Politecnico di Milano

Mechanics Department

Master of Science in Mechanical Engineering

An Integrated Approach from the Preliminary Design to the Final Proposal of Gaseous Fire Suppression Systems

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Abstract

Tyco Fire Integrated & Security is one of the world's largest fire protecting and security companies. They help protect more than three million industrial, commercial and residential customers worldwide. They have many branches around the world and their huge number of employees include a diverse group of scientists and engineers, sales professionals, technicians and business leaders.

The fire suppression systems are governed by the standard codes and certified by approval organizations. These systems typically consist of the agent, agent storage containers, agent release valves, fire detectors, fire detection system (wiring control panel, actuation signaling), agent delivery piping, and agent dispersion nozzles.

The Italian branch of Tyco is the best Italian company in producing, designing and installation of fire suppression systems in the market of Italy and a very strong competitor for other related companies in this industry in rest of Europe and Middle East. The proposal department of Tyco Italy introduced an internship stage and joined to the Politecnico di Milano for developing new ways of preparing a proposal that could optimize and speed up the process of preparing the proposal for the fire suppression systems.

The stage began by training sessions and courses and then, learning the different types of fire suppression systems and the responsibilities of fire proposal engineers and department. Next, for reaching to the goal of the company, we started to study on the procedure of preparing an offer for the clients and our solution was having Standard Documents.

Therefore, the logic and first idea of preparing standard documents was born and the statement of "To Remain Competitive, We Need Organization" became our slogan. Finally, as we went further in standardizing, we could better define our criteria and expand our work until finally reached our goal.

Key words: Tyco Integrated Fire & Security, Fire Proposal Engineering, Gaseous Fire Suppression System, SAPPHIRE™, FM-200®, iFLOW®, INERGEN®

Chapter 1

1 Introduction and Thesis Outline

Tyco Fire Integrated & Security with many branches around the globe is one of the world's largest fire protecting and security companies. They are the leaders of engineering, designing and producing of fire suppression systems.

The Fire Proposal Department of Tyco Italy was joined to Politecnico di Milano with an internship stage in order to generalize and standardize the documents of gaseous fire suppression systems.

In this thesis, I will try to present the general information about the company, different types of fire suppression systems and all I have done during the stage especially in the field of standardization.

Our activities at Tyco in the field of standardization has been done in two phases. The first phase was gathering and collecting all the available documents – Product Overview, Warranty, Approvals and Certificates, Application Sheet and Design Manual related to the fire suppression systems – then generalizing and standardizing them under the cover and label of Tyco Italy. However, the second phase was creating the unavailable documents – Data Sheet, Process & Instrument Diagram (P&ID) and General Assembly Drawing (GAD) – and then standardizing them under the brand of Tyco.

The main body of the work is organized as below:

Chapter 2: There will be a background and history of Tyco Company. Then the Tyco business unit will be presented with a brief explanation about each section of work.

Chapter 3: First, I will describe the fire proposal department, responsivities of the proposal engineers and procedure of preparing a quotation. Next, there will be complete information of internship and all the activities during the stage, specially the idea of preparation an integrated approach from the preliminary design to the final proposal for the gaseous fire suppression systems that will be developed in the following chapters.

Chapter 4: In this chapter, most of the used national organization that are concerning with creating and publishing standard codes for fire suppression systems, will be brought and then we will get familiar with approval and certification organizations working in this industry.

Chapter 5: This chapter will be explaining available gaseous agents in firefighting industry. There will be good explanation about both chemical and inert agents. At the end, a very good experimental comparison will be presented between all these gaseous fire suppression agents.

Chapter 6: All the details from basic components to designing and installation of one of the most used system – INERGEN® Fire Suppression System – will be presented in this chapter as application of the proposed standardization procedure. In addition, there will be a systematic guideline for the IMT Calculation software.

Chapter 7: This chapter will be the conclusion of the thesis and internship stage. I will present a brief summary of what I have done during the stage and what would be the possible next step stage.

Chapter 2

2 Tyco Integrated Fire & Security

Tyco (NYSE: TYC) is one of the world's largest pure-play fire safety and security companies. They help to protect more than three million industrial, commercial and residential customers worldwide. Their 69,000 employees include a diverse group of scientists and engineers, sales professionals, technicians and business leaders.

