlet/upstream pipe mass flow ratio)	%
N/P: Nozzle to pipe Area ratio	%
Dn: Nominiel pipe size	
Pres: Max pressure in pipe section at outlet	bar
Dia: Diameter of orifice (Nozzle / Manifold)	mm
M: Mach number of gas in pipe	

User	M Kroneder
Printed	12. august 2014 10:30:53 CEST
Filename	CI Manual 2014-08.imt
Information	

Nozzle calibration

Nozzle family : Mono orifice nozzle, maximum working pressure 125 bar.
Thread type : ISO

Node no.	Nozzle name	Nozzle type	Orifice mm^2	Orifice diameter (1 hole)	Drill 6*	Oxygen level	Max nozzle flow rate	total IG-541 mass
			mm^2	mm	mm	O_2 %	kg/s	kg
5	Nozzle1	IN-15	34.0	6.6	2.7	12.1	0.5	23.5
6	Nozzle2	IN-15	36.4	6.8	2.8	12.1	0.5	23.6
8	Nozzle3	IN-15	34.5	6.6	2.7	12.1	0.5	23.6
9	Nozzle4	IN-15	36.9	6.9	2.8	12.1	0.5	23.6
11	Nozzle5	IN-15	24.5	5.6	2.3	12.1	0.3	15.1
12	Nozzle6	IN-15	26.1	5.8	2.4	12.1	0.3	15.1

Orifice

Thread type : ISO

Orifice name	Orifice connections	Orifice diameter (mm)	Orifice type	Hose type
MT_no1	6	7.5	Ci-MTX manifold	Hose DN10-400 2.0m to 4.0m

Calibration QA :____________________________________ Date :______________

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Filename	CI Manual 2014-08.imt
Information	

Oxygen VS time

	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	
Time	4.9	10.7	17.8	26.3	36.8	49.9	67.0	91.1	132.1	172.3	**Sec.**
Room A	19.8	18.8	17.8	16.9	16.0	15.1	14.3	13.6	12.8	12.5	**% O_2**
Room B	19.8	18.8	17.8	16.9	16.0	15.1	14.3	13.6	12.8	12.5	**% O_2**

Room 1

Room 2

Calculation report

Hand wheel valve type: HWV Ø8mm type
Discharge valve type: Ci-IV8 type

Calculation method: Calculated pipe & orifices
Calculation time: 12-08-2014 10:30:53

Vendor: Fire Eater A/S
Program: IMT 2011 UL
IMT version: 2.2.0
Flow design engine: 2014-08-27
Room design engine: 2014-07-23

All components used in calculation are UL-FM Class A approved.
No errors during calculation.
No warnings during calculation.
No cautions during calculation.

Chapter 6: Installation

General

All installations are to be performed in accordance with the parameters of this manual and all appropriate codes and standards from the authority having jurisdiction.

Before the INERGEN system is installed, the qualified installer should develop installation drawings in order to locate the equipment, to determine an actuation and distribution piping routing, and to develop a bill of material.

For successful system performance, the INERGEN system components must be located within their approved temperature ranges.

Only certified personnel should install Fire Eater INERGEN systems.
Fire Eater Document INMON001 must be observed when handling pressurized cylinders.

Planning

The order in which the different parts are installed must be planned prior to the installation to avoid any dangerous situation which could arise in case of accidental activation of the extinguishing system.

Order in which the parts should be installed.

1. Distribution pipe-system
   Cylinders
   Manifold and Orifice
   Room pressure reliefs.
   Actuation circuitry (electrical and/or pneumatic)
   Detection system
   Control panels
   Alarm and Indicators
2. Nozzles
3. Discharge valves (pressurized for integrity test)
   Discharge hoses
4. Discharge valve accessories and actuators
5. Signs and labels
6. Open and Seal Hand wheel valves

Mounting of components

Cylinders & Cylinder rails & Brackets [01 + 02]

INERGEN cylinders may be located inside or outside the protected space, although it is preferable to locate them outside of the space. They must not be located where they will be exposed to a fire or explosion in the hazard. When they are installed within the space they protect, a remote manual control must be installed to release the system safely from outside the hazard area.

The cylinders should be installed so that they can be easily removed after use for recharging. Cylinders should be installed indoors; if located outdoors, cylinders must be protected using appropriate weather protection. Do not install the cylinders where they are exposed to direct sun. Cylinders may be installed horizontally or vertically. They should not be installed with the valve pointing downward as the valve could be blocked in case of dirt inside the cylinders.

Both steel brackets and wooden brackets are available.

For land bases system with standing (vertical) cylinders, minimum 1 rail/bracket set for each cylinder is required.
For Marine, Offshore and installations where vibrations and/or earthquakes may occure, or when discharge nozzles are fitted directly to the cylinder, minimum 2 cylinder brackets per cylinder are required.

Mount each INERGEN cylinder by completing the following:

CAUTION

Do not remove the safety shipping caps at this time. They are provided to prevent accidental actuation and discharge during shipping and handling. If valve assembly is accidentally operated, the velocity of the unrestricted escaping gas is powerful enough to cause injury, especially to the face and the head.

- Assemble bracket components.
- If a reserve system is being installed, mount the reserve cylinder(s) directly next to the main system cylinder(s).

CAUTION

Proper fasteners must be used when mounting cylinder bracketing to wall or support. Failure to properly mount could cause cylinder movement upon discharge.

- Securely mount bracketing to rigid wall or support.
- Fasten cylinder(s) securely in bracketing.

Figure 1 (single row)
01 & 02 INERGEN cylinder and brackets. See “Control Inert System description” for item numbers.

A. Cylinder rail is available in different length
The rail is fastened to the wall, drilling holes in the rail to accomplish installation is required
Use 1 screw + 1 nut per cylinder.
Screws must be minimum ø6mm and must be evenly distributed throughout the length of the rail.

B. Place the cylinder in front of the rail (Valve cap must be on the cylinder

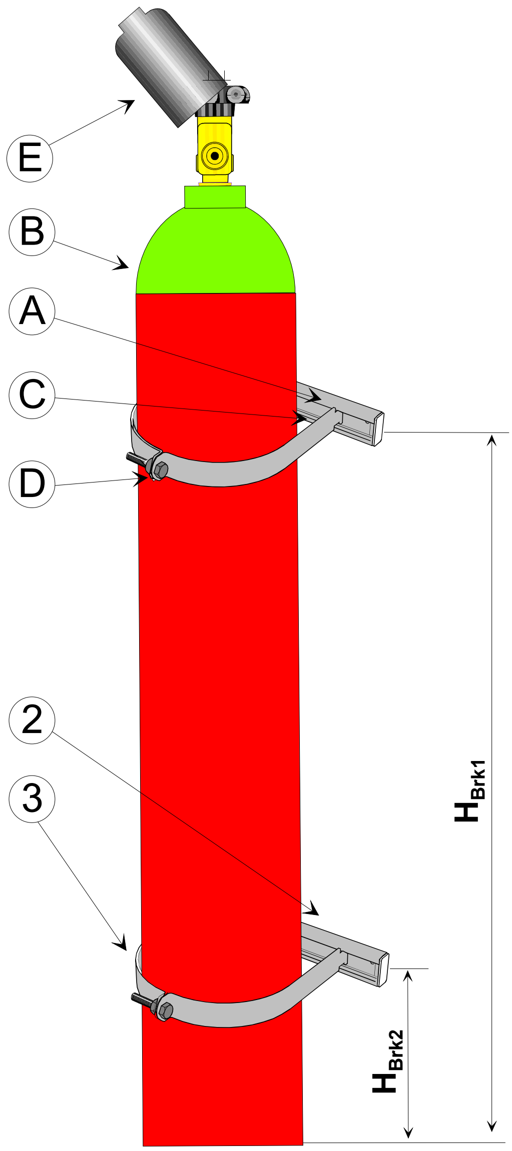
C. Cylinder bracket
Turn 45° and insert in slot of cylinder rail
One part on each side of the cylinder.

D. M10 bolt (included with cylinder bracket)
The bolt is inserted through the eye in the bracket and tightened to app 10Nm

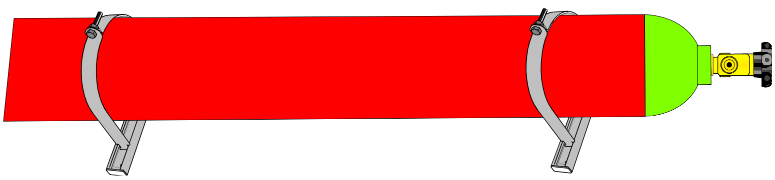
E. Remove the valve protection cap
Rotate the cylinder so that the valve outlet is pointing straight forward (if nessecary loosen the M10 bolt slightly).
Tighten the bolt and nut on the brackets

F. When 2 pairs of brackets are used, the lower bracket is mounted 200mm from the foot of the cylinder. The height of the top brackets (Hbrk1) depends on the size of the cylinder and is given in the table below.

Cylinder size	$H_{bracket}$
140 litre	1400
80 litre	1400
50 litre	1200
30 litre	700



Cylinders positioned laying down should be fixed with 2 brackets

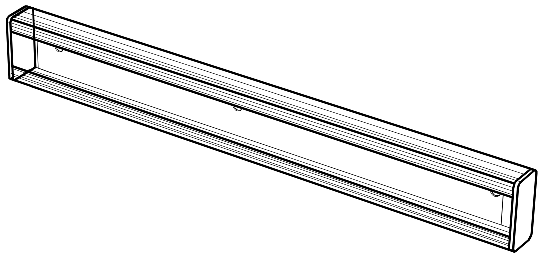


The rail

The rail is fixed to the wall by using screws compatible with the wall to which is attached.

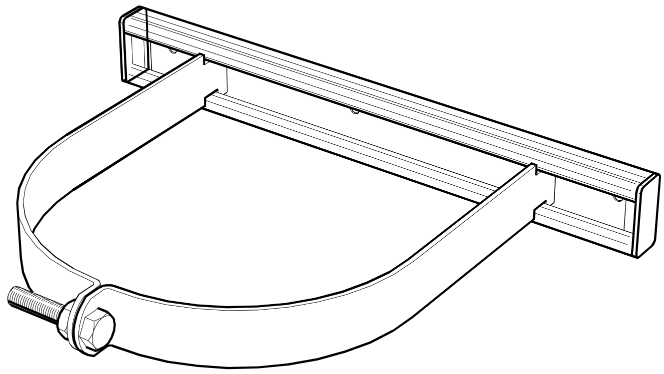
If the wall has insufficient strength to support the cylinders it is necessary to erect a frame to hold the cylinder rail.

The rail may also be welded to the fixture.



The Brackets

Simultaneously with the cylinder installation the brackets are placed in the rail by inserting and twisting them 45°. Notice that the brackets are still free to move from side to side until the bolt in front of the cylinder is tightened.



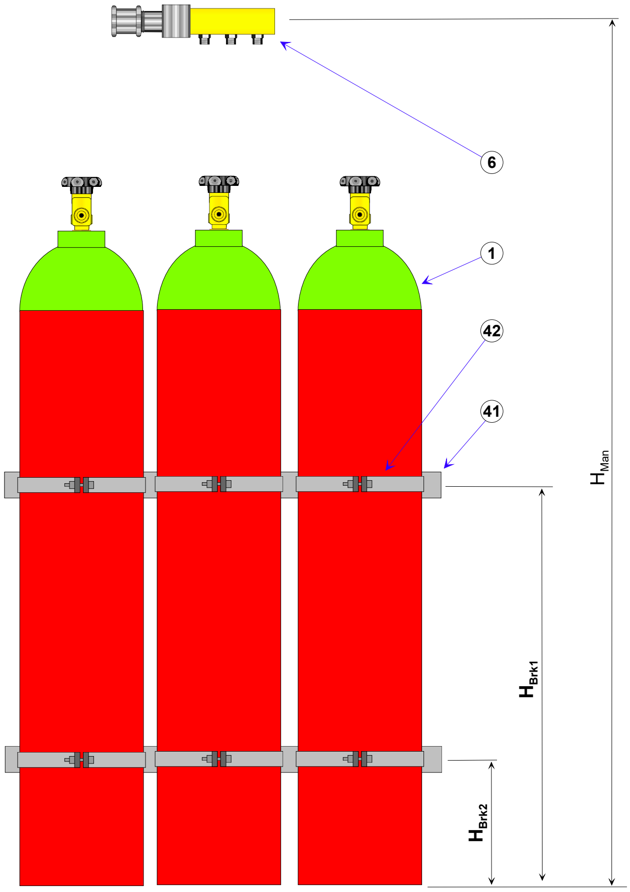
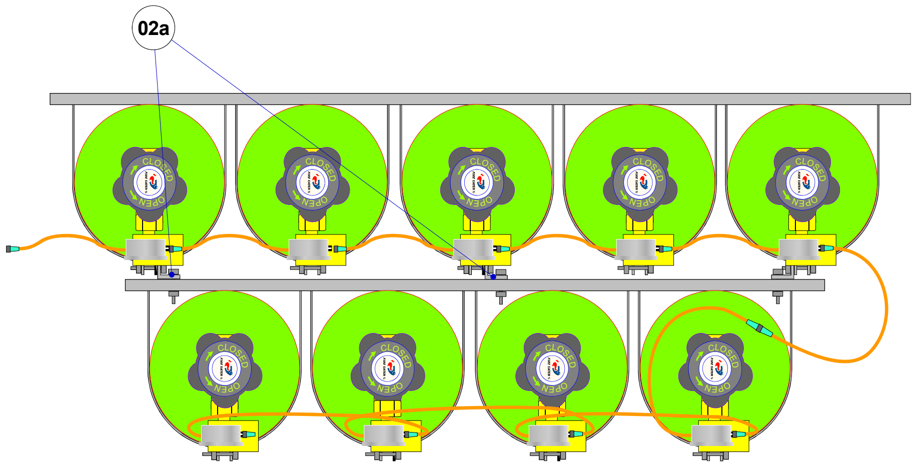


Figure 2 (multiple row)
Same rail and brackets as for single row are used. Additional rails are fastened to the first by using item 400123 bracket (Elbow)

G. Bracket (Elbow) Item 400123
One elbow + one elbow per 2 cylinder is required.
The M10 bolt from the brackets of the previous row of cylinder are unscrewed and put through the hole in the elbow and then fastened to the cylinder bracket.

H. M10 bolt (included with bracket)
The bolt is inserted in the other hole in the elbow and used for fastening the next cylinder rail (hole drilling in rail is required).



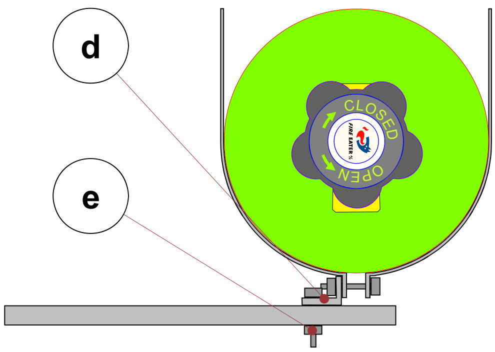


Figure 3 (wooden beams)
Wooden beams can also be used to support cylinders in vertical as well as horizontal position.
The wooden beams provide better support for the cylinders and should be used if cylinders are stacked laying down.

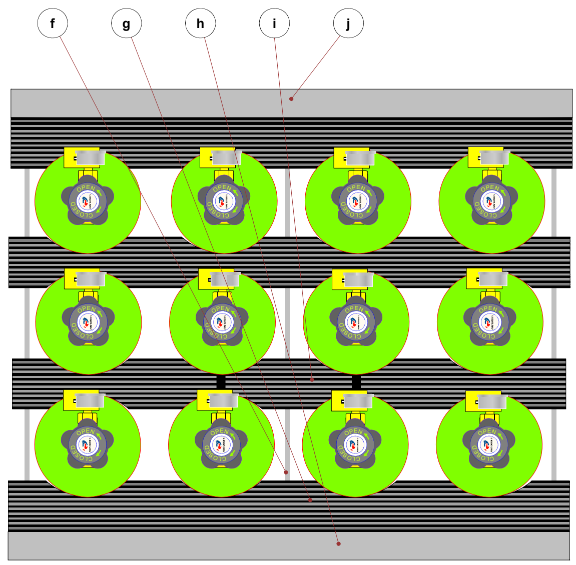
I. M12 threaded rod (Stainless) (f)
The rod is inserted through the center hole on the steel base and the wooden outer beam (g +h)

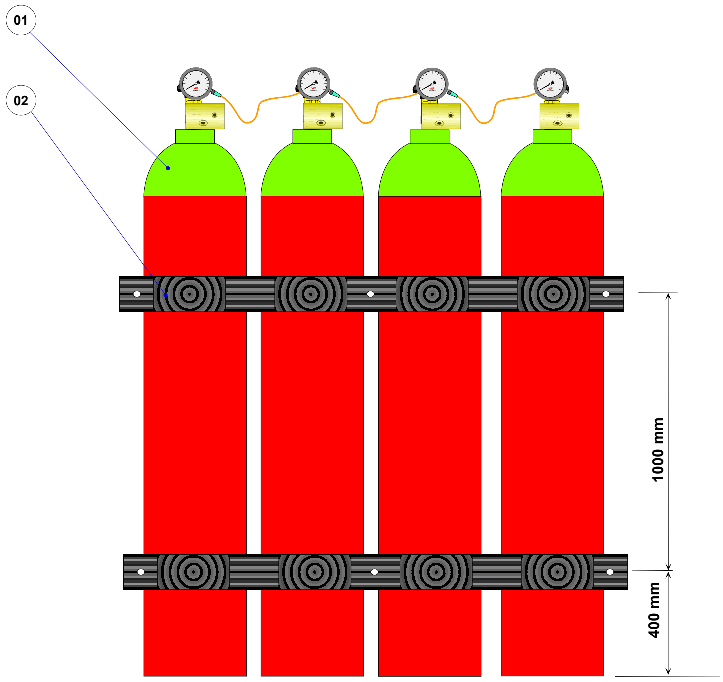
J. Rack Outer beam (g)
This is keeping the cylinder in place so it does not roll

K. Rack Bottom U-profile (h)
Is supporting the wooden beam

L. Rack Cross beam (i)
The rack cross beam is being placed on to of one layer of cylinders so that the next layer of cylinders can be added.

