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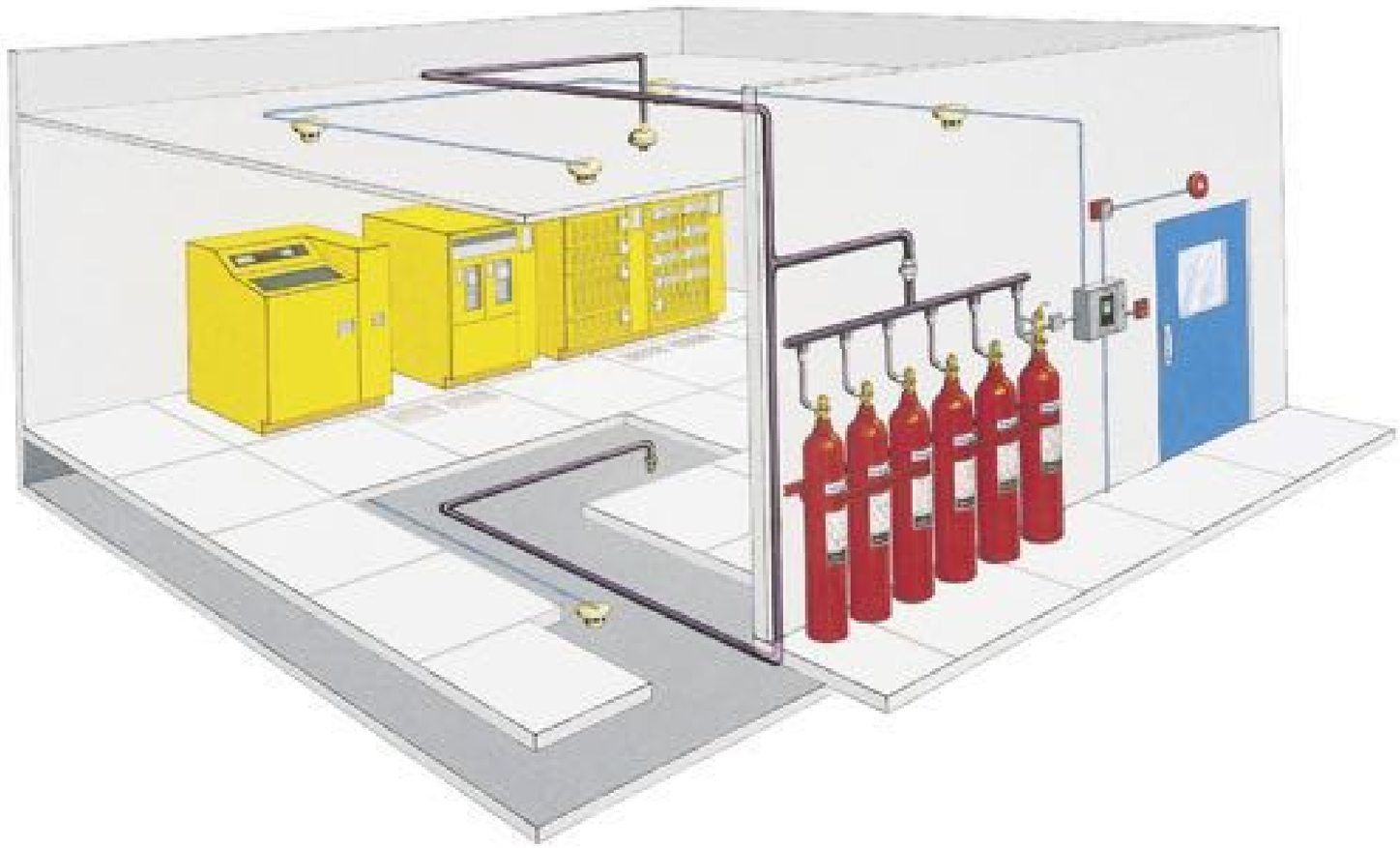
Gaseous Fire Suppression Systems
Agent Selection

INTRODUCTION – AGENT SELECTION

With the multiple Suppression System choices for protecting risks consideration should be taken by the fire system designer on a number of factors which will aid the selection of a suitable Gaseous Fire Suppression system during the risk analysis phase.



INTRODUCTION – AGENT SELECTION

1. Safety for people.
2. Design concentrations and amount of Agent needed for the particular risk.
3. Extinguishing mechanism used by the agent.
4. Any Toxic By Products produced by the Agent after discharge and extinguishment.
5. Ozone depletion potential (ODP), Global Warming potential (GWP) and Total Equivalent Warming Impact (TEWI) ***https://en.wikipedia.org/wiki/Total_equivalent_warming_impact***
6. The protected enclosures structural strength in regards to over and under pressures produced during the Agent Discharge.
7. Cylinder locations and Pipe distances to the protected area.
8. Agent Holding time in the protected area after system discharge.
9. Overall system costs, during installation and the lifetime of the system.