In more than 1,000 locations in nearly 50 countries – including research and development labs, manufacturing facilities, service and distribution centers, monitoring centers and sales offices – Tyco employees work together to deliver tailored, industry-specific and location-specific fire protection and security solutions to customers around the world.

Tyco's United States headquarters are in Princeton, New Jersey. The company's corporate headquarters are in Schaffhausen, Switzerland. Tyco grew to become one of the world's largest dedicated fire protection and security companies from humble beginnings [1].

2.1 Tyco Background and History

The 1960s

Arthur J. Rosenburg, Ph.D., as a research laboratory to conduct experimental work for the U.S. government, founded Tyco, Inc. in 1960. The business focused on solid-state science and energy conversion. By 1962, Tyco began to transition from U.S. government research contracts to commercial applications.

In 1964, Tyco went public, and one year later made its first acquisition, Mule Battery Products. The company also changed its name to Tyco Laboratories.

The 1970s

The second decade of Tyco's existence saw the company grow substantially via acquisitions. Two of the company's key purchases were Simplex Technologies, manufacturers of undersea fiber optic telecommunications cable; and Grinnell Fire Protection Systems, a fire sprinkler systems manufacturer and contractor. Tyco still owns these brands today.

In 1974, Tyco's stock was listed on the New York Stock Exchange. Over the next three decades, Tyco became a much larger and more diverse company.

The 1980s

Tyco continued its aggressive but deliberate acquisition strategy, procuring leading brands such as Allied Tube and Conduit and Grinnell Corporation. By the end of the decade, Tyco had reorganized its many subsidiaries into four segments: Electrical and Electronic Components; Healthcare and Specialty Products; Fire and Security Services; and Flow Control. This structure would remain in place until 2007.

The 1990s

This decade also saw a number of strategic acquisitions driving Tyco's rapid growth. Some of Tyco's key transactions involved Raychem, Submarine Systems, Inc., Thorn Security, Wells Fargo Alarm and Wormald International Limited.

In 1993, Tyco Laboratories, Inc. formally changed its name to Tyco International Ltd. In 1996, Tyco was added to the Standard & Poor's 500, the list of the 500 largest companies in the United States by market capitalization.

In 1997, Tyco merged with ADT, a leading provider of electronic security systems. Tyco formed a new subsidiary called ADT Security Systems.

The 2000s

Tyco continued to make strategic acquisitions, acquiring some of the leading companies in its industry. In 2001, Tyco acquired Sensormatic, one of the world's leading retail security firms. This move enabled Tyco to offer a complete security package to retailers around the globe. Tyco also acquired Scott Technologies, a leading designer and manufacturer of high-performance respiratory protection systems, gas detection instruments and fire-fighting products for fire-fighting, industrial, aviation and government customers. With the acquisition of Simplex Time Recorder, Tyco became one of the largest fire alarm companies in the world.

In 2006, Tyco's Board of Directors approved a plan to separate the company's portfolio of businesses into three separate, publicly traded companies: Tyco Healthcare (now known as Covidien), Tyco Electronics (now known as TE Connectivity), and Tyco International.

In 2009, Tyco's Board of Directors unanimously approved moving the company's place of incorporation from Bermuda to Switzerland. One year later, the company acquired Brink's Home Security Holdings, now operating as Broadview Security. Tyco also sold a majority interest in its electrical and metal products business to the private equity firm of Clayton, Dubilier & Rice.

The 2010s

Tyco continued to align its portfolio with the most attractive growth markets in the company's various sectors. In 2011, Tyco acquired such key businesses as Chemguard and Visonic.

Later in 2011, Tyco International announced a plan to separate the enterprise into three independent, publicly traded companies: Tyco, the largest of these businesses and the global fire protection and security leader, a standalone ADT North America residential and small business Security Company and a standalone flow control company.

On October 1, 2012, the new Tyco became one of the world's largest dedicated fire protection and security companies. The new Tyco consists of:

// **Installation and Services,** a leading global provider of system design, installations, and services, focused on new system installation as well as high margin service.
// **Fire Protection Products,** a global product business that designs, manufactures and sells fire protection products, including fire detection and suppression products.
// **Security Products,** a unified group of the most comprehensive world-leading premium access control, video, location-based tracking and intrusion solutions in the security industry.
// **Life Safety Products,** operating under the Scott Safety brand, a world leader in the design, manufacture, and sale of high performance respiratory protection, gas detection, and other Personal Protection Equipment (PPE) solutions [1].