M. M12 Nut, M12 washers
Washeres and nuts must be fitted to the threaded rod.
It is important that the washers and nuts are placed at the bottom of the center rod before cylinders are layed down, as it will not be accessible afterwards.





Discharge valve accessories [12]

DV7

If a cylinder is to be fitted with more than one discharge valve, or other outlets are required an adapter (DV7) can be fitted, allowing for installation of 2 or 3 discharge valves per cylinder. This way up to 3 separate hazards can be protected from a single cylinder.

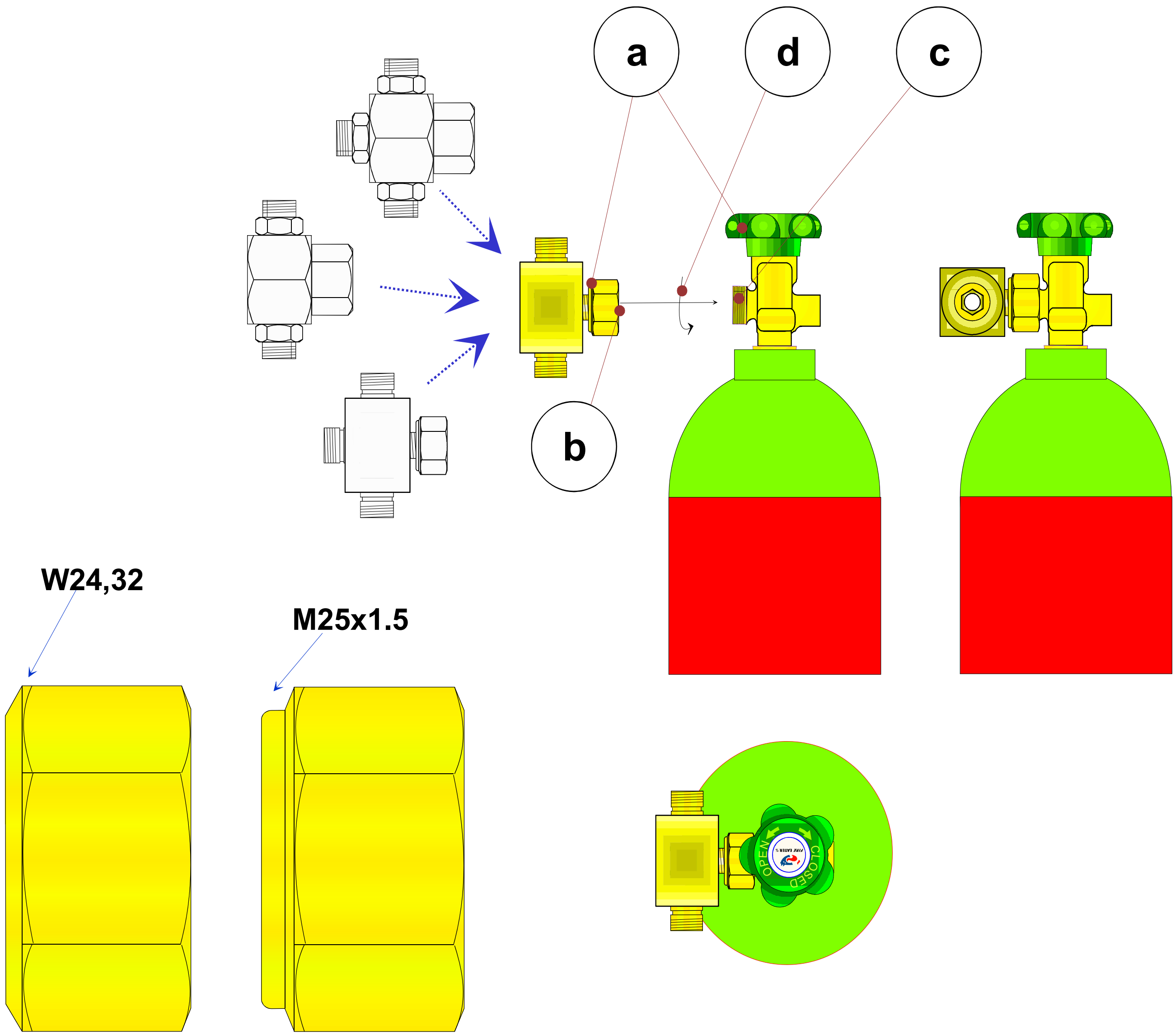
To install a DV7

A. Verify that the thread is correct
   300 bar = M25×1.5 = Green Hand wheel = Round edge (not chamfered)
   200 bar = W24.32 = Black Hand wheel = Chamfered edge

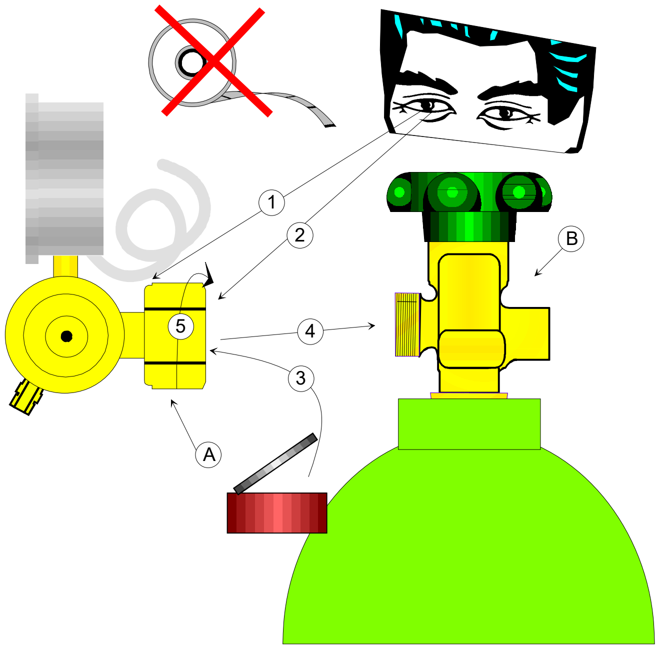
B. Make sure sealing surfaces are clean and well lubricated
   Apply additional O-ring lubricant

C. Place the DV7 on the valve outlet

D. Tighten the union nut by hand until O-ring reaches the valve outlet surface (tightening becomes hard - suddenly)
   A slow increase in tightening torque indicate that there is something wrong
   Tighten to approx 100Nm (max 1/8 turn).



Ci IV8 installation



Do not apply PTFE tape or any other thread sealant on the connecting thread.

Remove the plug from the valve inlet

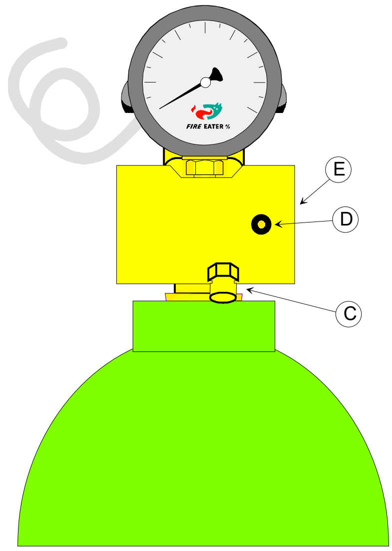
1. Check that nut matches the thread on the hand wheel valve.
   M25/300bar is identified by a green hand wheel and rounded edge on the nut.
   W24/200bar is identified by a black hand wheel and a 45° chamfer on the nut.
2. Inspect the O-ring. Ensure that it is clean and placed in its groove.
3. Apply some O-ring lubricant if nessecary.
4. Attach the IV8 to the hand wheel valve by simply screwing it on.
5. Tighten to approx 100Nm (max 1/8 turn)
   Use a 32mm spanner.

Ports of the discharge valve.

C: Discharge outlet 3/8” iso228 (bspp).
  This port is connected with a hose to the manifold, or directly to a nozzle through an adapter (orifice).
  When valve is activated INERGEN is discharged through this port.
  This is also used for backpressure activation on slave valves.

D: Pneumatic activation outlet and inlet.
  All equipment connected here MUST be rated for the same working pressure as the cylinder.
  If backpressure is disabled (Non-return valve in manifold eg.) this port is used for pneumatic activation.

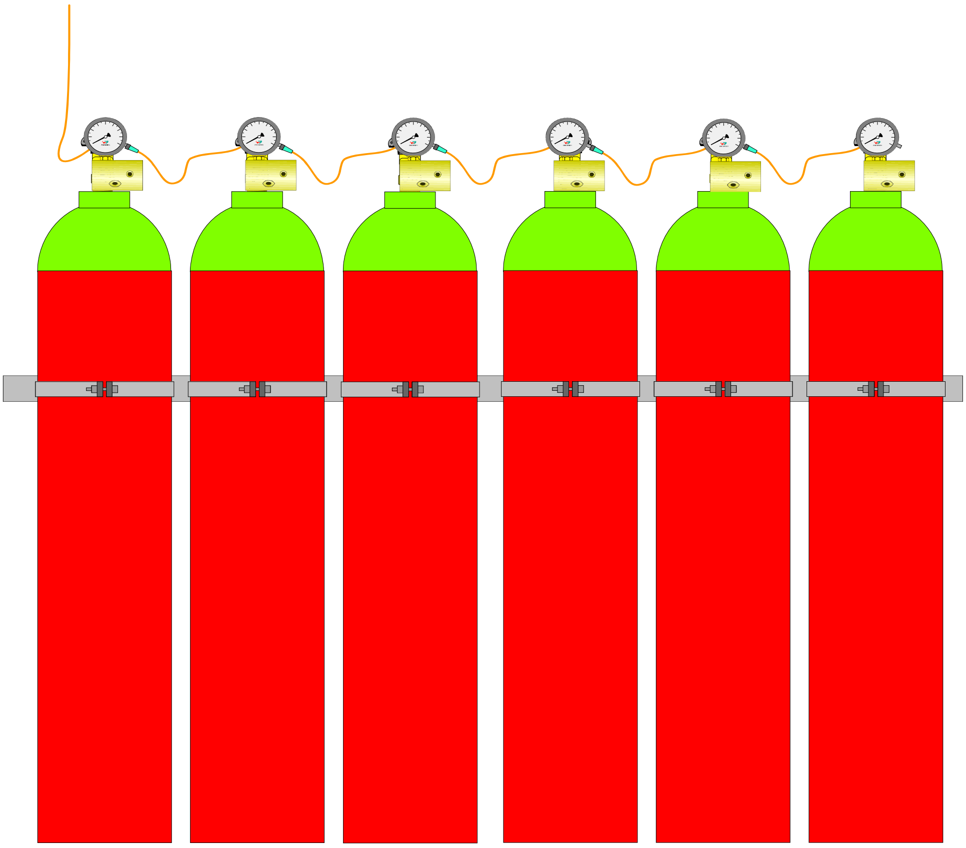
E: Actuator connection
  Actuators are only installed on the master cylinder.



Other valves
Proceed with connecting the discharge valves until all each cylinder has one.

DO NOT pressurize the valves at this stage, as a discharge hose must be installed first.

Pressure monitoring
The manoswitches are connected in a daisy chain and fitted with a end-of-line resistor to suit the control panel.



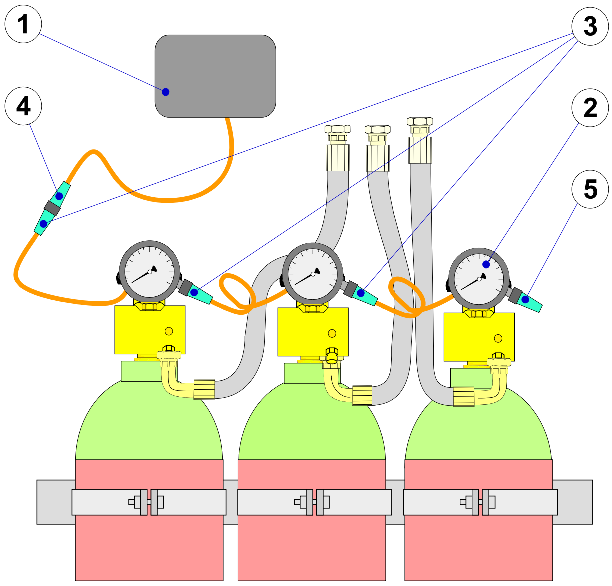
Cylinder pressure monitoring

The pressure switches are part of the standard Ci IV8 valve and feature a change-over switch enabling the switches to be connected in a daisy-chain with proper end of line resistors.

The cable from each manoswitch is connected to the plug on the next manoswitch.

To plug in the M8 connector

1. Make sure the connectors are clean
2. Align the male and the female connector
3. Rotate one of the connectors to align the pins with the sockets
4. Gently push the plug on, if necessary rotate careful to align pins
5. When connector is pushed in, start rotating the nut on the cable end
6. Tighten to approx 0.2Nm



Actuators [21]

General

The Ci IV8 is activated either by an actuator, the built-in Pneumatic actuator or by backpressure (outlet to manifold).
Different types of actuators are available depending on the requirements of the system design.

At least one actuator must be used on each system (zone being protected).
When using the Ci MT manifold (special check valves) all cylinders are activated by back-pressure from the Master cylinder (the one the actuator is placed on).
When using SV MT manifold (Non-return valves that disable the backpressure function), the built-in Pneumatic activated must be used (use the SV next kit, or PA kit).

For SV multi-zone the SV CiV valve is installed on the Master cylinder before installing the actuator.

CAUTION

Make sure that the actuator is reset before installing it on the discharge valve. Failure to do so will cause system activation. DO NOT install/connect actuators before cylinders are secured and discharge hoses are fitted.

Ensure all electric power from the panel to the actuator has been disconnected.
Failure to disconnect power may cause system to accidentally discharge.

Before installing an actuator, it must be inspected to verify that it has not been activated (plunger must be below end surface of the actuator). If it has been activated see “maintenance” for resetting.

Actuators can be fitted to any of the cylinders in a system. The cylinder with the actuator will be designated “Master Cylinder”. The remaining cylinders which are activated by the manifold pressure will be referred to as “Slave Cylinders”.

More than one actuator may be installed on the same system.

Built-in Pneumatic actuator

To connect the built-in pneumatic actuator, the 1/8 plug must be unscrewed from the valve body and the Tee from the PA kit is installed, the Dn6 hose are connected between the Tee’s. The ends of the PA line are fitted with Bleed fittings which prevents undesired pressure buildup.

Manual Actuator

The actuator is screwed into the Ci IV8 valve mechanical connection and tightened by hand (10Nm).

The two set screws are loosened and the knob is rotated so the safety pin is in a convenient position. Only loosen the set screws! The two set screws must be tightened again, do not use excessive torque!

Pneumatic Actuator

The actuator is screwed into the IV8 valve mechanical connection until it reaches the stop, then it is turned back so that one of the inlet connections (1/8” ISO7) is in a proper position, it should never be turned more than 1/2 turn back.
A hose or tube must be connected to at least one inlet connection, to avoid accidental unscrewing due to vibrations.

After installing the PA8 Pneumatic Actuator, one additional actuator may be installed on the PA8.

Solenoid actuator

Before installing an electrical actuator the actuator attachment switch must be installed on the Master cylinder in order to comply with NFPA 2001 4.3.4

The actuator is screwed into the IV8 valve mechanical connection and tightened by hand (10Nm).

The M12-4 electrical connection are connected to the junction box or directly to control panel.

Ci IS8 NFPA switch:

The Ci IS8 NFPA switch can be connected to the control panel in 3 ways. (a is the recommend way of connecting the monitoring switch)

a. To the Low pressure monitoring switch
When the actuator is removed from the Master valve/cylinder the control panel will indicate “Flooding Zone Fault.

b. To the Fault input signal
When the actuator is removed a general fault will be indicated

c. To separate set of lamps indicating whether the actuator is attached or if it has been removed.