DESIGN CONCENTRATION – INERT AGENTS (IG-55 & IG-541)

Inert Gases use oxygen reduction by reducing the levels of Oxygen (O_2) to between 11 and 12%

For a Design Concentration of **45.1%** for **IG-55,** this equates to a residual O_2 level of approx 11.5%
For a Design Concentration of **39.9%** for **IG-541,** this equates to a residual O_2 level of approx 12.5%

The **NOAEL** for both agents of **43%** equates to a residual O_2 level of approx 12%
The **LOAEL** (safety for people) for both agents of **52%** equates to a residual O_2 level of approx 10%

Agent	Design concentration Higher class A	NOAEL (No Observed Adverse Effects Level)	LOAEL (Lowest Observed Adverse Effects Level)
IG-55	45.1 %	43.0%	52.0%
IG-541	39.9 %	43.0%	52.0%

DESIGN CONCENTRATION – CHEMICAL AGENTS (FM200 & NOVEC 1230)

Chemical agents use a combination of Heat Absorption and Chemical Action in extinguishing a fire.

For a Design Concentration of **8.5%** for **FM200** the **NOAEL** is **9.0%** with an **LOAEL** of **10.5%**

For a Design Concentration of **5.6%** for **NOVEC 1230** the **NOAEL** is **10.0%** with an **LOAEL** of **10.0%**

References:-

LOAEL - https://en.wikipedia.org/wiki/Lowest-observed-adverse-effect_level

NOAEL - https://en.wikipedia.org/wiki/No-observed-adverse-effect_level

Agent	Design concentration Higher class A	NOAEL (No Observed Adverse Effects Level)	LOAEL (Lowest Observed Adverse Effects Level)
FM200®	8.5 %	9.0%	10.5%
NOVEC 1230™	5.6 %	10.0%	10.0%

ENVIROMENTAL CONSIDERATIONS

- ODP, GWP and TEWI.
- ODP = Ozone Depleting Potential
- GWP = Global Warming Potential
- CO_2, used as the reference over 100 years
- SGG = Synthetic Greenhouse Gas lifetime
- SGG = impact over lifetime
- TEWI = Total Environmental Warming Impact and lifetime

Inert Gases such as **IG-55** and **IG-541** have **ZERO** Ozone Depleting Potential, **ZERO** Global Warming Potential and **ZERO** Total Environmental Warming Impact.

INERT AGENTS.

IG-55 & IG-541

INERGEN (IG-541)

An **INERGEN (IG-541)** system extinguishes fires by a reduction of the oxygen concentration in the atmosphere of the hazard enclosure.

As an example an **INERGEN (IG-541)** system will reduce the oxygen content in the atmosphere from **20.9%** to approximately **12.5%** whilst increasing the carbon dioxide content from **0.03%** to around **3.0%.**