2.2 Tyco Business Unit

Today, Tyco has more than three million customers around the world, ranging in size from large Fortune 500 companies to single-location commercial customers and residential customers outside North America. Tyco generates approximately 55 percent of its revenue in markets outside of North America. The company's presence in key growth markets is accelerating rapidly, with a global installation and service footprint unmatched by its competitors. Through direct sales, wholesalers, distributors, commercial builders and contractors, Tyco helps protect[1] [12]:

Figure 2-1: Spread of Tyco business unit around the globe

[1] Numbers based on internal company estimates.

2.2.1 Installation and Services

The Tyco Installation and Services business is a leading global provider of system sales, design, installation, and service. The business has a broad geographic reach, maintaining over 1,000 locations in 33 countries, with regional headquarters in six continents. The business is focused on new system installation as well as after-market services [1]. Tyco's goal with this business unit is to convert new installations into long-term customer relationships.

2.2.1.1 Installation and Services Markets

Tyco is a global market leader in the installation of fire protection and security solutions in this $40 billion sector. The company holds approximately 10 percent market share in a sector that is fragmented across smaller local and regional players. Tyco thrives in this market due to its strong abilities in project management and execution. Tyco is also a global market leader in providing vital services related to fire protection and security solutions, a $30 billion market. The company holds approximately 15 percent market share across this sector, which, like installation, is also fragmented across small local and regional companies. Tyco succeeds in this market because of their ability to consistently meet customer needs across a wide spectrum of innovative services [1].

2.2.1.2 Fire Protection

The Fire Protection group within Installation and Services sells, designs, installs and services fire detection, fire suppression, emergency communications, and nurse call systems in both new and existing facilities. Demand is driven primarily by commercial construction as well as codes, standards and legislative requirements governing the installation and service of fire detection, sprinkler and suppression systems [27].

2.2.1.3 Security Solutions

The Security Solutions group within Installation and Services sells, designs, installs, services and integrates systems to detect intrusion, control access and react to a variety of hazards. They develop and deliver tailored, industry-specific solutions. This business is a leading provider in North America of monitored commercial security solutions, and outside of North America of monitored residential and commercial security systems. In addition, the business provides patrol and alarm response services in select geographies [1].

2.2.2 Fire Protection Products

Fire Protection Products designs, manufactures and sells fire protection products, including both fire detection and suppression products.

The unit designs, manufactures and sells fire detection & alarm systems, automatic fire sprinklers & valves, special hazard suppression systems and portable fire extinguishers, including many of the products that the Tyco Installation & Services business uses. Fire Protection Products also manufactures and sells grooved products for the rapid joining of piping in both the fire and non-fire markets [27].

The detection offerings include fire alarm control panels, advanced fire alarm monitoring systems, smoke, heat and Carbon monoxide detectors and voice evacuation systems. Tyco also offers a wide range of water-based sprinkler systems and custom designed special hazard suppression systems, which incorporate specialized extinguishing agents such as foams, dry chemicals and gases. These systems are utilized for fire protection in a wide variety of industries and applications, such as oil and gas, mining, commercial/institutional construction, power generation, marine, warehousing/storage, and residential [27].

2.2.3 Security Products

Security Products is a unified group of the most comprehensive world-leading premium access control, video, location-based tracking and intrusion solutions in the security industry. Security Products conducts business in over 176 countries around the world, in multiple languages and employs over 2,700 employees globally, including research and development, marketing, manufacturing, sales, service and logistics teams in the Americas, Europe, the Middle East, Africa, and Asia Pacific. Their products, built by developers from all product disciplines, consistently allow customers to see more, do more, and save more across multiple industries and segments including healthcare, government, transportation, finance, retail, commercial and residential.

Worldwide, Security Products helps protect 42% of Fortune 500 companies, transportation systems on five continents, 37% of the world’s top 100 retailers, over two million commercial enterprises, thousands of students in more than 900 educational facilities, and over five million private residences [12].