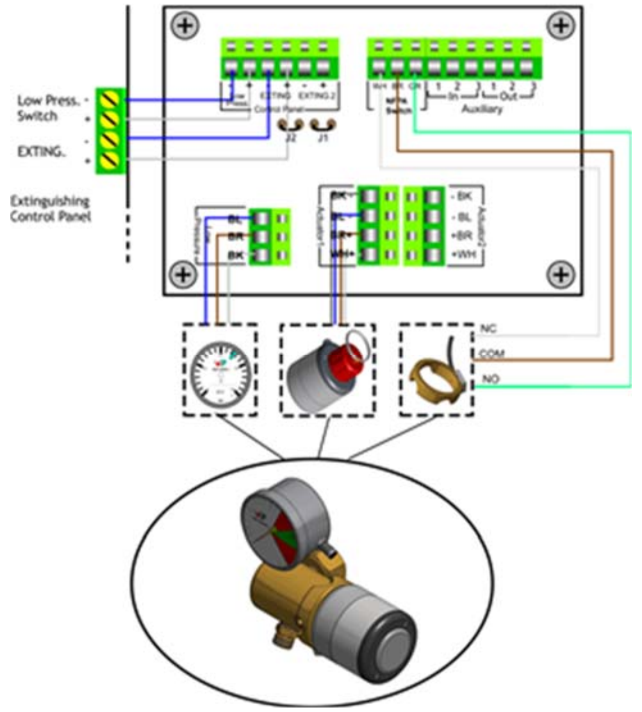


Diagram a.

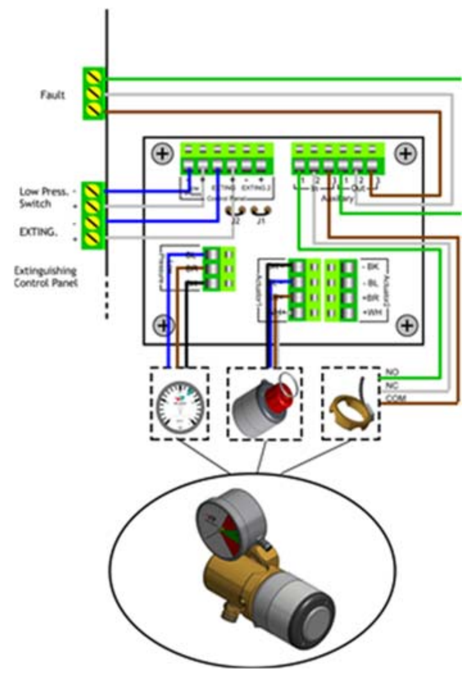


Diagram b.

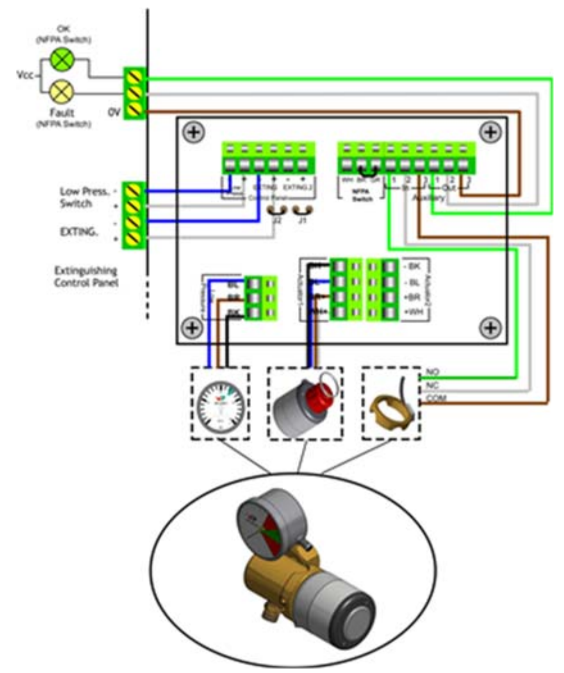


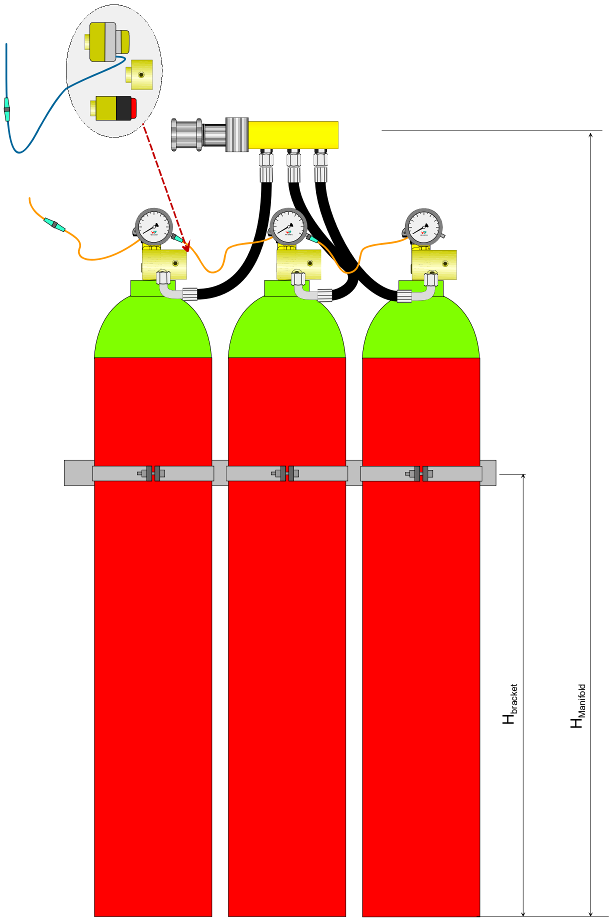
Diagram c.

Ci IS8 wire code:

1: Brown	+Ve
2: White	+Ve
3: Black	-Ve
4: Blue	-Ve

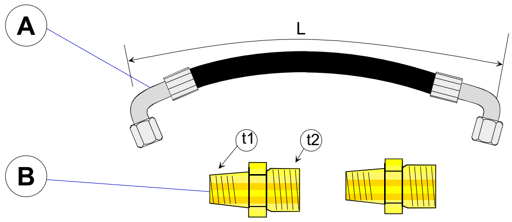
Ci IS8 NFPA switch:

1: Brown	Common
2: White	Closed with Actuator removed
4: Green	Closed with Actuator attached



Ci MT Next kit

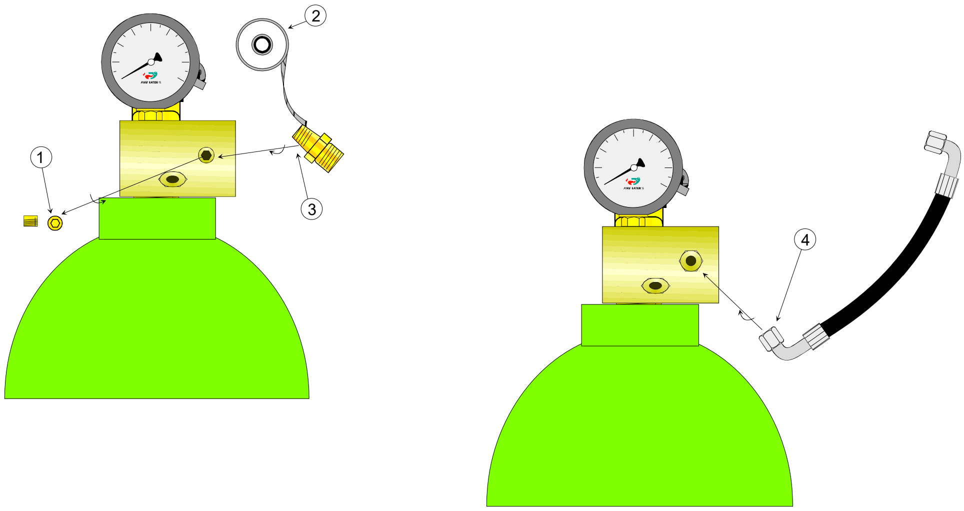
Attaching Actuators to discharge valve

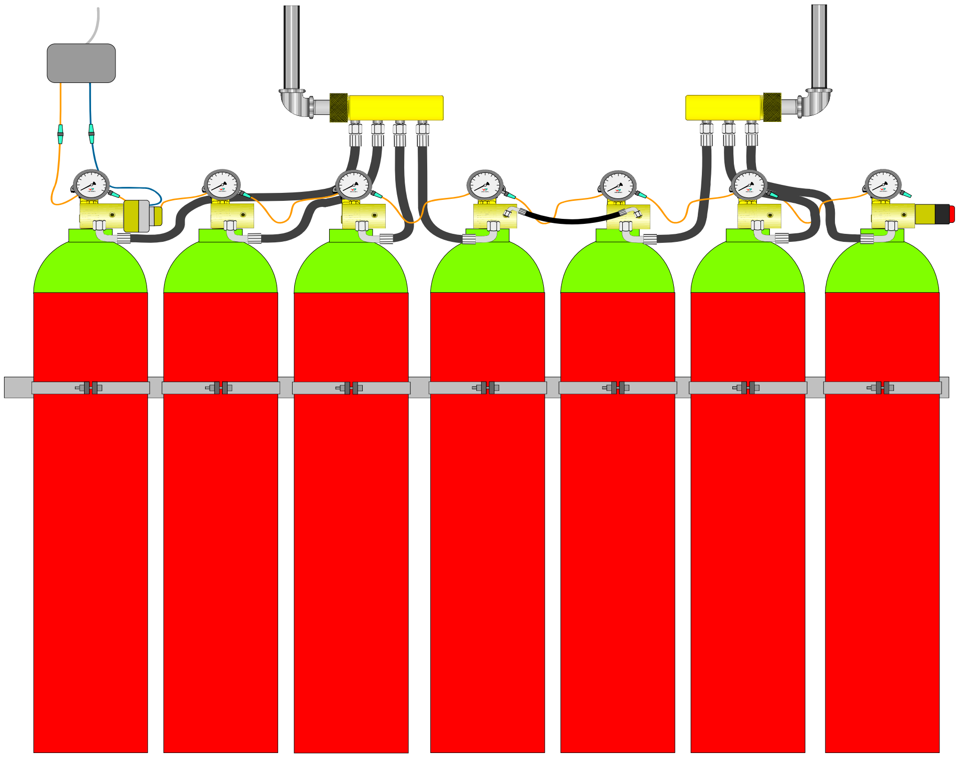


When more than one manifold is used on a stand-alone system, it is necessary to get the activation pressure from valves activated by the pressure in one manifold to one valve on the next manifold.

To install the kit

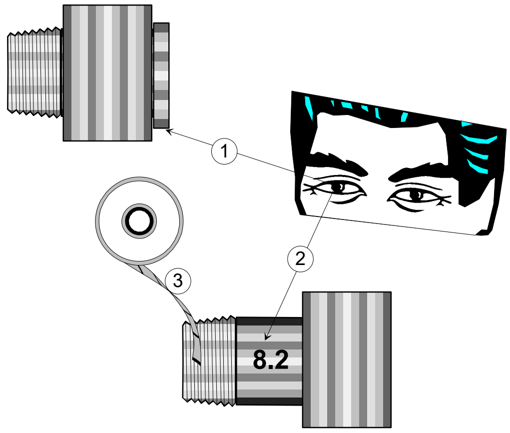
1. Remove the 1/8” plug from the IV8 PA in/outlet using a 5mm Inhex wrench
2. Apply PTFE tape or other thread sealant to the tapered 1/8” thread on the adapter 302467.
3. Screw the adapter into the valve
4. Attach the hose to the adapter and tighten
   DO NOT apply thread sealant on the ¼” thread for the hose connection.





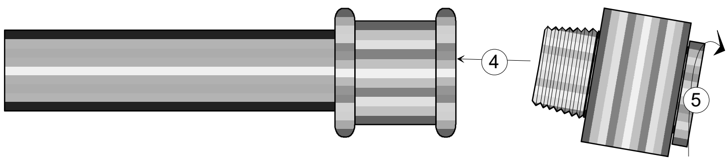
Manifold to Pipe installation

Orifice Installation

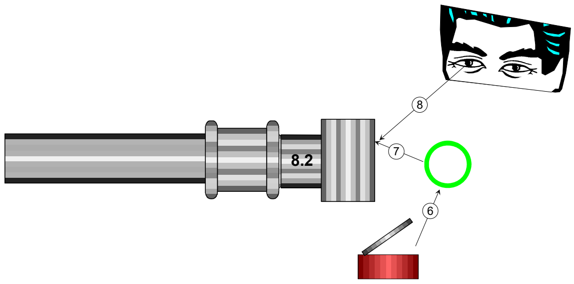


Proceed as follows:

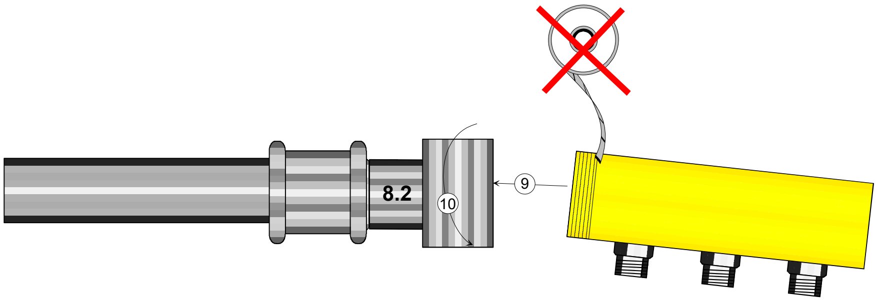
1. Identify that the orifice has the right connection thread (NPT is identified by a groove in the shoulder.
   ISO (bspt) has no groove
2. Identify that the orifice has been calibrated to the correct orifice diameter.
   The orifice diameter is stamped into the side of the adapter, and can be seen with the union pulled up over the shoulder.
3. Remove the plug from the orifice pipe thread
   Apply PTFE tape or other thread sealant to the pipe thread.
4. Insert the thread into the pipe system socket.
5. Tighten the adapter by using a pipe wrench, do ONLY grip on the curled schoulder, never on the smooth surface of the pipe as this will damage the marking making identification dificult.



Manifold Installation



6. Find the O-ring 212097 (26×1.5) and apply O-ring lubricant.
7. Insert the O-ring in the groove in the orifice (/pipe adapter)
8. Check to see that it is placed correctly.

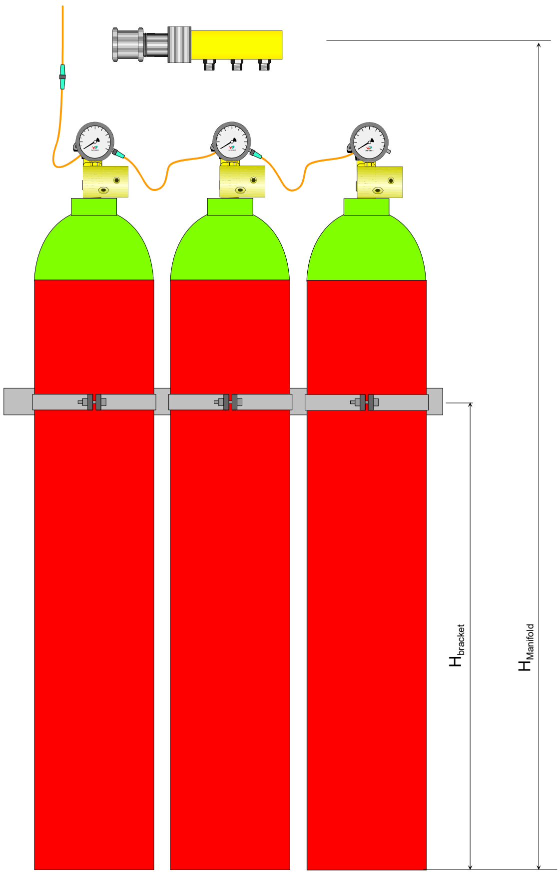


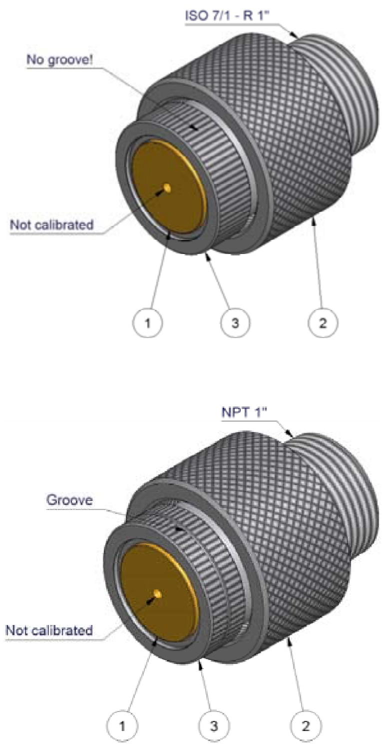
Remove the plastic cap from the Manifold M40 thread

Do NOT apply thread sealant to the manifold thread

9. Insert the manifold to the orifice
10. Tighten the union nut on the manifold. App 50Nm

NPT thread is identified by a goove in the shoulder, ISO (bspt has no groove).