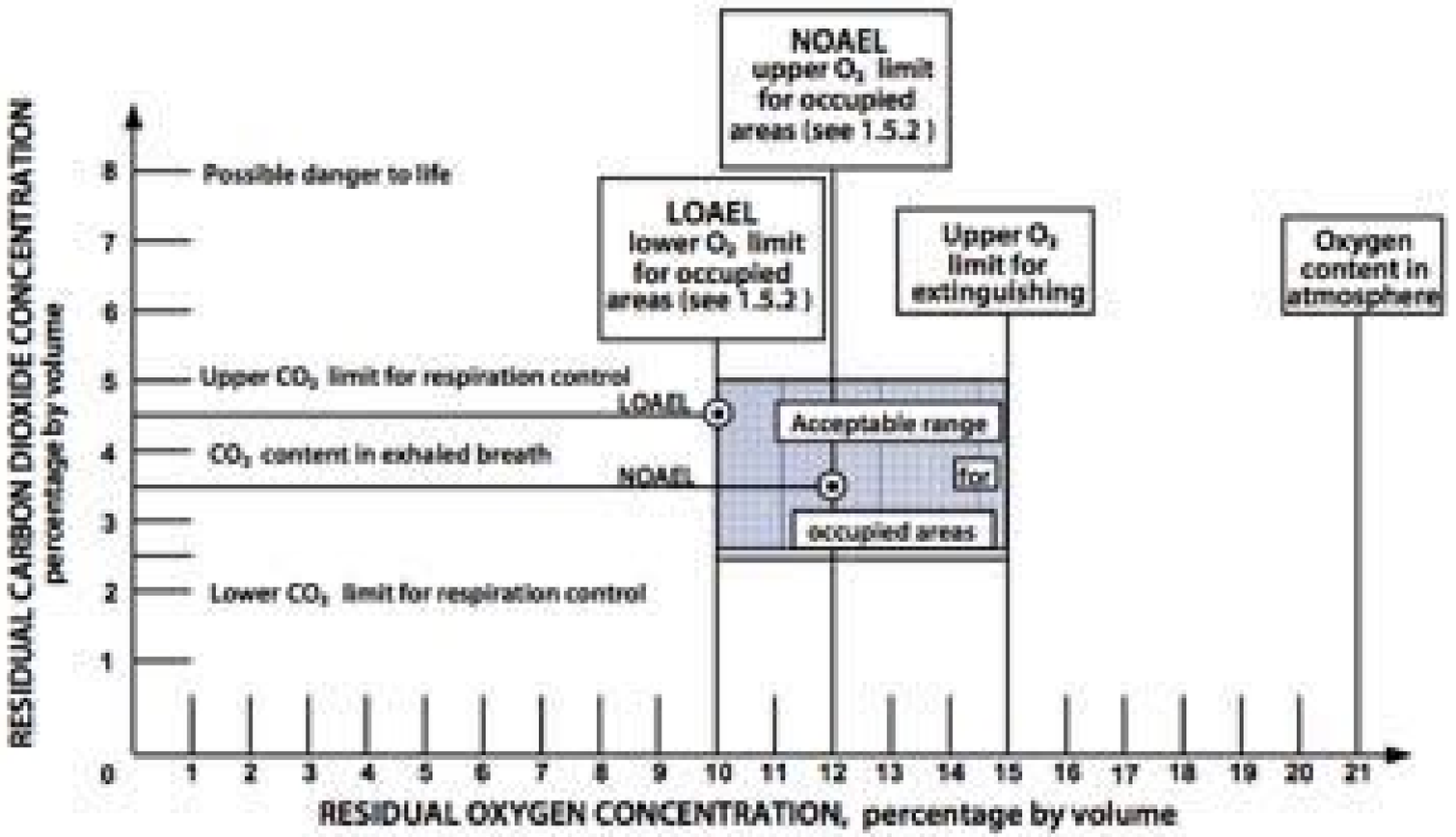
The increase in carbon dioxide content increases an individual's respiration rate and the body's ability to absorb oxygen thus allowing the body to compensate for the lower oxygen content.

Since **INERGEN (IG-541)** is stored as a gas, it discharges as an invisible gas, allowing people to safely exit a protected space without obscured vision.

Inert gas systems are particularly valuable in extinguishing fires in enclosures containing hazards or equipment where a clean, electrically non-conductive medium is essential or where the cleaning up of foam, water or powder would be problematic.

INERGEN (IG-541)

Inergen (IG-541) Inert Gas System - Graph



* Predicted oxygen and carbon dioxide residual concentration for NOAEL and LOAEL

I3 / PROINERT / ARGONITE (IG-55)

An **I3 (IG-55)** system extinguishes fires by a reduction of the oxygen concentration in the atmosphere of the hazard enclosure.

As an example an **I3 (IG-55)** system will reduce the oxygen content in the atmosphere from **20.9%** to approximately **12.5%.**

Since **I3 (IG-55)** agent is stored as a gas, it discharges as an invisible gas, allowing people to safely exit a protected space without obscured vision.

Inert gas systems are particularly valuable in extinguishing fires in enclosures containing hazards or equipment where a clean, electrically non-conductive medium is essential or where the cleaning up of foam, water or powder would be problematic.

CHEMICAL AGENTS.

FM200® & NOVEC 1230™

FM200 (HFC 227EA)

FM200 (HFC 227ea) is a colourless, almost odourless, electrically non-conductive gas with a density approximately six times that of air.

FM200 (HFC 227ea) extinguishes fires mainly by physical means, but also by some chemical means.

FM200 (HFC 227ea) systems are particularly valuable in extinguishing fires in enclosures containing hazards or equipment where a clean, electrically non-conductive medium is essential or where the cleaning up of foam, water or powder would be problematic.

NOVEC 1230™ (FK-5-1-12)

NOVEC 1230 (FK-5-1-12) is a clear, colourless, almost odourless, electrically non-conductive gas with a density approximately 11 times that of air.

NOVEC 1230 (FK-5-1-12) extinguishes fires mainly by physical means, but also by some chemical means.