2.2.3.1 Access Control

Their comprehensive access control portfolio includes security management software, door controllers, readers, keypads and cards all designed to scale from the smallest business to widely dispersed enterprise organizations [1].

2.2.3.2 Video

With technologies that range from low-cost analog to high-performance IP solutions, their video portfolio is one of the most well-known and respected in the industry. They offer end-to-end solutions that include analog and IP cameras, video management systems, matrix switchers and controllers, digital multiplexers, monitors, and storage solutions [1].

2.2.3.3 Intrusion

Intrusion solutions for homes and businesses range from basic burglar alarms to comprehensive interactive wired or wireless security systems, including alarm control panels, key-pads, sensors, and central station receiving equipment used in security monitoring centers [1].

2.2.3.4 Real-Time Location System (RTLS)

RTLS technology provides visibility of people and assets throughout an organization. The portfolio includes RFID tags, sensors, and management software that combine to provide real-time personnel and object tracking solutions ideal for hospitals, correctional facilities, museums, and corporations [1].

2.2.3.5 Beyond Integration: Unified Solutions

With the growing number of applications coming together in a customer's environment, Tyco Security Products is committed to providing an intuitive, unified experience to help effectively manage security as well as enhance business performance. The victor unifying client provides customers with one easy to use interface that brings together products from all of the categories Tyco specializes in; Access Control, Video, Intrusion, and Real-Time Location Systems [1].

2.2.4 Life Safety Products

Life Safety Products, operating under the Scott Safety brand, is a world leader in the design, manufacture, and sale of high performance respiratory protection, gas detection, and other Personal Protection Equipment (PPE) solutions. Scott Safety has an 80-year legacy of innovation of purpose-built technology and product solutions critical to firefighters, emergency-response, industrial and military professionals in industries such as petrochemical, oil and gas, chemical, military and civil defense, and marine.

Scott Safety employs more than 1,150 employees and serves customers in over 50 countries around the world, including operations in the United States, United Kingdom, Finland, China, Australia, United Arab Emirates, and Mexico. Scott Safety products include Self-Contained Breathing Apparatus (Scott Air-Pak), fixed and portable gas detection products, thermal imaging and search and rescue equipment, communications and accountability products, compressors, and eye, hearing and head protection [12].

Figure 2-2: Variety of Tyco activities

2.3 Conclusion

This chapter was allocated to Tyco Company. There are brief but general information about its background from beginning until now. In addition, different activities of company both in Fire Protecting and in Security – products, installations and services – have been presented.

Chapter 3

3 Tyco Fire Proposal Department

3.1 Introduction

In Tyco Company like all other companies, there are some different departments with specified and determined responsibilities. These departments are included marketing, sale, proposal, engineering, installation, service and maintenance.

In general, after receiving a request from a client at sale department, it is the proposal department's duty to prepare a competitive quotation that could compete with other quotations from competitor companies. Usually this is how the activity of proposal engineer begins in proposal department.

In this chapter, after presenting a description of Tyco fire proposal department, the whole activities of a fire proposal engineer at this department and the procedure of preparing a quotation will be explained. In addition, I will explain my activities and performances during my stage at Tyco fire proposal department.

Finally, there are complete presentation about the standardizing the fire suppression systems documents that is the important output of this internship stage for Tyco Italy.

3.2 Description of Tyco Proposal Department

As it was described before in the first chapter, Tyco business unit is divided into different categories – installation & services, fire protection products, security products and life safety products – therefore due to this reason there are two major sub departments under the Tyco proposal department, one of them is fire proposal department and the other one is security proposal department.

This department consists of 7 employees, there is 1 manager for managing and supervising all the sales offering and there are 3 proposal engineers at each sub department for creating and preparing offers related to the received requests from the clients.