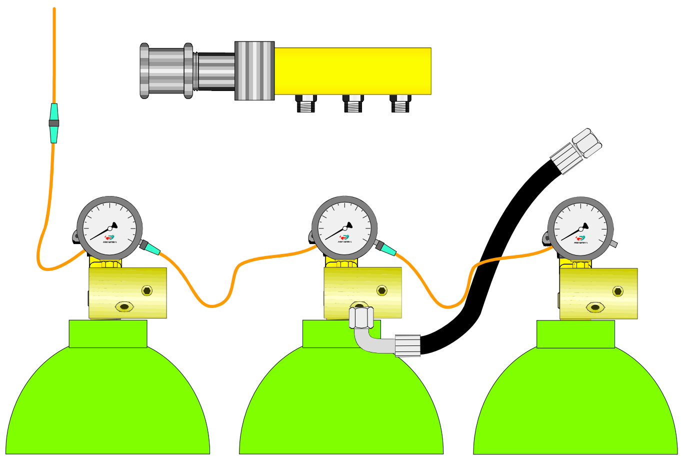


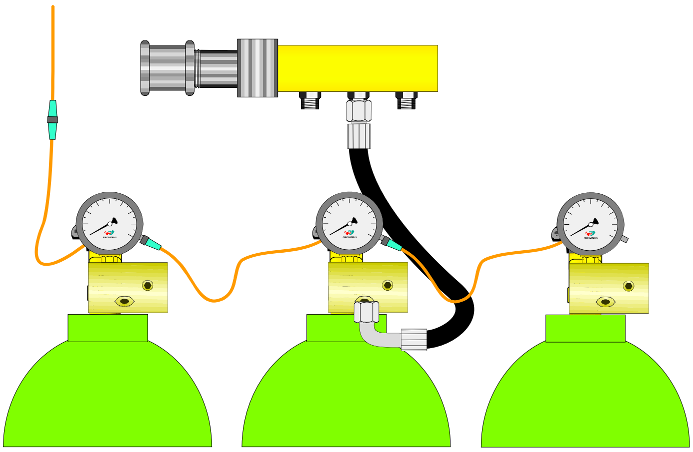


Discharge hoses

Attaching hos to valve

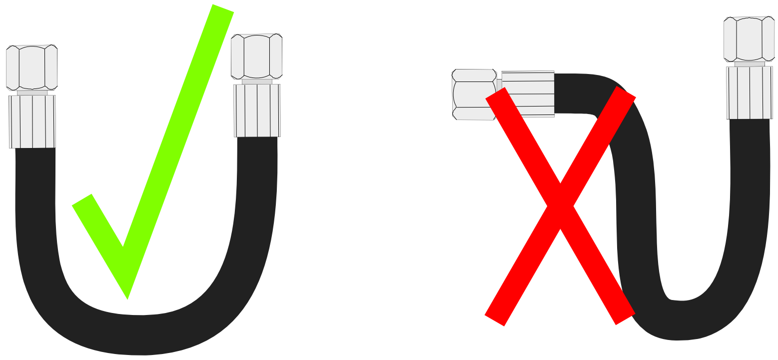
1. Connect the hose with the elobw to the discharge outlet.
   Always start with the shortest hoses.
2. Connect the hose to the manifold.
   When hose is attached to the manifold the check valve in the manifold will open slightly.
3. Tighten both hose connections.
4. Proceed with the next dischagre valve until all valves are connected to manifolds.

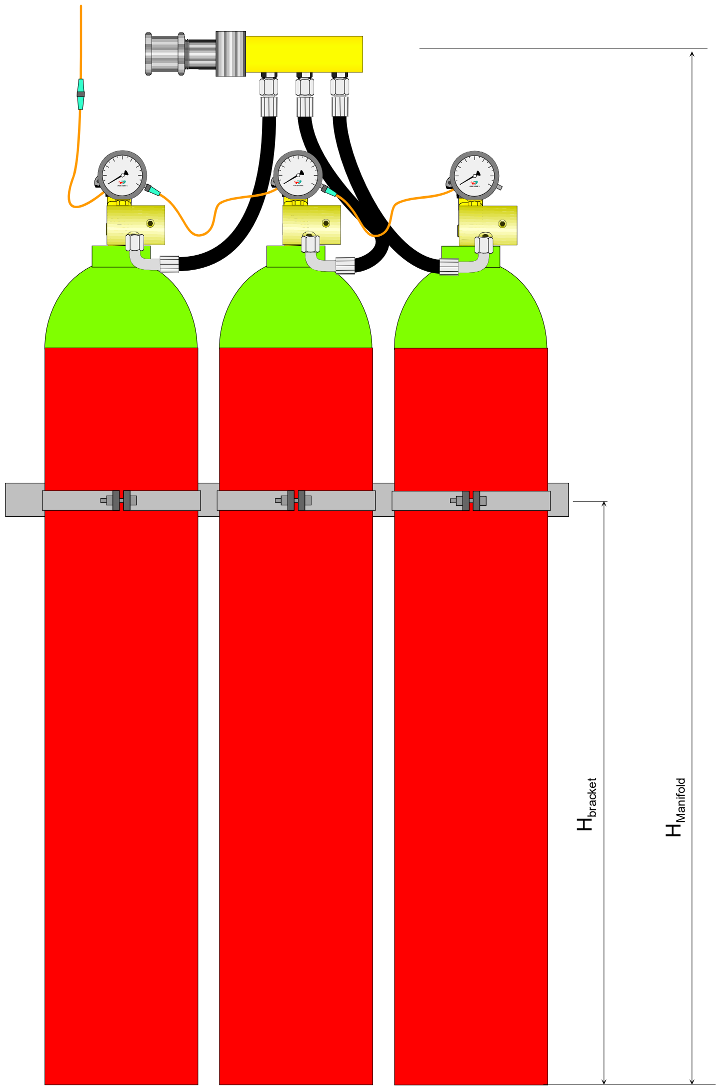




Hose details

Make sure that there are no sharp bends in the hoses:





Distribution piping [51 – 54]

Only pipe described on page 19, and pipe hangers and fasteners described on page 20 should be used

Install the pipe hangers in accordance with good piping practice as well as the following:

1. Refer to ASME 831.1, "Power Piping Code," and any appropriate local codes and standards.
2. A hanger should be installed between fittings when the fittings are more than 600mm apart.
3. A hanger should be installed at a maximum of 100 mm for pipe <DN25 and 250mm for >DN25 from the nozzle. It must be located to keep nozzle from moving vertically.
4. The hangers must be UL listed and/or FM Approved and rigidly supported.

Installation

1. All threaded pipe beyond the manifold, or selector valve if applicable, to be black iron or galvanized
2. Cylinder and piping to be securely bracketed – especially at the fittings and nozzles.
3. Ream, clean, and blowout all pipe before installing.
4. All dead end pipe lines to be provided with a capped nipple, 2 in. long.
5. All pipe lengths are measured center to center of fittings.
6. All distribution pipe and fittings must be assembled using either pipe tape or other appropriate sealant. Do not add to the first two threads nearest the end of the pipe.
7. Size reductions can be accomplished with the use of reducing bushings, reducing couplings, reducing tees or reducing elbows.
8. Bushing up (increasing pipe size) in the downstream piping is acceptable immediately after the pressure reducer only. Increase in size can be no greater than two nominal pipe sizes. Only the use of a close nipple and reducing coupling or a *swaged* nipple can be used.
9. Nozzles to be located at the top of the hazard area, directed downwards.

Nozzle [61]

Nozzles are installed on the pipe by the same way as the pipe fitting.

Nozzles must be placed in the correct location in accordance with the installation drawings in order to supply the correct amount of INERGEN to the designated area.

Multizone systems [1xx]

Selector valves and Manifolds

To support the SV22 or SV48 during installation a Cylinder railed is fastened to the wall.
SV22 app 2600 mm above cylinder foot
SV48 app 2780mm above cylinder foot.

SV22 system

The distribution manifold is made by the Tee's supplied with the Zone and Manifold kits.

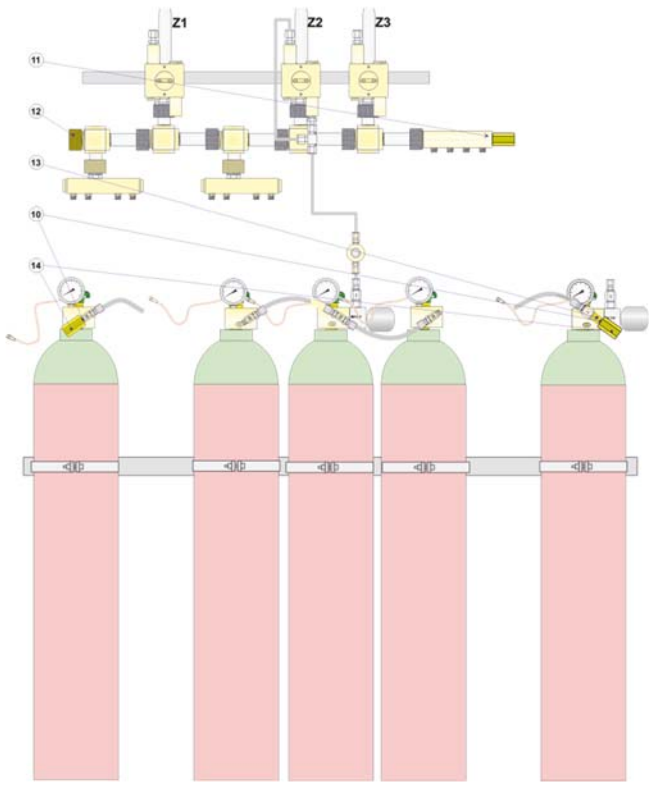
The Zone kit is assembled and hanged in the cylinder rail minimum 2 selectorvalves must be placed in the rail, Manifold kits can be placed between these zone kit, the kits are slided together and sealed by the O-ring in the Tee. Unions are tightened so that the will not come loose due to vibration etc.

The distribution manifold is completed by installing the end plugs in the first and last Tee from the zone/manifold kit.

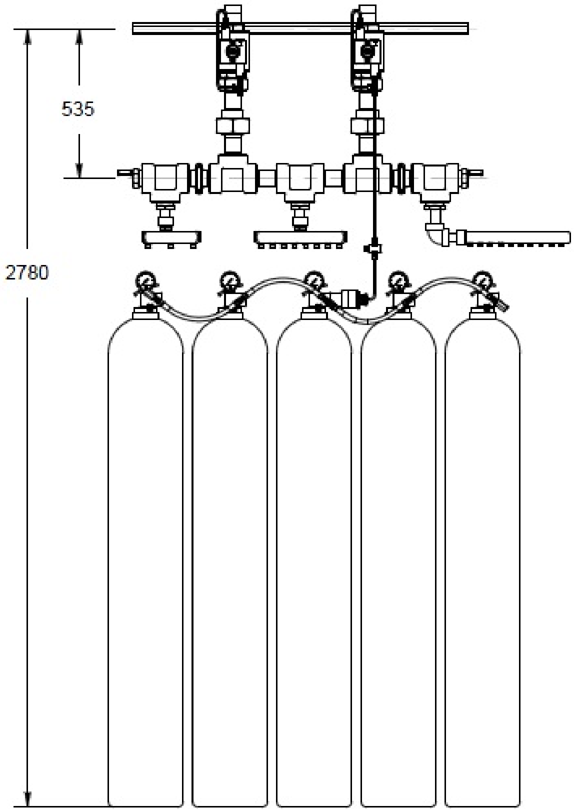
Additional bracket may be used to support the SV48 valve.

For SV48 it is recommended to assembly the manifold distribution line on the floor due to the high tightening forces and then lift the manifold into place as a assembled manifold with Selector valves, the inlet manifolds should be fitted after as the connections on these are sensitive to physical damage.