NOVEC 1230 (FK-5-1-12) systems are particularly valuable in extinguishing fires in enclosures containing hazards or equipment where a clean, electrically non-conductive medium is essential or where the cleaning up of foam, water or powder would be problematic.

Agent Comparison

AGENT COMPARISON TABLE

Name	NOVEC 1230™	Inert Gas	FM200 ® (HFC-227ea)
Ingredients	1,1,1,2,2,4,5,5 5-NONAFLOURO-4-(TRIFLOUROMETHYL) -3-PENTAN ONE 99.9%	**IG-541** Nitrogen 52% Argon 40% CO_2 8% **IG-55** Argon 50% Nitrogen 50%	Heptaflouropropane 99.6%
Stored as	Liquid	Compressed Gas	Liquid
Propellant	N2 in Cylinder	NA	N2 in Cylinder
Storage Pressure	25 / 42 Bar	300 Bar	25 / 42 Bar
Room Pressure relief required	Yes (Over / Under pressures)	Yes (Overpressure)	Yes (Over / Under pressures)
Appearance	Colourless, Low Odour	Colourless, Odourless	Colourless, Odourless

AGENT COMPARISON TABLE - CONTINUED

Name	NOVEC 1230™	Inert Gas	FM200 ® (HFC-227ea)
Closest Cylinder Filling	Most Major Capital Cities	Most Major Capital Cities Some SupaGas centres	Most Major Capital Cities
Design Concentration Higher Class A - Electrical	5.6%	IG-541 = 39.9% IG-55 = 45.1%	8.5%
Pipe, fittings	Schedule 40 Pipe, Galvanised Steel fittings	Schedule 40 Pipe, 3000lb fittings	Schedule 40 Pipe, Galvanised Steel fittings
How it works	Heat Absorption	Inert gas, reduces oxygen levels to between 11 and 12%	80% Cooling 20% Chemical Action
Suitable for Class of Fire	A,B,E	A,B,E	A,B,E
Safe for Humans	At design concentration	At design concentration	At design concentration

AGENT COMPARISON TABLE - CONTINUED

Name	NOVEC 1230™	Inert Gas	FM200 ® (HFC-227ea)
Ozone Depleting Potential	0	0	0
Global Warming Potential	1	0	2900
Atmospheric Life	5 days	NA	33 Years
Environmental Controls	None	None	* see below
Cylinder Storage	Inside or adjacent risk area	Inside, adjacent or **remote** from risk area	Inside or adjacent risk area
Actuation	Solenoid type, Auto or Manual, Cable, Pressure	Solenoid type, Auto or Manual, Pressure	Solenoid type, Auto or Manual, Cable, Pressure
Discharge Duration	6 to 10 seconds	Maximum 60 seconds	6 to 10 seconds

*** Listed By Dept Environment Water Heritage and the Arts as a controlled substance (imports). Installers and maintainers require license from the FPAA. Owners / Maintainers must report discharges. Permits required from ODS & SGG Board for discharge tests.**

AGENT COMPARISON TABLE - CONTINUED

Name	NOVEC 1230™	Inert Gas	FM200 ® (HFC-227ea)
Room sealing requirements	**Extremely** well sealed	Well sealed	**Very** well sealed
Fan Test Retention Time ($100m^3$)	6.2 Minutes **FAIL**	20.2 Minutes **PASS**	7.6 Minutes **FAIL**
Fan Test Retention Time ($500m^3$)	11.5 Minutes **PASS**	35.4 Minutes **PASS**	13.1 Minutes **PASS**
Fan Test Retention Time ($1500m^3$)	19.9 Minutes **PASS**	48.2 Minutes **PASS**	22.0 Minutes **PASS**