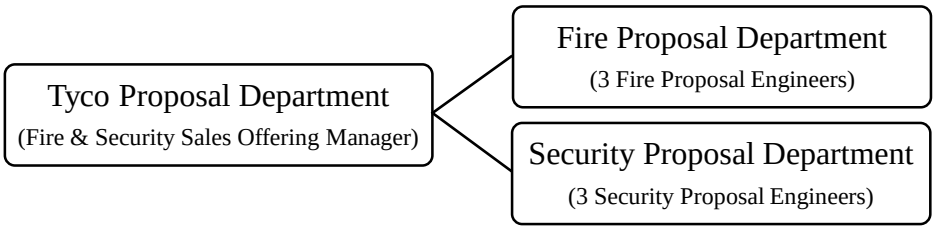

Figure 3-1: Tyco Proposal Department

3.3 Fire Proposal Department

The main goal at this department is to make an offer with the highest quality but lowest price, which could remain the Tyco to be able for competing with other competitors company in the fire-protecting field. All the related activities to the fire proposal department are described in below:

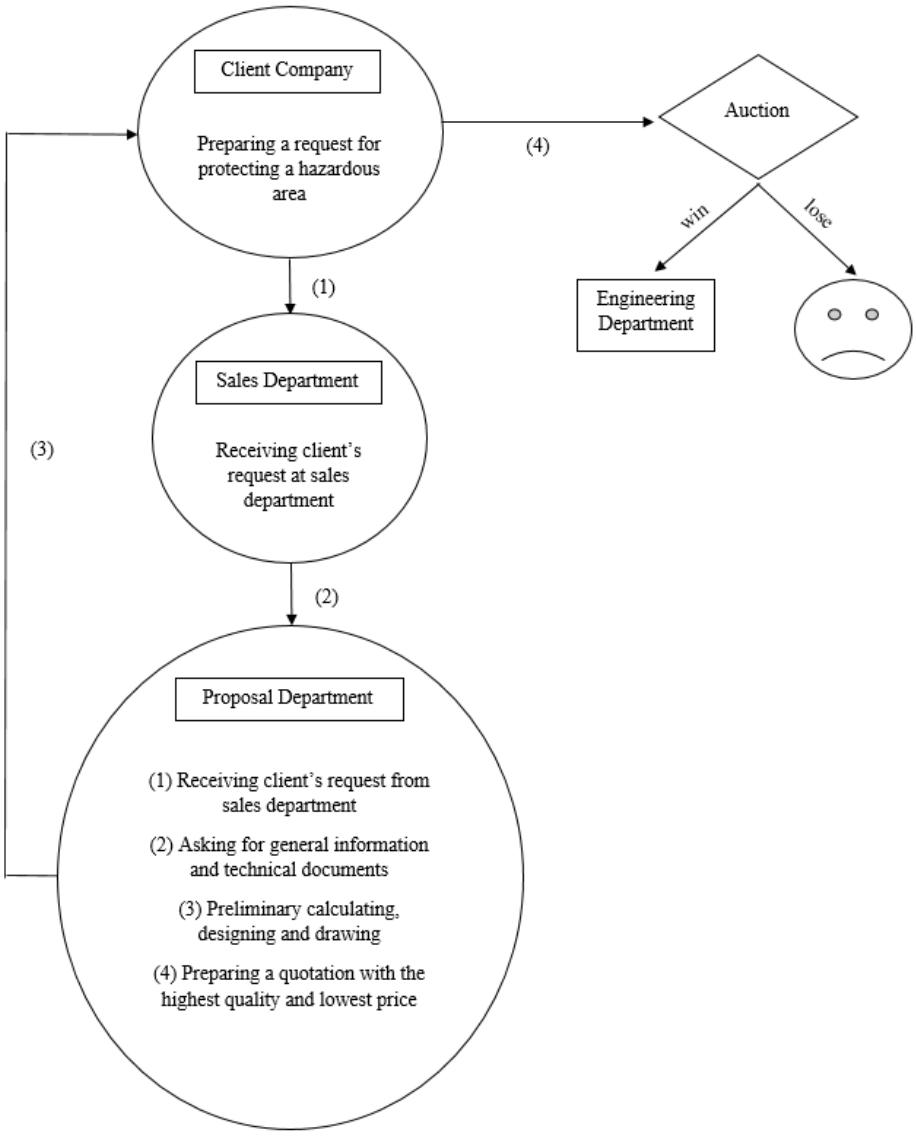

Figure 3-2: Tyco Fire Proposal Department Activity Chart

The whole activities in fire proposal department, which are mentioned in the figure 3.2, are recording to the planning and designing parts that have been explained in previous chapter.