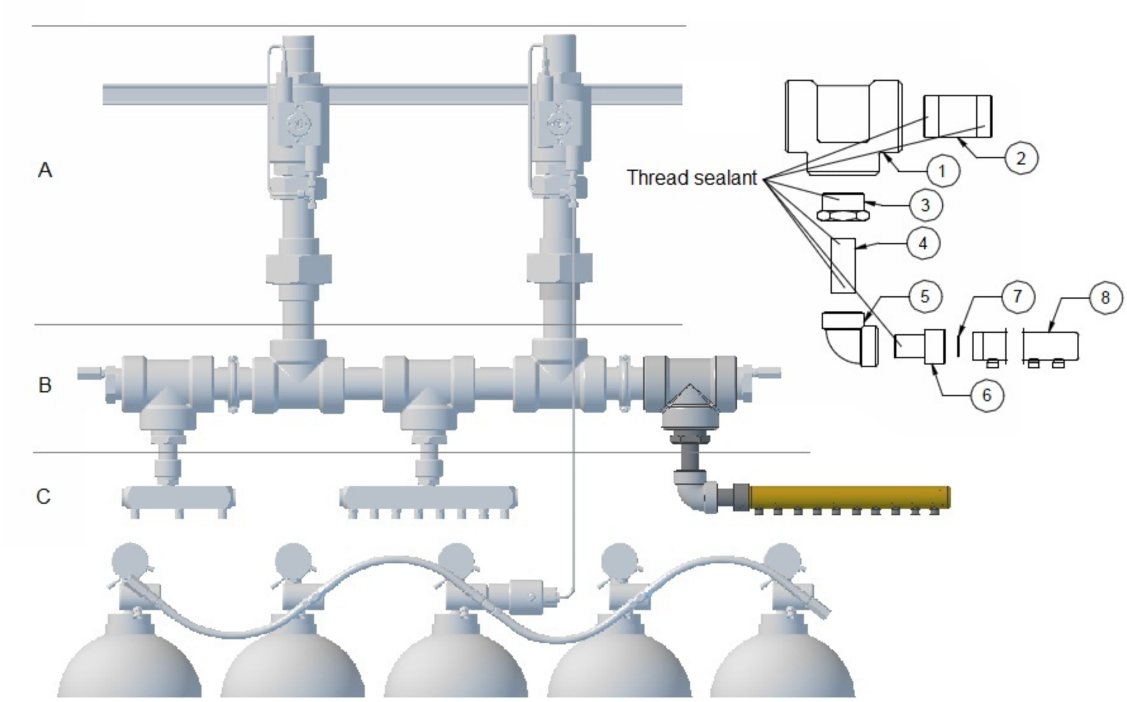
SV22 system drawing

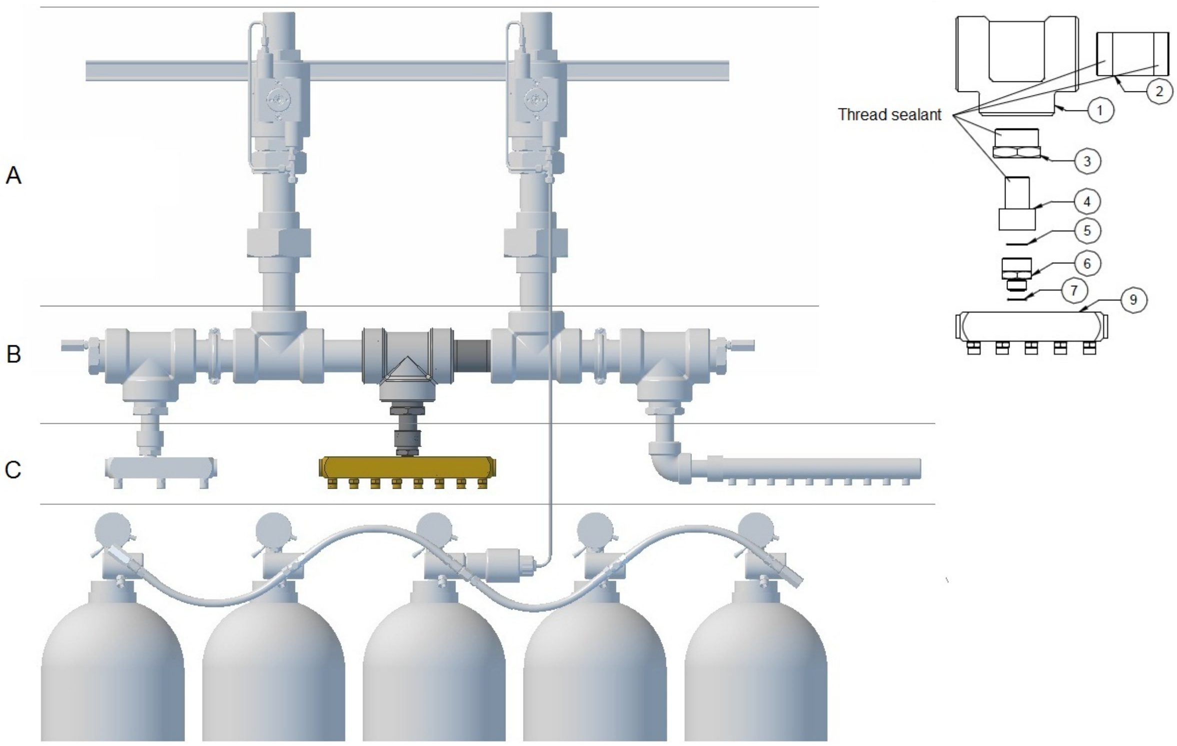


SV48 system

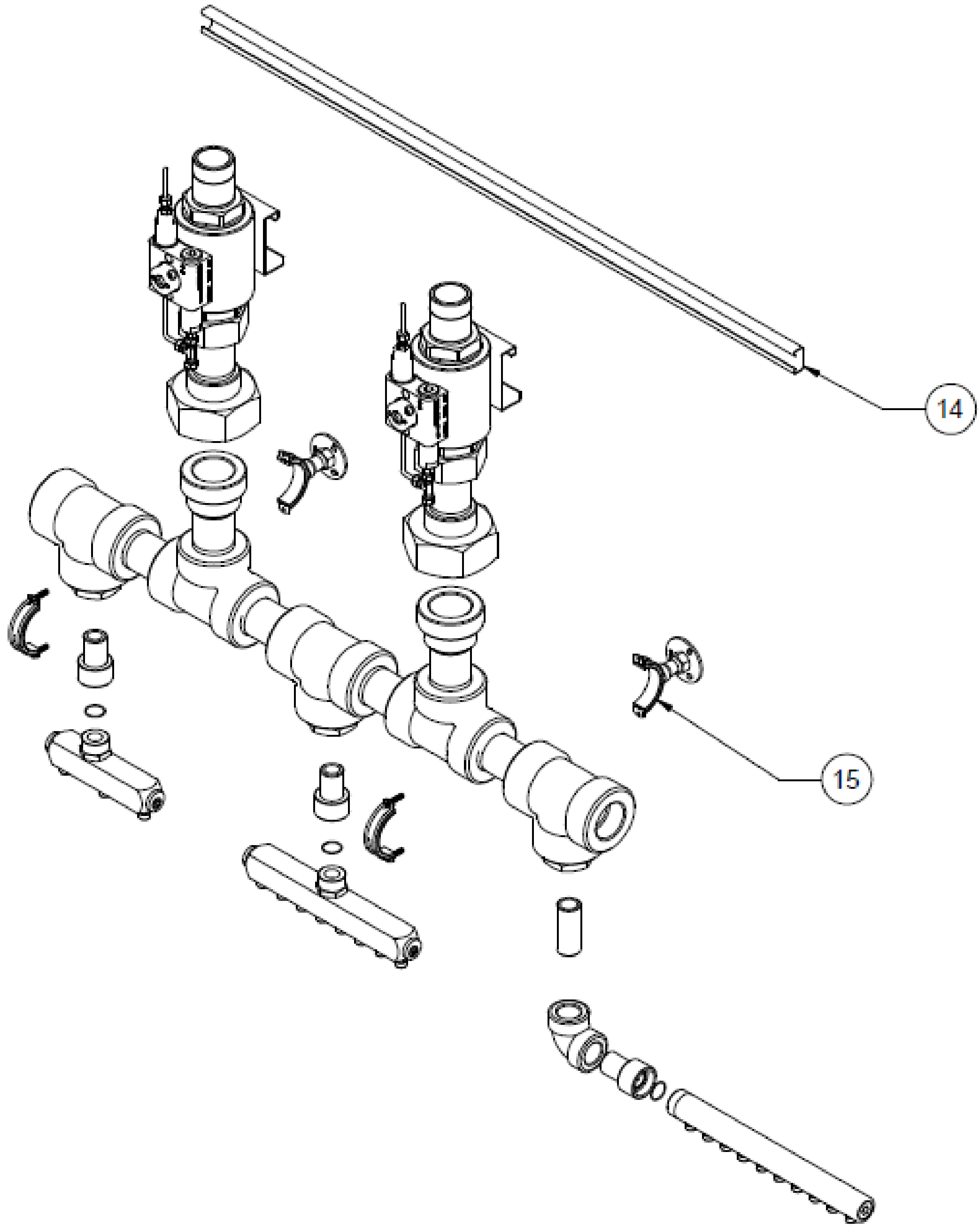


Manifold kit details





SV48 distribution manifold



Chapter 7: Testing and Commissioning

General

This chapter serves as a guide for final test and inspection before a system is commissioned.

Always check with the authorities having jurisdiction if additional requirements apply.
Always check the system specifications to see if special attention should be required if other components are used etc.

The purpose is ensure that the system has been properly installed and will function as specified.

All mechanical components shall be checked for their suitability for the application and to make sure that their installation is in accordance with the system listing.

Non-system listed components must be identified and checked to ensure they are suitable for the system and acceptable to the authority having jurisdiction.

The completed system shall be tested by competent personnel to prove the correct operation of all required functions.

The detection and actuation system shall be tested in accordance with the control panel manual.

NOTE: Before starting any testing, REMOVE ALL ACTUATORS from their discharge valves.
Reinstalling the actuators after testing is the LAST operation to do.

Inspection & Test

Use the check list in chapter 9, and the guide and requirements in this chapter.

Tightness verification

In addition to these test a 24 hour leakage test should be made very time permanent pressurized parts have been dismantled. The Leakage test is performed by pressurizing the discharge valve/acc, by opening the hand wheel valve for 1 minute and the close it again. Mark the pressure on the pressure gauge dial and after 24 hours the hand wheel valve is reopened, if a pressure drop can be recorded the leakage must be identified and repaired.

System configuration

Review the “as-installed” plans to ensure that they accurately represent the system configuration of the area to be protected.

Warning signs and notices

Check that warning signs and safety instructions are installed in accordance with NFPA 2001 Section 4.3.5, and observe if local regulations require additional signs.

Enclosure integrity & venting

All total flooding systems shall have the protected enclosure checked to locate and effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified extinguishing agent concentration level for the specified holding period.

NOTE: The data derived from this test should be retained as a benchmark for future tests.

Review the adequacy of the enclosure for its ability to vent pressure fluctuations developed during system discharge, taking into account the following:

- the equivalent leakage area determined from the enclosure integrity test.
- the provision of any required additional pressure vents.

Cylinders

Cylinders may be stored in the protected area or in a separate cylinder storage room.
The cylinders are high pressure cylinders and local authorities may have special regulations of how these have to be inspected and tested.

Check that all INERGEN cylinders are

- properly located in accordance with the approved drawings
- in correct number and size and are appropriately marked
- charged in accordance with the “as-installed” drawing and correctly labeled
- positioned such that gauges can be read
- Securely fastened in accordance with the manufacturer's requirements.

Discharge valves Manoswitch and Actuators

Verify that actuator is positioned on the correct Master Valve.

Check that all actuators are:

- attached to the cylinder as indicated on the “as-installed” drawings
- properly connected, correctly set to operate and with safety devices disengaged
- when pneumatic actuation is used, that the hoses, pipes and adapters are correctly fitted
- installed correctly and have safety pin in place and are sealed (manual actuators)
- readily accessible, accurately identified, and properly protected to prevent damage

NOTE: Particular care should be taken to ensure labeling is unambiguous where manual actuators for more than one system are in close proximity and could be confused or the wrong system could be actuated.

Manifolds, Hoses and Zone valves

Check the following:

- manifold piping joints are physically checked for tightness and supports are checked A pneumatic pressure test at 2.7 bar (40 psi) should be performed[1]
- Hoses are free from kinks and physically checked for tightness. Ensure that flexible connectors with integral check valves are installed for the correct direction of flow.
- PA hoses are used on correct inter-manifold valves and SV system.
- Selector valves, where used, are correctly fitted, and actuation circuitry is correctly installed.
- Bleed fittings are all open (pin is flush with the housing).
- All hand wheel valves are opened and sealed when all tests are completed.

SV Distribution manifold leakage test. This test is to be done pneumatically (preferable with pure Nitrogen) as parts are to be dry and clean after the test.
As all SV22 parts has been pressure tested to 600bar at Fire Eater only the leak tightness of the assembly has to be verified. As all seals are based on O-rings the test can be performed at low pressure, but as O-rings require pressure to seal it may be necessary to elevate the pressure to ensure the O-rings will seat and hold tight.
Manifolds made with welding and tapered thread has not been pressure tested at Fire Eater and have to be pressure tested at 1.43x working pressure, if this is done with hydraulic pressure testing all SV valves and manifolds should be removed prior to pressure testing, or must be dried after the pressure testing.
The parts are designed to hold gas pressure for a limited time only. Prolonged exposure to high gas pressure may have adverse effect on the parts depending on the applied gas.

1. Remove any hoses connected to the manifold.
2. Close all SV valves.
3. For distribution manifolds based on Fire Eater SV22 parts (O-ring seals)
   Pressurise the manifold to 20bar for 3 minutes and inspect for leakages.
   if leakages are found it may be necessary to increase pressure to ensure proper O-ring seating, or inspect for missing O-rings.
   Notice that
   small leakages from check valves on Ci MT manifolds are acceptable,
   No Leakage on the outlet of SV MT manifolds are acceptable.
4. Depressurise the manifold by opening a SV22 through the installed test port.

[1] According to NFPA2100 chapter 7.7.2.2.12

Pipe system

Review pipe work to ensure that its layout conforms to the "as-installed" plans; pipe sizes, means of pipe size reduction and configuration of tees conform to the "as-installed" plans as required for proper agent flow splitting and hydraulic performance and piping joints, discharge nozzles, and piping supports are securely fastened to prevent unacceptable vertical or lateral movement during discharge.

Pipe work must be pressure tested to 1.43x work pressure (as per Fire Eater INMON002),

5. Pipe system visually inspected joints are checked, nozzles are blinded.
6. Pressurized to 20% of test pressure maintained for 1 minute wo. pressure drop.
7. Pressure increased in steps of 1/10 (11 bar) until test pressure (typical 110 bar).
8. Test pressure maintained for 30 min.
9. Pressure lowered to work pressure.
10. Pipe system visually inspected and leak tested.
11. Pipe system depressurized.
12. If the test was made hydraulic the pipe system has to be drained and dried.
13. End plugs are removed and nozzles are fitted.

Pipe test and test report must satisfy the authorities' requirement.

Nozzles

Ensure that discharge nozzles are

- drilled and stamped in accordance with the system design and are correctly positioned
- installed so that they will not cause injury to personnel or located where their discharge could dislodge ceiling fittings such as lighting, exit signs and fire detectors; and
- installed such that they are not likely to detach or cause pipe work to be unthreaded by reaction forces during discharge.

NOTE: Wherever possible, the extinguishing agent should not directly impinge on areas where personnel may be found in the normal work area, on any loose objects or shelves, cabinet tops, or similar surfaces where loose objects could be present and become missiles.

Electrical system

Review the system to ensure compliance with the system drawings and local laws.

Verify that there is enough power to activate the system (use a powermeter).

Verify that cables are listed and comply with local authorities.

When manoswitch is used, verify that signals from the low pressure alarms work correctly by using the Manoswitch emulator.

Verify that alarm devices (sounders, optical beacons) are fitted according to local authorities and emit signal.

Pressure relief

Verify function and position, they should be install far from nozzles to minimize loss of gas.

Function test

Actuators are to be removed from the discharge valve during this testing to prevent accidental discharge of the INERGEN system and test the actuators.

An initial alarm test should be conducted following installation to determine that all parts of the system are functioning properly. The panels should remain powered for 24 to 36 hours prior to connecting the releasing solenoids. This precaution will avoid false activation of the suppression system in case of faulty or improperly placed detectors.
To perform an alarm test on the control panel, proceed with the following steps:

1. Disconnect AC power and battery power
2. Disconnect the installed solenoid valve circuit leads and connect spare solenoid valves or connect an End-of-Line device to serve as a dummy load
3. Reconnect AC and battery power
4. Initiate a first zone alarm condition by introducing smoke into one of the Zone 1 detectors.

This should cause the first zone alarm condition

- ✓ The red Fire Alarm indicator will illuminate
- ✓ The LCD display will indicate an alarm condition for zone 1
- ✓ The control panel piezo will sound
- ✓ The Alarm relay will energize
- ✓ The devices connected to the Indicating Circuit(s) programmed to activate on Zone 1

alarm will turn on

5. Repeat step 4 for each input zone
6. When testing has been completed, remove AC and battery power, reconnect the solenoid valve circuits removed in step 2, reconnect AC and battery power and ensure that the control panel is in normal standby condition

Confirm the correct operation of all system components, including the following:

- audible discharge alarms
- visual warning devices
- door-closers and ventilation dampers
- discharge time delay
- directional valves
- container release actuators

Manual release devices

Operate all manual release devices and verify that each manual release device functions according to design specifications. Reset the system.

Stop & Delay switch

Operate and verify the function of the switch. Confirm that visual and audible supervisory signals are received at the control panel.

Pneumatic equipment

Where fitted, check pneumatic equipment for integrity, to ensure proper operation.

After the test, reset all tested components in accordance with their respective datasheets.

Full-scale discharge test

Discharge test is not mandatory. If it is performed, a recommendation of how to perform it is given here:

1. Complete the system commissioning inspection
2. Disable stops that are not desired for the full-scale testing
3. Install measuring equipment
4. Inform all personnel affected by the full scale test
5. Activate the INERGEN system discharge procedure
   If electrically controlled, use a manual discharge call point
   If manually controlled, close all opening first and stop ventilation manually.
6. Verify that ventilation stops, doors and gussets close
7. INERGEN releases
8. Read the oxygen level every 15 seconds for the first 120 sec (note that the test equipment may have a delay for more than 15 seconds) and every minute thereafter
9. After 10 minutes verify that the oxygen concentration is still below the extinguishing concentration or that the clean agent concentration is still a minimum of 85% of the design concentration (NFPA 2001 ch 5.6).

NOTICE: When releasing a fire extinguishing system, there will be very high sound levels, and very large ventilation in the enclosure, blowing dust in the room and into adjacent rooms.
This must be taken into consideration as unintended dust could set-off undesired fire alarms.

Resetting

After the full scale test, the system must be reset and components that have been used should be inspected according to the commissioning inspection.

Test report must include

1. System name, location, participants, date when test was performed, signature
2. List of equipment in the extinguishing system, a description of enclosure including hazards, temperature record prior to the discharge
3. IMT calculations (design concentration)
4. Rules applied
5. Location of all measuring points
6. Measurements
   If manual oxygen measurement is performed, a sample rate of 1 per 15 Seconds is recommended.
7. All pages should contain date and file name

Documents to be submitted

1. Components list
2. Components certificates
    a. Cylinder certificates
    b. Cylinder filling certificates
    c. Pipe pressure test report
3. IMT calculations
4. Drawings
5. Checklist
6. Certificate of completion

Chapter 8: Resetting and recharging

General

A fire can cause damage to many parts and components in a fire extinguishing system, and it is therefore very important to do a thorough inspection of the complete system before resetting it.
Failure to do so may cause damage and accidental discharge.
It is also very important to clear the area from smoke
Always refer to the control panel manual regarding instructions how this should be reset.
Check all electrical and mechanical equipment

Piping and nozzles

Check all pipe, support member and nozzles.
Inspect all nozzles for obstructions.

Selector valves

Bleed off the pressure in the actuation line by attaching the APTB tool to the test port (should the tool not be available a discharge hose may be used, simply screw it to the Test port and the pressure will bleed out.
With the actuation line bleed insert the SV22 reset tool in the slot in the SV and turn 90° (Arrow on tool is across the direction of flow. When removing the tool check that the slot is across the flow direction.

Electrical and manual actuators

Remove the actuator from the discharge valve.
Use Ci Reset tool to reset the actuator. Screw the tool apart until the line in the recess on the tool is visible, Screw the tool onto the actuator by rotating the part closest to the actuator. When it is fitted completely turn the outer part until. Just before it reaches bottom you will feel a small click and you should only turn ½ turn after that.
For the Manual actuator the pin must be inserted with the tool tightened. Insert the pin through the hole and seal it using fine sealing thread and seal.
Before removing the tool Loosen it by turning the outer part ½ turn back.

Pneumatic actuators

Remove the actuator from the discharge valve.
Push back the pin by hand

Bleed fitting

With the line they are attached to depressurized the pin sticking out must be pushed back to almost flush with the body.
Notice not all bleed fittings may have actuated as some are only installed to bleed pressure not intended to be in the system.
Notice on stand-alone system Bleed fittings are not utilized.

Discharge valves

To ensure 100% leak proof the piston in the discharge valve and the O-ring between the hand wheel valve and the discharge valve must be replaced.

305403	Ci IV8 piston inside discharge valve.
2141160	O-ring 14.1x1.6 between discharge valve and hand wheel valve

Recharging cylinders

As the cylinders are equipped with hand wheel valve it is very easy to have a filling station refilling the cylinders. Before refilling the discharge valve is to be removed.