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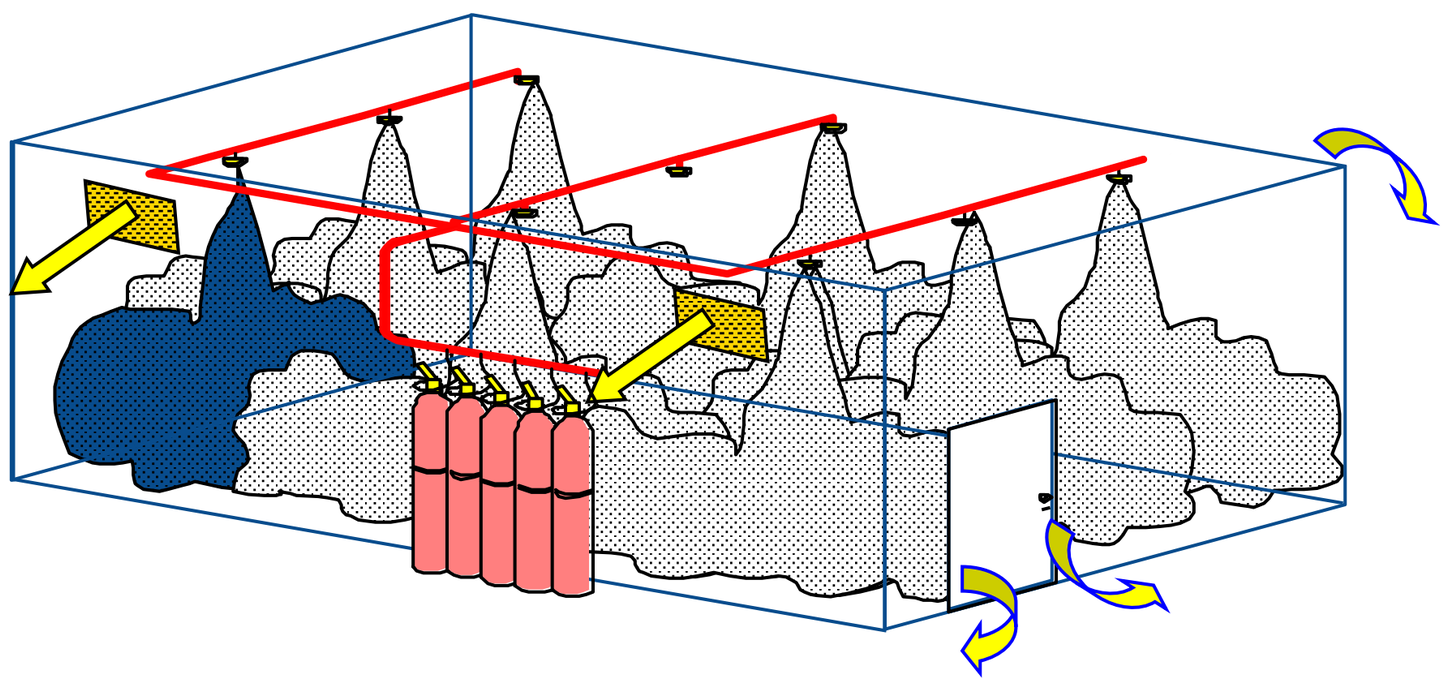
Pressure Relief

Discharge of extinguishing agent into a protected enclosure will result in a change of pressure in the enclosure.

If the enclosure is sealed too tightly during the agent discharge the pressure change could exceed the structural strength of its bounding surfaces – windows, doors, walls, ceiling.

This can result in both failure of the enclosure and then failure of the gaseous flooding system to achieve suppression due to the agent leaking out due to structural failure.



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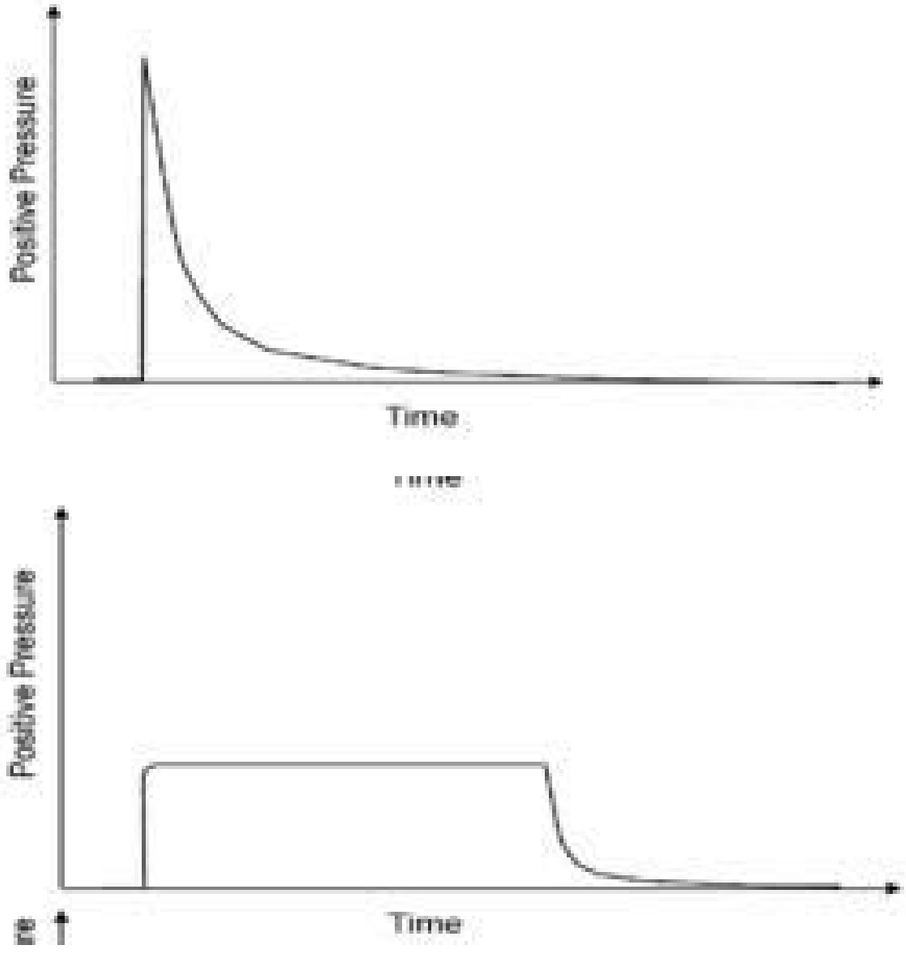
Pressure Relief