It is necessary to mention, all the calculating and designing at this stage are preliminary and are not final version for installation. Thus in the case of winning the project, all the job must be done accurately in engineering department with considering the proposed quotation.

3.3.1 Fire Proposal Engineer

The engineers at the fire proposal departments have to prepare an offer with the compatible price and quality based on the client's request as soon as possible.

An engineer cannot propose a price quotation without considering the preliminary planning, calculating, designing and drawing for that project. Therefore, each time, the procedure of preparing a proposal takes a remarkable working time from the engineer and department.

The other noticeable characteristics of the fire proposal department and specially the proposal engineer is having the short and determined time with the huge number of received requests from clients for protecting their hazardous areas.

Always there are some requests that the department misses them because it is not possible to make an offer before the deadline and also there are always many projects that company loses in the competition due to many reasons which usually the most important of them is the lowest offered price by competitor companies.

Tyco as the one of the leaders in the firefighting industries in the world must always be up to date and more than that must be innovate to could keep its position and situation at the market. Due to this reason, the Tyco fire proposal department at Italy decided to introduce an internship stage to try and experience new ways of innovation in the proposing procedure.

Further, the preliminary idea for the hiring a trainee and then all the activities that have been done during this stage and also their results will be presented in the next parts of this chapter.

3.3.2 Fire Suppression System Quotation

One quotation that is provided by the proposal engineer at fire proposal department consist many steps. Here we will get familiar to the procedure of making a quotation at fire proposal department step by step.

STEP NO.1 – Receiving Client's Request

At the first step, the purchasing department of the client company sends their request to Tyco sales department. After analyzing the request and determining one of the salespersons of the sales department as the supervisor of the project, the request will be put in the portal of proposal department in the internal network of the company.

STEP NO.2 – Collecting the Required Information

At this step, the fire proposal engineer checks out the general information, technical documents, drawing and any other attachments that have been sent by the client to find out the needed data:

- ✓ Protected area (Volume, plans, temperature, pressure & …)
- ✓ Type of the fire suppression system and agent
- ✓ Standard code
- ✓ Certificates and approvals

If the engineer cannot find any of these important designing data, he will ask the client to send him the needed information.

STEP NO.3 – Design Data

By gathering the previous information in the prior step, now it is the time to calculate the quantity of the required agent, the number of cylinders, nozzles and in the case of need the selector valves.

Depends on the type of requested system and agent, there are different calculation software and applications for passing this step. Anyway at the end we are looking for to fill the below table and provide the necessary measurements and calculations, which is called Design Data table.

Item	Protected Area	Dimension			Design Concentration	Design Temperature	Flooding Factor	Agent	Cylinder Battery			Agent	SV	SV Diameter	Nozzle
		Area	Height	Volume					Q.ty	Cap.	Charge		Q.ty		
		m^2	m	m^3	%	°C	Nm^3 $In./m^3$	m^3	No.	lit	m^3	m^3	No.	m	No.

Table 3-1: Design Data Table

STEP NO.4 – Design & Drawing

Now it is the time for designing the system, which means determining the location of cylinders battery, piping distribution, location of the nozzles and all the other details of the system.

At the end of this step, we have to provide Process & Instrument Diagram (P&ID) and General Assembly Drawing (GAD).

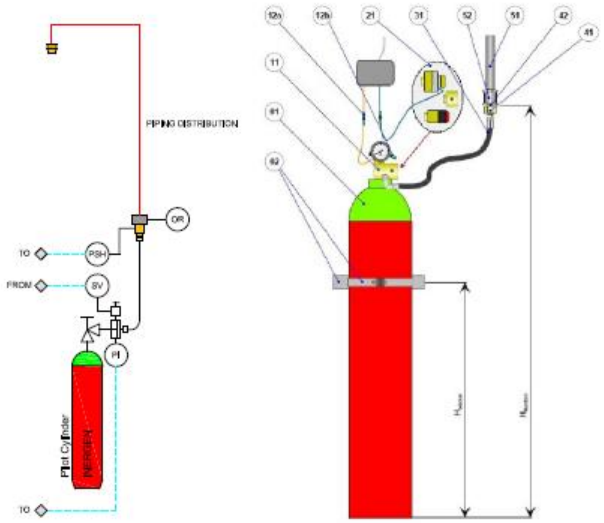

Figure 3-3: P&ID and GAD Sample - INERGEN® Single Cylinder System

STEP NO.5 – Bill of Material

We need to know exactly all the used components in the system and also their exact number, due to this reason at this step we will provide the bill of material. In this list, there are the commercial name of the components with all their technical description and required quantity of them.