Caution:
Filling is only to be performed by personnel with the required certification to perform this operation.
Ensure that the cylinder is fixed well and con not move, and that it will not be able to move in case the filling adapter breaks (reaction forces must be taken into account).

Filling equipment requirements

The filling equipment must have a suitable pressure gauge to verify correct filling (min class 0.5 accuracy), the gauge on the discharge valve is not suitable for this purpose.

Pressure relive valves with a capacity that exceeds the capacity of the pump being used or the flow capacity of the outlet of the tank being filled from, so that the max pressure is limited to the max operating pressure of the system @ 60°C.

Pressure reducers are not to be used as means for controlling filling pressure or protecting the cylinder to be filled from over pressurization.

INERGEN, IG541 as per NFPA 2001

General

This is a supplement to datasheet 200500 dealing with specifications of how filling stations should handle filling of cylinders with IG541.

Please refer to latest data sheet 200500-1 Instruction filling station for specifications.

Before filling

The validity of the cylinder pressure test period must be checked in accordance with local regulations before they are refilled.

Some typical requirements are:

Europe:	10 years	TPED EEC 1999/36, ADR instruction P200: 2005
Marine (EU):	5 years	(recertification 10-20 years depending on authority).
Asia:	5 years	

As there is no residual pressure valve in the valve, it must be checked that the cylinder has not been filled with any liquids.

ISO 10286 defines 15˚C as cylinder reference temperature.

Gas mixture

	Nominal	EN 15004/ ISO 14520	NFPA 2001	CCC-FM
Carbon dioxide:	8%	7.6 to 8.4%	8.0 to 9.0%	8.0 to 8.4%
Argon:	40%	37.2 to 42.8%	36 to 44%	37.2 to 42.8%
Nitrogen:	52%	48.8 to 55.2%	48 to 56%	48.8 to 55.2%
Moisture (Dew point):	0	<-60 ˚C (< 6ppm m)	<-60 ˚C (< 6ppm m)	<-59 ˚C (< 12ppm v))

Dewpoint shall always will be below freezing point at the pressure,
m=Mass, v= Volume.

Pressure & Cylinder volume

Cylinder volumes tolerances must always be -0 to +5%. The actual volume in a cylinder should never be less than the designated volume.
Filling pressure are in accordance with the ADR regulation, nominal pressure @ 15˚C. Filled cylinders' pressure is always to be verified after cylinders have been conditioned 24 hours at a stable temperature between 15 ˚C and 30˚C.
Tolerance for filling pressure is -0 to +10bar @15˚C for both 200 and 300bar filling pressures

CCC-FM Fillings

Filling in compliance with CCCF and NFPA.
Filling pressure are 200bar (20MPa) @ 20˚C, Filling tolerance is -0 to +10bar @ 20˚C
Cylinder volume is minimum 82 litre water volume.
Water contents are not to exceed 12 ppm giving a Dew point below -59˚C.

Filling

Only correct adapters should be used, damaged adapters etc. are to be destroyed to prevent accidental use.

The filling has to comply with the requirements of ISO14520-15
Fire Eater recommendations for this is to:

Connect hoses, close hand wheel valves.

1. Verify system integrity
   Evacuate to 100 Pa (1 mbar) vacuum (accuracy 50 – 1000 Pa)
2. Verify free flow
   Open all hand wheel valves and evacuate cylinders
3. Remove moist
   Keep at 100 Pa for 5 minutes.
4. Flush:
   Pressurize with Nitrogen or INERGEN to 2 bar

Repeat step 3+4 so that the cylinder is flushed minimum 3 times
   Evacuate to 100 Pa (vacuum) for 5 minutes

5. Fill:
   Start with CO_2, follow with N_2 and Ar or use premixed INERGEN.
6. Close Hand Wheel Valve
   Tighten to 7Nm
6. Verify cylinder interiority
   Check for leakage (use soap-water):
   a. Cylinder-Valve connection
   b. Burst-disc

Carbon dioxide: 8.0 to 9.0%

Argon: 36.0 to 44.0%

Nitrogen: 48.0 to 56.0%

Purities

In the filled cylinder the purity of the individual gas must be within the ISO14520-15 specifications

	Argon	Nitrogen	Carbon dioxide	
Class	min 4.7	min 4.0	min 2.5	
Purity	99.997 %	99.99 %	99.5 %	(by volume, min.)
Water content	4×10^{-6}.	5×10^{-6}	10×10^{-6}.	(by mass, max.)
Oxygen	3×10^{-6}.	3×10^{-6}	10×10^{-6}.	(by mass, max.)

Only principal contaminants are shown. Other measurements may include hydrocarbons, CO, NO, NO_2. Most are 20×10^{-6}

For the filled INERGEN cylinder

Impurities:	Less than: 0.04%
Water content:	Dew point below -60˚C (6 ppm weight) (UL spec 20ppm are not applicable for cylinders transported in Europe as they may be exposed to sub 0˚C)
Oxygen:	Less than: 3×10^{-6}

Analysis

A batch or container analysis must be performed for:

a. CO2 contents.

b. Water contents.

c. Pressure after stabilizing (15 to 30 ˚C)

Minimum annually gas samples must be submitted to third party analysis.
Analysis results must be filed and be available on request by Fire Eater.
The analysis must as a minimum be of the mixed INERGEN.
For the INERGEN analysis of each gas component (N2, Ar, CO_2) as well for oxygen and moisture and any other present substances.
The individual gases are analyzed for purity and water contents, data must be available for FPC audits.

Filling certificates

Filling records and certificates are to contain information of:

Cylinder number, Filling spec, Date, Pressure , CO_2 and Moisture contents.

Chapter 9: Inspection, Service & Maintenance

General

Periodical inspection and maintenance by qualified and trained personnel must be made minimum in accordance with the authority having jurisdiction.
Minimum service intervals

DBI 253:	Annual service + inspection
UL:	Semi-annual (cylinder pressure must be verified)
NFPA:	At least annual: inspection and test; at least semi-annually: pressure check
MED:	
GA400:	
LPCB:	Annual service + inspection

For components with limited service life, always refer to the engineering datasheet for information regarding replacement intervals or required service.

At the end of this chapter there is a service check list where these parts are indicated.

When working on the system always keep personal safety in mind.

Cleaning

General

Cleaning is only necessary when the components of the fire extinguishing system are heavily soiled.

The fire extinguishing system is only to be operated by instructed personnel.

Service and recharge of the system is only to be performed by a Fire Eater A/S approved fitter.

The person responsible for the installation performs the service at 6 or 12 month intervals. Components with limited life are replaced during these inspections.

Pipe system

Pipes are not to be damaged, deformed or used for fixation of equipment. Pipe hangers are no to be removed or moved without proper approval.

Pipes may be painted.

Cleaning:

Pipes should be cleaned with water and detergent suitable for cleaning copper, aluminum or galvanized steel, depending on installation, NEVER use chlorine or acidic cleaning agents.

Nozzles

Nozzles are not to be removed, blocked or altered in any way without consulting the person responsible for the installation for directions.

Nozzles are not to be painted, as this may alter the nozzle area.

Cleaning:

Nozzles should be cleaned with ordinary detergent and water suitable for cleaning of brass.

INERGEN® cylinders.

Steel cylinders with INERGEN® gas at 200 or 300 bar. The content information is located on a label on the side of the cylinder. Pressure information is also available here.

Cylinder color must be according to national and international standards if painted.

Cylinder valves must be sealed, if seal is broken contact the installation responsible.

Cleaning:

Water and ordinary detergent. High pressure cleaner may be used if heavily soiled (steam cleaner is not recommended due to elevated temperatures).

Discharge valve.

Brass valve with equipment according to specifications on datasheet.

Cleaning:

Water and ordinary detergent. Valves are not to be submerged into or sprayed with water.

Inspection

General

A visual inspection must be performed regularly to ensure proper function of the system.

The visual inspection is intended to give reasonable assurance that the system will operate, and has not been tampered with, and has not been rendered inefficient due to changes in the protected areas.

Below is given a list of items that should be inspected monthly, and what should be observed on each item.

If any parts of the described service is omitted for any reason or faults or deviations are recorded during the service it must be noted on the Certificate of Service & Maintenance and the owner of the system must be informed of the potential consequences.

0 Information

As may people and process can be affected by a fire alarm it is important to inform everybody affected by the INERGEN system about the test and inspection to avoid unintended actions.

1. Room

Fire detection and fire extinguishing systems are dimensioned specially for the room and the hazard they are installed in.
A verification of the room integrity and sufficient pressure relief should always be verified using a quantifying measuring method (such as a blower dorr or similar), this test can be waivered if it can be verified that no changes has been made which would affect the INERGEN system.
If the rooms are modified, the person responsible for the installation must be contacted to evaluate if the alteration will affect the performance of the fire extinguishing system.

Construction changes:

- Ventilation: Has it or its controls been changed?
- Doors/windows: Change, installation, removal.
- Lowered sealing: Installation, removal.
- Raised floors: Installation, removal.
- Walls: Both light and heavy. Installation, removal.
- Machines: Any new machines or changes.
- Pipe & cabling: Pipe and cable ducts and wall cut outs.
- Fuels: Is the extinguishing system designed for the fuels present?

Detection, activation and indication system

- Detectors: Are all in place, undamaged, clean.
- Release station: Easy access, clean, undamaged.
- Beacons, horns: Clean, undamaged

Pipe system

- Nozzles: No obstructions, clean, check distance to objects prone to damage.
- Pipe: Damages, corrosion, loose parts
- Pipe brackets: Damages, corrosion, loose parts

Signs

- Alarm: Are all indicators labeled correctly?
- Escape routes: Clearly marked and free from obstructions.

NFPA 2001: Warning and instruction signs at entrances to and inside protected areas shall be provided, and located such that they will be readily visible to personnel in the area where the clean agent design concentration exceeds that approved for use in normally occupied spaces.

At all entrance to the INERGEN cylinder storage room warning and safety instruction signs shall be located. All signs shall be in accordance with ANSI Z535

2. Cylinders

Cylinders may be stored in the protected area or in a separate cylinder storage room.
The cylinders are high pressure cylinders and local authorities may have special regulations of how these have to be inspected and tested.

Cylinder pressure has to be tested at each service by reading the pressure on the gauge of the discharge valve and correct it for temperature. (See Engineering datasheet for Pressure Correction Chart).

UL requires that the pressure of the cylinder must be verified in accordance with NFPA 2001
2 times per year, with a test pressure gauge with an accuracy of Cl 0.5 (grade 2A) 0.5%
If an agent container shows a loss in pressure (adjusted for temperature) of more than 5%, it shall be refilled or replaced.

Cylinder recertification interval vary depending on authority having jurisdiction:
NFPA 2001 specifies Cylinders continuously in service without discharging shall be given a complete external visual inspection every 5 years or more frequently if required. The visual inspection shall be in accordance with Section 3 of CGA C-6, except that the cylinders need not be emptied or stamped while under pressure. Inspections shall be made only by competent personnel, and the results recorded on both of the following:

(1) A record tag permanently attached to each cylinder
(2) A suitable inspection report.

TPED specifies 10 years interval for recertification testing.

3. Control systems

The INERGEN system may be activated manually or automatic.

If a control panel is fitted it is important to test this according to ist manual and ensure that it is in good operating condition.

4. Discharge valve

The quick actuating discharge valve that when activated will open fully and release the INERGEN in the storage cylinder.

To test Master valves:
1. Close Hand wheel valve on Master cylinder
2. Remove hose from valve and manifold.
3. Remove any connected PA circuitry and place plug in PA connection
4. Remove the actuator and install the test tool in its place
5. Operate test tool until IV8 discharges and record the force required to open.
6. Reset the valve by pushing piston back,
   if too high activation force was required replace the Ci IV8 Piston with a new.

5. Manoswitch

This is the combined pressure gauge and pressure switch which is fitted to all cylinders to monitor the pressure of the cylinder.

6. Actuators

The device activating the discharge valve .

7. Hoses

Pressure hoses must be examined for cracks in the skin or corrosion in fittings.
Pressure hoses are special hoses with connections which opens check valves in manifold, supply sufficient flow to ensure correct backpressure operation of the valves.

Hoses should be replaced every 10 years to ensure proper function.

When the hoses are hydrostatic tested it is important that they are dried properly afterward.

Local authorities may have different requirements for testing the hoses

NFPA 2001: All system hose shall be examined annually for damage. If visual examination shows any deficiency, the hose shall be immediately replaced.
Hose shall be hydrostatic tested every 5 years at 1.5x max container pressure at 130°F (54.4°C).

8. Manifolds

Collecting the gas from the discharge valve, ensuring build-up of pressure for backpressure operating of slave discharge valves.

9. Pipesystem

Local authority regulations must be observed (For EU PED must be observed).

NFPA2001 The piping distribution system shall be in compliance with the design and installation documents.
Means of pipe size reduction and attitudes of tees shall be checked for conformance to the design.
Securely fastened to prevent unacceptable vertical or lateral movement during discharge. Discharge nozzles shall be installed in such a manner that piping cannot become detached during discharge.

10. Nozzles

Nozzle shall be oriented in such a manner that optimum agent dispersal can be effected.

If nozzle deflectors are installed, they shall be positioned to obtain maximum benefit.
Nozzles, piping, and mounting brackets shall be installed in such a manner that they will not potentially cause injury to personnel. Pointing away from areas where personnel could be found in the normal work area. Agent shall not directly impinge on any loose objects (shelves, cabinet tops, etc).

11. Signaling devices

Acoustic and Optical beacons, sirens etc.

12. Pressure relief

Function and size must be tested

14. Selector valves

Function must be tested

SV with test port installed

Attach the APTB tool and check the valve opening pressure
The APTB tool is connected to this port and slowly pressurized until the Selector valve opens fully. The pressure at which the selector valve opens is recorded.
The connection is loosened to bleed the pressure and with the tool still attached the SV22 is closed manually.

15. Non-return valves

Position and direction must be verified.
Opening and closing function must be verified

16. Bleed fitting

Correct position. All bleed fittings are to be open when the system has not been released, notice that the bleed fittings will close during pressurization and may require to be reset manually (pin is pushed back).

17. Additional system inspections

If other components are used these should be verified with their instructions.

18. Final

Always open the cylinders hand wheel valves and seal them in open position when completed work on the installation.

Service & Maintenance

General

Systems shall be serviced at regular intervals satisfying the authorities having jurisdiction (see page 175 for a list of rules and requirements)

It is intended to give maximum assurance that the system will operate efficiently and as designed. If any damages, or changes, that would reduce the efficiency of the system are found during the service these are to be repaired before the Service & maintenance protocol is signed.

Procedures listed in this section are the minimum necessary to maintain an efficient system.

Service intervals may be different than here stated if:

- Authorities having jurisdiction requires so
- System installations are subject to harsh environment.

The service must always be performed by a Fire Eater licensed service technician.

The checklist can be used both as a commissioning checklist as well as the annual service checklist.

For Marine systems MSC/Circ 1432 and MSC/Circ 1516 must be followed.