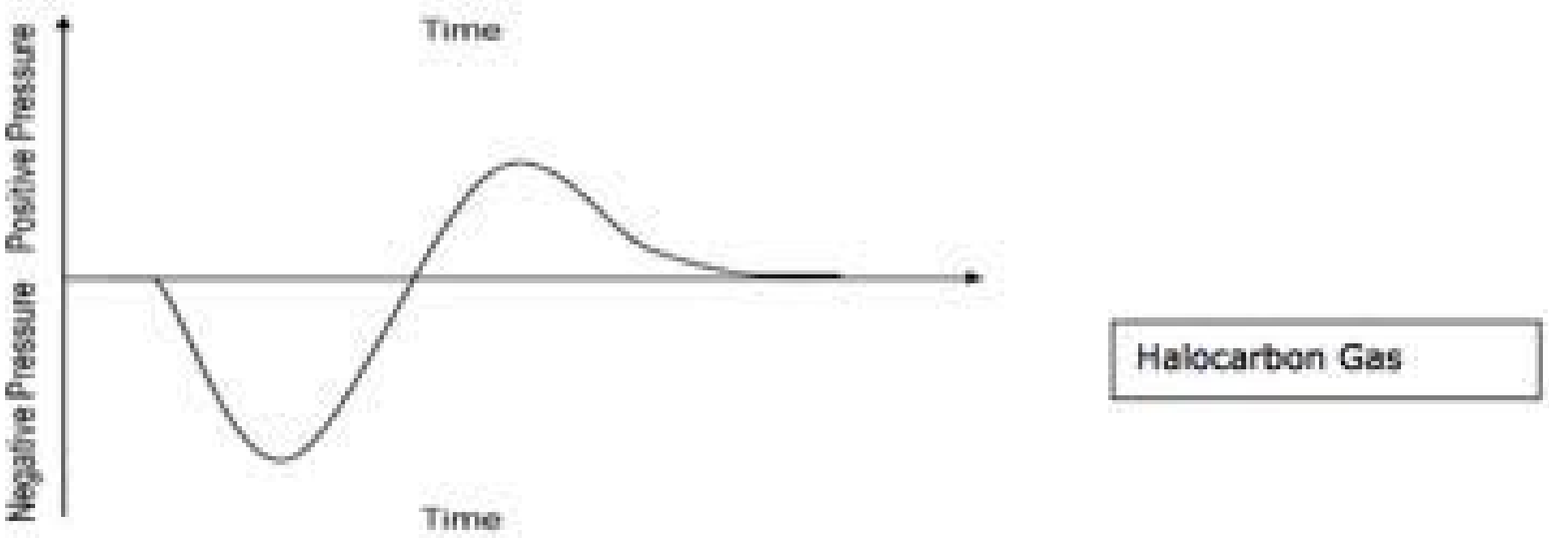
INERT GASES – CONSIDERATION FOR ROOM POSITIVE OVERPRESSURE ONLY



Inert Gas

Inert Gas (Constant Flow)

CHEMICAL AGENTS – CONSIDERATION FOR BOTH ROOM POSITIVE & NEGATIVE PRESSURES



AGENT HOLD TIMES

Agent Holding Times after system discharge and during the ten (10) minute hold time required by AS ISO 14520 directly relate to the enclosures ability to retain the Agent during this period with particular attention to Room Sealing.

The table below is based on Higher Class A risks, density of mixing air and the gaseous agent.

- Air Density is 1.200 kg/m^3 @ 20 deg ^{C}
- The Higher above 1.200 kg/m^3 the lower the predicted agent hold time.

Agent	Density of Mixing Air & Gaseous Agent
IG-541	1.279
IG-55	1.296
FM200®	1.723
NOVEC 1230™	1.912

Inert Agents such as IG-541 maintain a longer agent hold due to their lower density as opposed to the Chemical Agents such as FM200

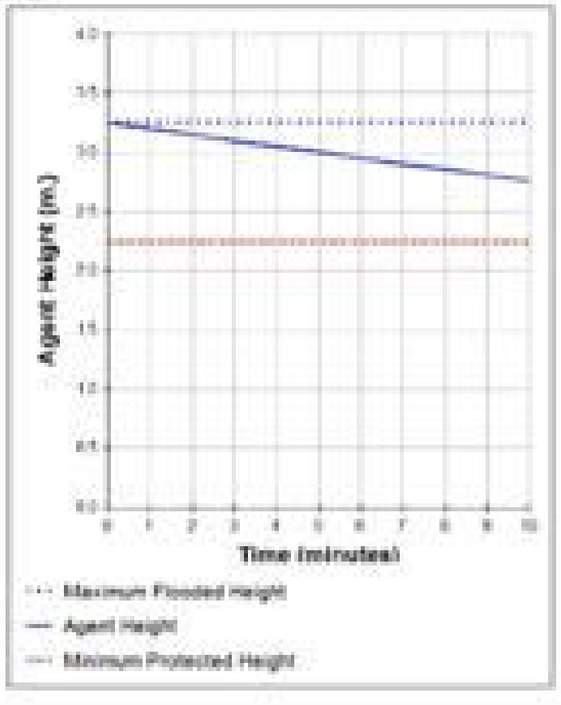
ENCLOSURE INTEGRITY TEST EXAMPLE - IG541

Test date/time	*2013/05/07 14:13*	Net protected volume, V_n	*89 m^3*
Tester	*Ryan Moffet*	Maximum Flooded Height, H_0	*3.25 m.*
Certified to Level:	*2 - Single fan NFPA room test*	Minimum Protected Height, H	*2.24 m.*
Signature	.....	Static during discharge, P_{ss}	*0.0 Pa*
Elevation above sea level	*0 m.*	Operating temperature	*20 C*
Correction method	*NFPA 2001 (2000) Formula A-3-5.3.3*	Initial concentration, C	*42.74%*
Correction factor	*1*	Mixing during retention	*No*
Agent	*INERGEN by Weight (IG-541)*	Agent quantity	*50 m^3*
Actual total leakage, A_t	*0.0490 m^2*	Minimum concentration, C_{min}	*42.74%*
Actual lower leakage, A_l	*0.0245 m^2*	Minimum retention time	*10.0 minutes*

Below ceiling leakage defaulting to worst case -- 50% of total leakage.

This enclosure was tested in compliance with ISO 14520.1 Annex E.
Assuming no continual mixing during the retention period, enclosure leakage could allow sufficient agent to be lost to cause an air/agent interface to descend from a Maximum Protected Height of **3.25 m.** to the Minimum Protected Height specified of **2.24 m.**
The retention time would then be **21.5 minutes** which exceeds the minimum retention time of **10 minutes**. The enclosure therefore **passes** this acceptance procedure.

Notes ***Example using IG-541 (Inergen) or other similar Inert Gas***



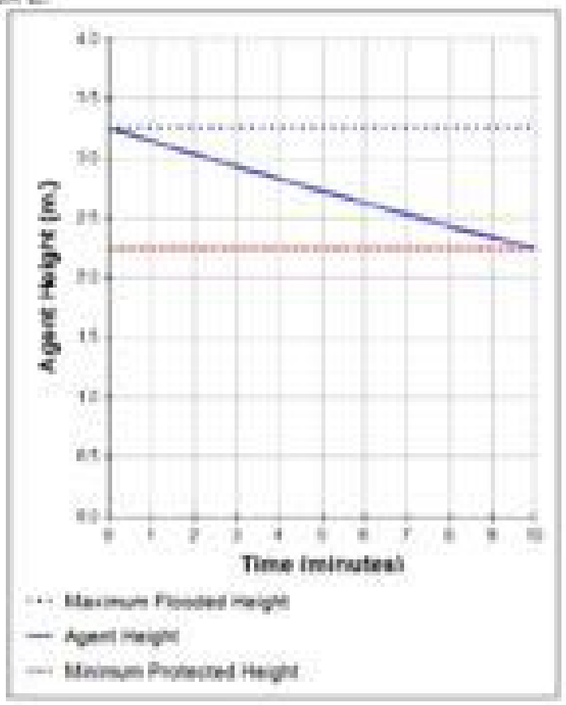
ENCLOSURE INTEGRITY TEST EXAMPLE - FM200®