Check list

	Description	☒
0	**Inform the involved personnel.** Inform the employees about the maintenance. Especially receivers of signals from the system (security department, local fire-brigade.)	❑ ❑
1a	**System configuration** Review the as-installed plans to ensure they accurately represent the system configuration to be protected.	❑
1b	**Room inspection** (see page 177) Verify that no alteration is made to the protect room. If alternations are made, verify that they do not conflict with the function of the system. Check fuels present. Test: Doors, windows and ventilation are closed/close during fire. Leakage: ___________	❑ ❑ ❑ ❑
1b	**Signs** Visual inspection: Signs are correctly placed, mounted securely, not damaged, easy to follow and readable. Local authorities' regulations must be observed.	❑
2	**INERGEN cylinders** Tools required: Cylinder pressure gauge (530508) Temperature gauge (530512) Isolate system activation by is disconnecting it. Visual inspection: All cylinders are opened and sealed. Visual inspection: No corrosion, mechanical damages or similar. Test: INERGEN pressure checked and within limits*. Cylinder test date is within limitation** (to be tested year: ___________) Test: All cylinders are fastened securely	❑ ❑ ❑ ❑ ❑
3	**General** All actuators are to be removed before any system testing is performed. All actuators are to be installed after completing the testing	❑ ❑
3a	**Control panel** Tools required: Power Meter (530500) Manoswitch emulator (540501) According to manual. Test: Sufficient power for actuation. replace all actuators with power meter and activate control panel Test: Correct signals from pressure switches. Normal pressure - Low Pressure– Short circuitry – Open circuitry. Battery capacity Lamps, Visual and Acoustic alarms Manual Alarm points Detectors Acoustic alarm devices Optical alarm devices	❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑
4	**Ci IV8 Discharge valve** Tools required: Ci IV8 activation tester (530520) Visual inspection: No cracks, mechanical damages/deformation or corrosion Master valve (with an actuator) opening pressure: _______MPa (max 500N)	❑ ❑

5	**Manoswitch / Pressure gauge / Pressure switch** Visual inspection: No cracks, mechanical damages/deformation or corrosion Visual inspection: Cables and plugs are undamaged.	❑ ❑
6a	**Actuator Ci IS8B** Tools required: IS8 Test interface (530505) Ci Actuator Reset (305495) Remove all actuators from the discharge valve. Test: Actuation. Visual inspection: No cracks, mechanical damages or corrosion Reset IM8 with reset tool	❑ ❑ ❑
6b	**Actuator Ci PA8** Tools required: Ci Actuator Reset (305495 Remove all actuators from the discharge valve. Test: Actuation. Visual inspection: No cracks, mechanical damages or corrosion Reset by pushing in plunger	❑ ❑ ❑
6c	**Actuator Ci IM8** Remove all actuators from the discharge valve. Test: Actuation. Visual inspection: No cracks, mechanical damages or corrosion Reset IM8 with reset tool	❑ ❑ ❑
6d	**PA system (next manifold)** See Pressure hoses (pt 7) Test: All inlet/outlet adapters are tightened. Verify every manifold is connected via the PA system.	❑ ❑ ❑
7	**Pressure hoses** Hoses are less than 10 years old (to be replaced in: __________) Visual inspection: No cracks, mechanical damages (check at bends), or corrosion Test: All hoses are tightened.	❑ ❑
8	**Manifold and Orifices** Visual inspection: Intact no corrosion or mechanical damages. Visual inspection: Correct Orifice size (as per IMT calculation). Test: Union is tightened	❑ ❑ ❑
9	**Pipe system** Visual inspection: Intact no corrosion or mechanical damages. Test: Hydrostatic pressure test (only new installations) Measure: Bracket distance (only new installations)	❑ ❑ ❑
10	**Nozzles** Visual inspection: Undisturbed flow of INERGEN, no corrosion or mechanical damages. Placed according to drawings and nozzle numbers (only new installations).	❑ ❑
11	**Signal Devices** Visual and audible inspection: Bells, sirens and flash work. Alarms as required by local authorities	❑ ❑

12	**Pressure relief** Test for correct function. Correct dimension. (As per IMT Calculation) (Area: ____)	❑
14	**Selector valves** Tools required: APTB tool (305148) SV22 Reset tool (305149) Visual inspection: Intact and correct actuation lines No cracks, mechanical damages (check at bends), or corrosion Verify every correct direction of each non-return valve in the PA system. SV22 Opening pressure ((Opening pressure: _______bar (max 35bar) Test: All inlet/outlet adapters are tightened	❑ ❑ ❑ ❑ ❑
14b	**SV with remote pneumatic actuation (PDS)** Verify that pressure reaches the intended Actuator Verify that the intended zone valve(s) opens within its required pressure (SV22=35bar) For PDS-II systems: 1. Place a Test gauge (0-100 bar kl 1.0 in place of the Pneumatic Actuator (IV7, NPP or Ci PA8) 2. Open the “Discharge“ valve 3. Open the pilot cylinder until the Test gauge reads 10bar, then close the Pilot cylinder 4. Open the “Zone” valve” 5. Increase pressure until the Selector valve opens by opening the pilot cylinder	❑ ❑
15	**Non return valves** Verify every correct direction of each non-return valve in the PA system	❑
16	**Bleed fittings** Visual inspection: All taps on bleed fittings are pushed down. When the system has been pressurized these taps will be out from the body requiring to be pushed down manually)	❑ ❑
17	**Additional system inspection** Visual inspection: Non-return/Check valve on pipe systems is installed correctly. Visual inspection: Non-return valves on pilot systems installed correctly. Selector valves as in accordance with SV22 manual	❑ ❑ ❑
18	**Final** All cylinders are opened and sealed in open position. All Actuators are installed. All Selector valves are closed The system is set for use. (activation is reconnected) Informed the employees that the test is finish. Informed the security department that the test is finish. Record that the system has been serviced.	❑ ❑ ❑ ❑ ❑ ❑ ❑

Tools necessary to perform service

530509	Tool Cylinder Pressure gauge M25+W24
530810	Toolkit: Ci 2015
530820	Toolkit: FE SV 2015
530830	Toolkit: Ci SV 2015

305490 IV8 sep disc	Used for resetting after discharge
305491 IV8 Act plug	Used for resetting after discharge

For dismantling the valve for resetting after discharge

305495 Ci Actuator Reset Tool — Used for service
For resetting the Ci Actuators after activation (whether or not the cylinder has been discharged)

530506 IS8B Electric Circ Tester — Used for service
Verifies that sufficient power can be routed to the electrical actuator.

530502 Manoswitch tester — Used for service
Verifies y the cylinder pressure monitoring circuitry

530520 Ci Force Act test — Used for service
Measure the required force to operate the discharge valve and measure the force provided by the actuator (all actuators, electrical, manual, and pneumatic)

530525 Ci Outlet Damper — Used for service
Testing the discharge valve

305149 SV22 Reset tool — Used for service
To reset the SV selector valve

305148 APTB (Test port) — Used for service
Measure the required pressure to activate the Selector valve

530530 Tool: NRV 1/4 Test Flow — Used for service
Test the Non Return Valve for flow

530531 Tool: NRV 1/4 Test No Flow — Used for service
Test the Non Return Valve for leaktightness

530540 Tool: Pressure switch setter — Used for service
To verify the switchpoint for manifold and pipe pressure switches.

Certification of Service & Maintenance

Customer

Company : ______________________ Tel. (Primary) : ______________
Address : ______________________ Tel. (Secondary) : ______________
City & Zip ______________________ Tel. (Other): ______________
Contact. : ______________________ ______________
Invoice address : ______________________ Att: ______________

System information

General ______________________
Location ______________________
Type : ________ Control panel ________ Sect: ________
Alarm point: ________ Battery backup : ________ Qty : ________ Year: ________
Detector Qty: ________ Cylinder : ________ Qty : ________
Valves : ________ Press relief: ________
Location : ______________________

Check list (signaler)

							Tested Yes No	OK Yes No
				Signal transmission				
☐	Fault :						❑ ❑	❑ ❑
☐	Fire : 1. ☐, 2. ☐						❑ ❑	❑ ❑
☐	Extinguishing.:						❑ ❑	❑ ❑
☐	Other :						❑ ❑	❑ ❑
☒	***1.***	***2.***	***Ext***	***Restart*** *Aut. Man.*	***Type***	***Section.***		
☐	☐	☐	☐	❑ ❑	Engine stop :		❑ ❑	❑ ❑
☐	☐	☐	☐	❑ ❑	Vent. stop :		❑ ❑	❑ ❑
☐	☐	☐	☐	❑ ❑	Doors :		❑ ❑	❑ ❑
☐	☐	☐	☐	❑ ❑	Dampers :		❑ ❑	❑ ❑
☐	☐	☐	☐	❑ ❑	Other :		❑ ❑	❑ ❑

Receipt

Service & Maintenance performed in accordance with checklist : *Yes* ❑
System is in normal operation Auto. ❑ Man. ❑ : *Yes* ❑
The system is found to be in compliance with current rules and requirements:: *Yes* ❑
System is in operation but arrangements for corrections must be made: ❑

____

____

Serious breaches are found and the system is not approved ❑

____

____

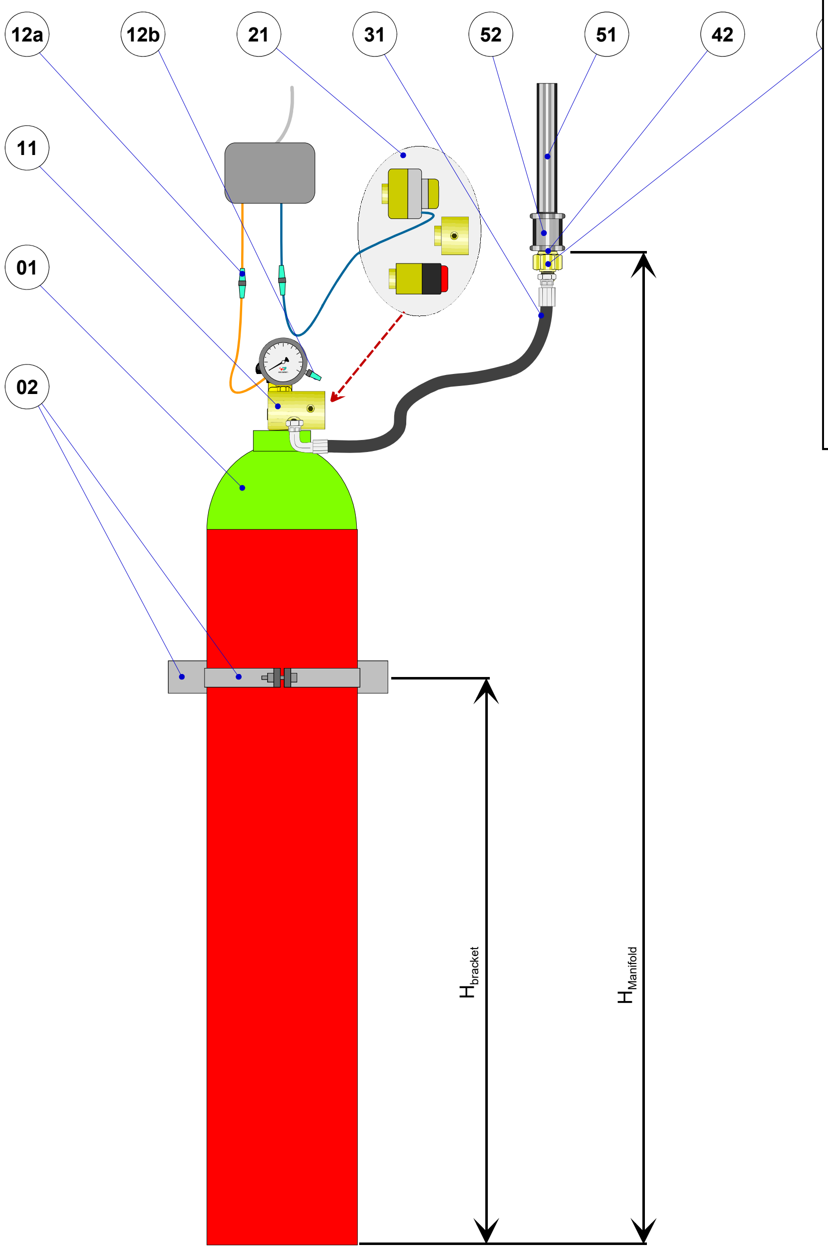
Date + signature

______________________ ______________________
Inspector Owners representative

Chapter 10: Typical installations

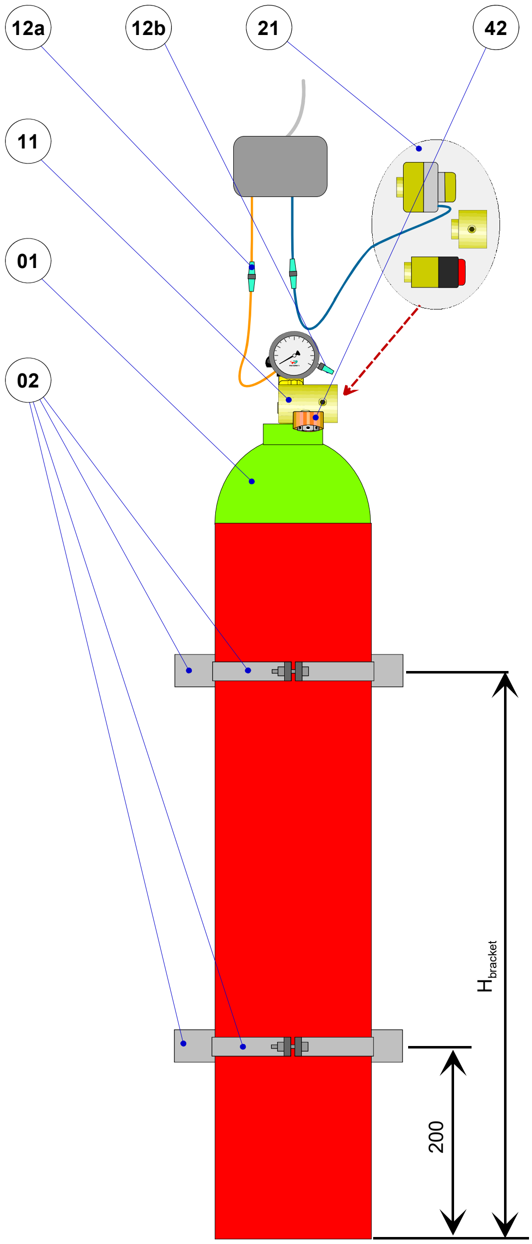
Single cylinder system

Pos.	Name			Quantity	Item	
01	Cylinders	H_{brkt}	H_{Mfld}			
	Cylinder 80-300 M25	1400	2100	1	200624	
	Cylinder 50-300 M25	1200	1850		200615	
	Cylinder 30-300 M25	700	1400		200609	
	Cylinder 80-200 W24	1400	2100		200616	
	Cylinder 50-200 W24	1200	1850		200610	
	Cylinder 30-200 W24	700	1400		200606	
02	Cylinder rail			1	400301	
	Cylinder bracket 80l			1	400109	
11	Ci IV8-300 Manoswitch			1	305410	
	Ci IV8-300 Basic				305411	Ci
	IV8-200 Manoswitch				305420	
	Ci IV8-200 Manoswitch				305420	
	Ci IV8-200 Basic				305421	
12	Manoswitch 470-5K6 cable 2m start kit			1	540360	
21	Ci IM8 Manual actuator				305442	
	Ci IS8B w manual				305451	
	Ci IS8B Solenoid only				305450	
	Ci PA8 Pneumatic actuator				305448	
31	Hose Dn10-400, 0.5m std INERGEN			1	303102	
	Hose Dn10-400, 1.0m std INERGEN				303104	
	Hose Dn10-400, 1.5m std INERGEN				303106	
	Hose Dn10-400, 2.0m std INERGEN				303108	
	Hose Dn10-400, 2.5m std INERGEN				303109	
	Hose Dn10-400, 3.0m std INERGEN				303111	
	Hose Dn10-400, 4.0m std INERGEN				303113	
41	Ci MT1 Manifold			1	305701	
	Ci MT2 Manifold				305702	
	Ci MT3 Manifold				305703	
	Ci MT4 Manifold				305704	
	Ci MT5 Manifold				305705	
	Ci MT6 Manifold				305706	
	Ci MT7 Manifold				305707	
	Ci MT8 Manifold				305708	
	Ci MT9 Manifold				305709	
	Ci MT10 Manifold				305710	
42	Ci MT ISO Orifice kit 1”				305730	
	Ci MT orifice kit npt 1”				305731	
51	Pipe system					
52	Fittings for pipe system					
61	Nozzles (IN-xx …) (not shown on drawing)					
71	Pressure relief) (not shown on drawing)					
72	Signs and labels					
73	Accessories					
	Junction box				540350	
91	Remote activation					
92	Control panels					
	See system manual for complete list and options for the individual components					



Single cylinder w nozzle

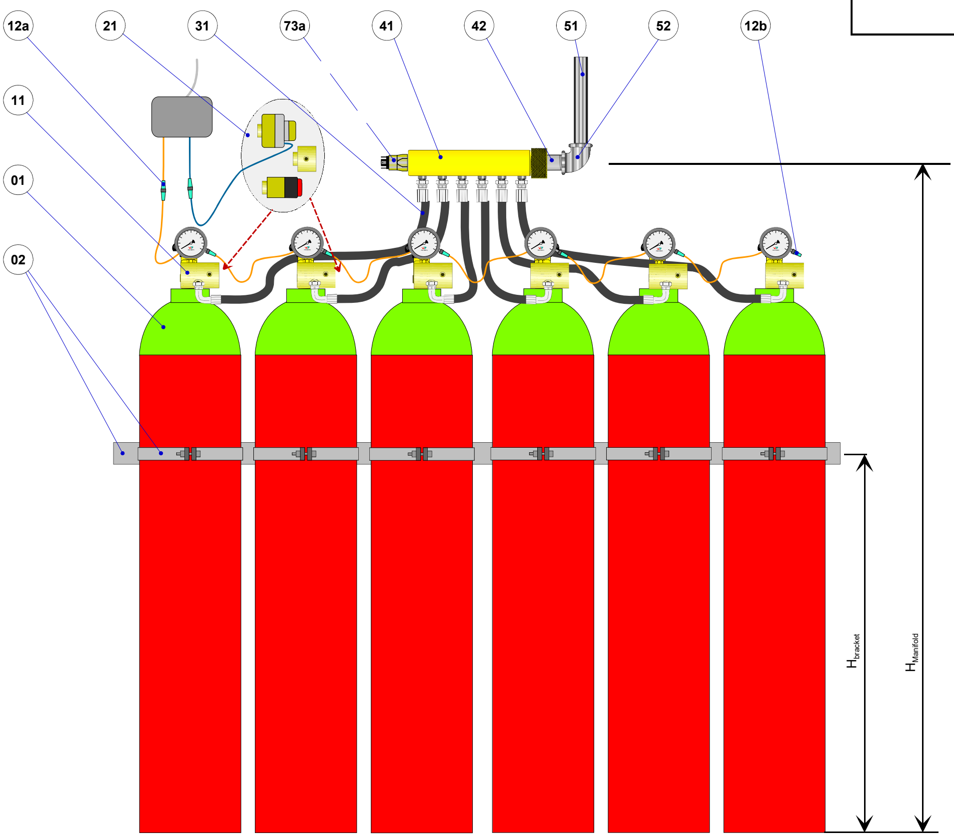
Pos.	Name			Quantity	Item	
01	Cylinders	H_{brkt}	H_{Mfld}			
	Cylinder 80-300 M25	1400		1	200624	
	Cylinder 50-300 M25	1200	1850		200615	
	Cylinder 30-300 M25	700	1400		200609	
	Cylinder 80-200 W24	1400	2100		200616	
	Cylinder 50-200 W24	1200	1850		200610	
	Cylinder 30-200 W24	700	1400		200606	
02	Cylinder rail	2	400301			
	Cylinder bracket 80l	2	400109			
11	Ci IV8-300 Manoswitch			1	305410	
	Ci IV8-300 Basic				305411	Ci
	IV8-200 Manoswitch				305420	
	Ci IV8-200 Manoswitch				305420	
	Ci IV8-200 Basic				305421	
12	Manoswitch 470-5K6 cable 2m start kit			1	540360	
21	Ci IM8 Manual actuator				305442	
	Ci IS8B w manual				305451	
	Ci IS8B Solenoid only				305450	
	Ci PA8 Pneumatic actuator				305448	
61	Nozzle w deflector				303129	
71	Pressure relief) (not shown on drawing)					
72	Signs and labels					
73	Accessories					
	Junction box				540350	
91	Remote activation					
92	Control panels					
	See system manual for complete list and options for the individual components					



Single manifold system

All discharge valves connected to a common manifold will be “back pressure activated” meaning they will be activated by the pressure from the manifold when the Master cylinder connected to that manifold is activated.

Pos.	Name			Quantity	Item	
01	Cylinders	H_{brkt}	H_{Mfld}			
	Cylinder 80-300 M25	1400	2100	1	200624	
	Cylinder 50-300 M25	1200	1850		200615	
	Cylinder 30-300 M25	700	1400		200609	
	Cylinder 80-200 W24	1400	2100		200616	
	Cylinder 50-200 W24	1200	1850		200610	
	Cylinder 30-200 W24	700	1400		200606	
02	Cylinder rail	1	400301			
	Cylinder bracket 80l	1	400109			
11	Ci IV8-300 Manoswitch			1	305410	
	Ci IV8-300 Basic				305411	Ci
	IV8-200 Manoswitch				305420	
	Ci IV8-200 Manoswitch				305420	
	Ci IV8-200 Basic				305421	
12	Manoswitch 470-5K6 cable 2m start kit			1	540360	
21	Ci IM8 Manual actuator				305442	
	Ci IS8B w manual				305451	
	Ci IS8B Solenoid only				305450	
	Ci PA8 Pneumatic actuator				305448	
31	Hose Dn10-400, 0.5m std INERGEN			1	303102	
	Hose Dn10-400, 1.0m std INERGEN				303104	
	Hose Dn10-400, 1.5m std INERGEN				303106	
	Hose Dn10-400, 2.0m std INERGEN				303108	
	Hose Dn10-400, 2.5m std INERGEN				303109	
	Hose Dn10-400, 3.0m std INERGEN				303111	
	Hose Dn10-400, 4.0m std INERGEN				303113	
41	Ci MT1 Manifold			1	305701	
	Ci MT2 Manifold				305702	
	Ci MT3 Manifold				305703	
	Ci MT4 Manifold				305704	
	Ci MT5 Manifold				305705	
	Ci MT6 Manifold				305706	
	Ci MT7 Manifold				305707	
	Ci MT8 Manifold				305708	
	Ci MT9 Manifold				305709	
	Ci MT10 Manifold				305710	
42	Ci MT ISO Orifice kit 1”				305730	
	Ci MT orifice kit npt 1”				305731	
51	Pipe system					
52	Fittings for pipe system					
61	Nozzles (IN-xx …) (not shown on drawing)					
71	Pressure relief) (not shown on drawing)					
72	Signs and labels					
73	Accessories					
	Junction box				540350	
91	Remote activation					
92	Control panels					
	See system manual for complete list and options for the individual components					

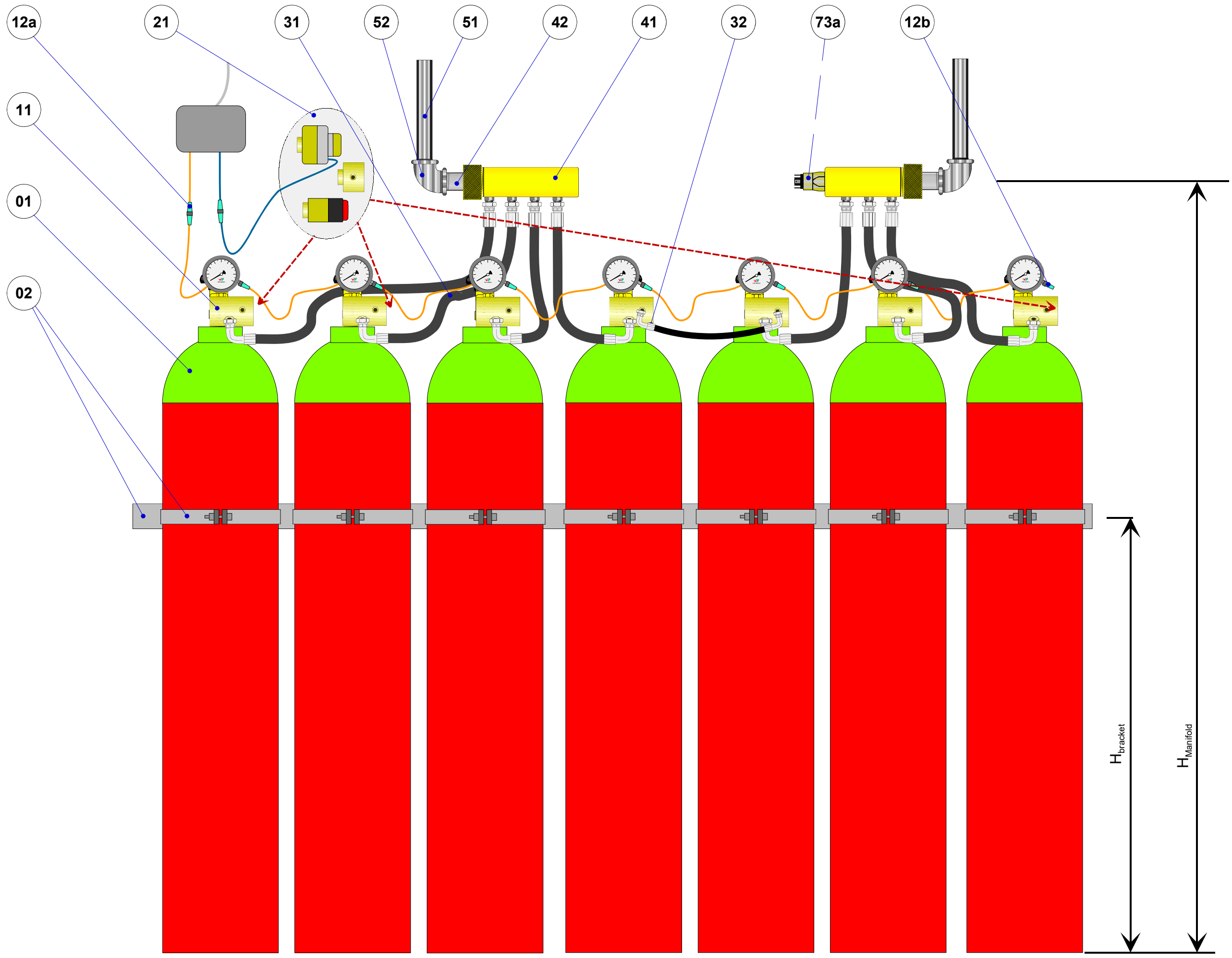


Multiple manifold system I

If multiple manifolds are used in a system the pressure from a activated cylinder on one manifold must be used to activate a cylinder on the next manifold. The cylinders do not have to be the first and last on the manifold.

See datasheet on previous page for items not listed here.

Pos.	Name	Quantity	Item
32	Ci MT next kit (350mm)	1	305621

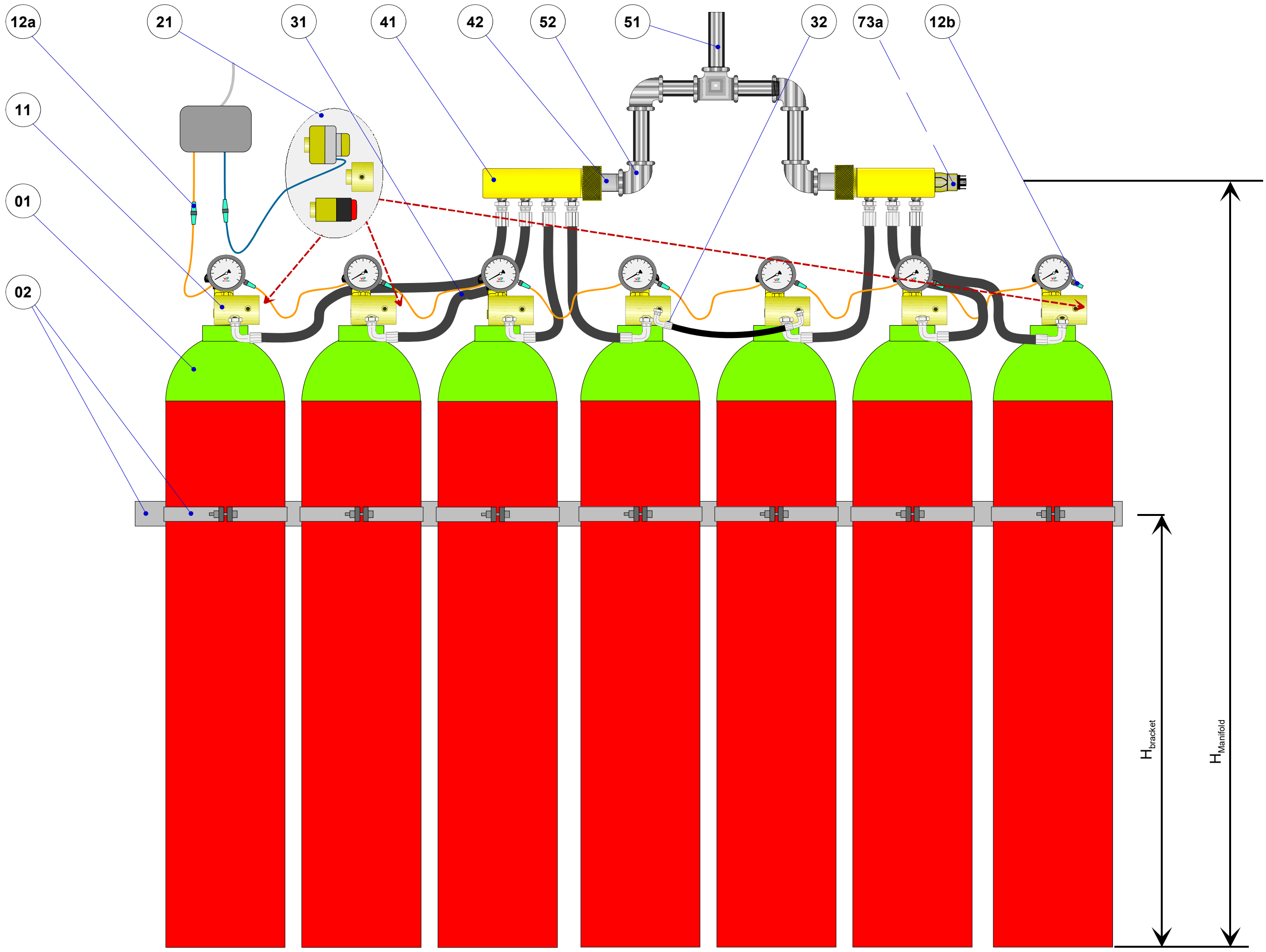


Multiple manifold system II

Even if the manifolds are connected to the same pipe system pressure must be taken from a valve to ensure sufficient pressure for activation.

See datasheet on previous page for items not listed here.

Pos.	Name	Quantity	Item
32	Ci MT next kit (350mm)	1	305621



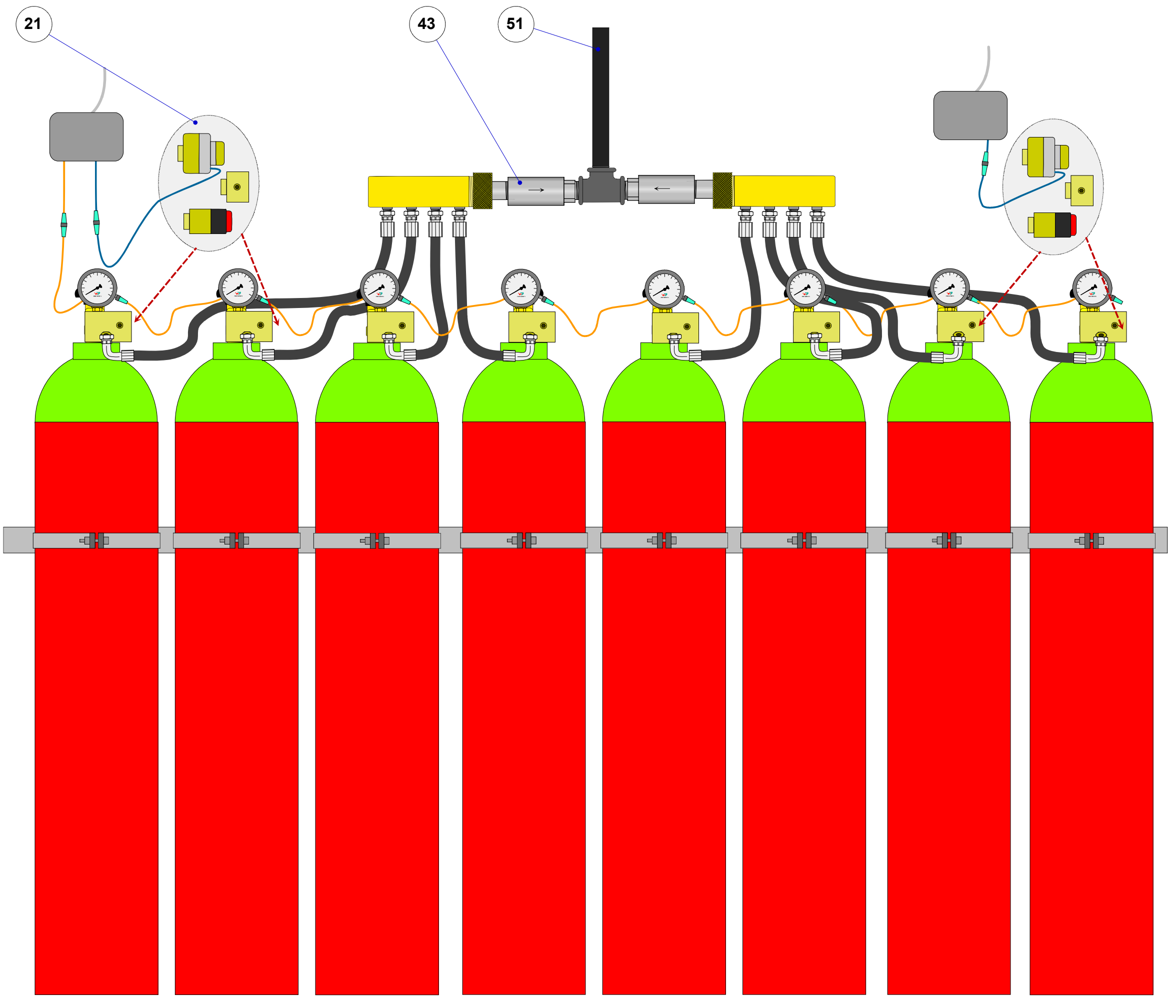
System with back-up system

If a back-up fire extinguishing system is sharing the same pipe system a non-return valve must be used to separate the 2 systems in order to prevent the back-up systemn to be activated by the pressure generated in the pipe system when the first extinguishing system is activated.

Activators must be doubled, as each system must have its own actuators.

See datasheet on previous page for items not listed here.

Pos.	Name	Quantity	Item
43	Non Return valve 1”	2	305304



Directional system using DV7a

Up to 3 discharge valves may be fitted to each cylinder, this way up to 3 zones can be protected.

See datasheet on previous page for items not listed here.

Pos.	Name	Quantity	Item
12c	DV7a-2 M25 (300 bar)	6	304042
	DV7a-3 M25 (300 bar)		304043
	DV7-2 W24 (200 bar)		302163
	DV7-3 W24 (200 bar)		302164