Test date/time	*2013/05/07 14:20*	Net protected volume, V_n	*89 m^3*
Tester	*Ryan Moffet*	Maximum Flooded Height, H_0	*3.25 m.*
Certified to Level:	*2 - Single fan NFPA room test*	Minimum Protected Height, H	*2.24 m.*
Signature	.....	Static during discharge, P_{ba}	*0.0 Pa*
Elevation above sea level	*0 m.*	Operating temperature	*20 C*
Correction method	*NFPA 2001 (2000) Formula A-3-5.3.3*	Initial concentration, C	*8.50%*
Correction factor	*1*	Mixing during retention	*No*
Agent	*HFC227ea (FM200)*	Agent quantity	*8 m^3*
Actual total leakage, A_t	*0.0490 m^2*	Minimum concentration, C_{min}	*8.50%*
Actual lower leakage, A_l	*0.0245 m^2*	Minimum retention time	*10.0 minutes*

Below ceiling leakage defaulting to worst case -- 50% of total leakage.

This enclosure was tested in compliance with ISO 14520.1 Annex E.
Assuming no continual mixing during the retention period, enclosure leakage could allow sufficient agent to be lost to cause an air/agent interface to descend from a Maximum Protected Height of **3.25 m.** to the Minimum Protected Height specified of **2.24 m.**
The retention time would then be **10.1 minutes** which exceeds the minimum retention time of **10 minutes**. The enclosure therefore **passes** this acceptance procedure.

Notes ***Example using FM200 gas***



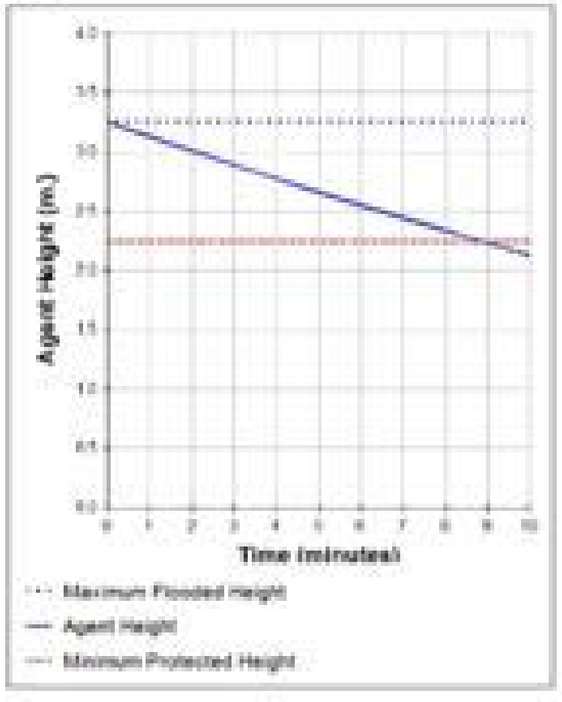
ENCLOSURE INTEGRITY TEST EXAMPLE - NOVEC 1230™

Test date/time	*2013/05/07 14:16*	Net protected volume, V_n	*89 m^3*
Tester	*Ryan Moffet*	Maximum Flooded Height, H_0	*3.25 m.*
Certified to Level:	*2 - Single fan NFPA room test*	Minimum Protected Height, H	*2.24 m.*
Signature	.....	Static during discharge, P_{ss}	*0.0 Pa*
Elevation above sea level	*0 m.*	Operating temperature	*20 C*
Correction method	*NFPA 2001 (2000) Formula A-3-5.3.3*	Initial concentration, C	*5.60%*
Correction factor	*1*	Mixing during retention	*No*
Agent	*Novec 1230*	Agent quantity	*5 m^3*
Actual total leakage, A_t	*0.0490 m^2*	Minimum concentration, C_{min}	*5.60%*
Actual lower leakage, A_l	*0.0245 m^2*	Minimum retention time	*10.0 minutes*

Below ceiling leakage defaulting to worst case -- 50% of total leakage.

This enclosure was tested in compliance with ISO 14520.1 Annex E.
Assuming no continual mixing during the retention period, enclosure leakage could allow sufficient agent to be lost to cause an air/agent interface to descend from a Maximum Protected Height of **3.25 m.** to the Minimum Protected Height specified of **2.24 m.**
The retention time would then be **8.9 minutes** which is less than the minimum retention time of **10 minutes**. The enclosure therefore **FAILS** this acceptance procedure.

Notes ***Example using NOVEC gas***



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Questions ?