No.	15	INERGEN® 300 bar cylinder assembly	
		Cylinder certification	GOST-K
		Cylinder capacity	80 litres
		Cylinder pressurized	300 bar @ 15°C
		Agent	INERGEN® (IG-541)
		Agent charge	24 Nm³ (each cylinder)
		Total agent charge	48 Nm³
		Cylinder diameter	267 mm
		Cylinder height (valve outlet)	1780 mm
		Cylinder weight (filled)	140 kg
		Hand wheel valve burst disc	430±20 bar
		Hand wheel valve certification	EC (CPD) 1116-CPD-017

Figure 3-4: Bill of Material Sample - INERGEN® Cylinder Assembly

STEP NO.6 – Price List

By having the bill of materials, now we can easily calculate the list of prices. Usually there are cost accounting excel files belong to Tyco that help the proposal engineer calculating the final price of the project regarding to all the done previous steps.

ITEM	DESCRIPTION	TOTAL PRICE EURO
1.1	INERGEN 300 BAR FIRE SUPPRESSION SYSTEM	
1.2	ENGINEERING AND CYLINDER BATTERY	
	OPTION:	
2.1	Spare Parts for commissioning and start-up	
…		

Figure 3-5: Price List Sample - INERGEN® Fire Suppression System

STEP NO.7 – Presenting the Proposal

After completing all the previous steps that lead to prepare a quotation, the last step is classifying and organizing a standard quotation that includes all the required information and documents.

Tyco proposal is composed of the following sections:

1. Scope of Work
2. General Description of System
3. Design Data
4. Process & Instrument Diagram
5. General Assembly Drawing
6. Bill of Materials
7. General Condition of Supply
8. Price List

When the final quotation is ready, it will be sent to client as the version zero of the proposal. Usually the technical and commercial departments of the client company check the offer and ask for some modification; therefore, there can be next versions of the quotation. Finally, if our proposed offer could win the project in the competition with other competitor companies, the job will be sent to Tyco Engineering Department for final designing and execution.

3.4 Internship of Fire Proposal Department

Tyco as the one of the leaders in the firefighting industries in the world must always be up to date and more than that must be innovate to could keep its position and situation at the market. Due to this reason, the Tyco fire proposal department at Italy decided to introduce an internship stage to try and experience new ways of innovation in the proposing procedure.

The first concept of the company was hiring a qualified mechanical engineering student and making him/her to a skillful proposal engineer. In addition, they wanted to experience new way of proposing.

3.4.1 Trainee Activities

I found the Tyco's stage at Polimi Career Service in the December of 2014. I applied for it and fortunately they nominated me as one of their candidate for the interview. After passing two interview with Sales & Offering Manager and Human Resource Manager of the company, I admitted for the stage of proposal engineer at fire proposal department under supervision of Engineer Rossi at Tyco Integrated & Security Company and Professor Lo Conte at Politecnico di Milano for the six months from 19th of January to 17th of July 2015.

In general, my activities during this period divide to three major categories:

1. Learning
2. Proposing & Engineering
3. Standardization

3.4.1.1 Learning

Generally, my learning period at Tyco can be divided into three categories.

First is general learning that I had under supervision of chief proposal engineer of Tyco, Mr. Rossi. My main knowledge in gaseous fire suppression systems has come from him in both theory and practical part. In addition, he taught me the whole procedure of preparing the quotation.

Second is the training sessions and courses that were held at Tyco for training the employees. Attendance in these courses gave me a very good and useful information about firefighting industry. For example, one of these courses was the training course for INERGEN® fire suppression systems, which was held at Tyco by Fire Eater Company. This Danish company is one of the leaders of producing and selling INERGEN® fire suppression systems in the world. During

this course, I could get excellent knowledge about this type of systems and learnt the IMT calculation software that is created and released by Fire Eater.

Third and final part of my learning at Tyco is consisted of the activities and studies that I have done that can be called self-learning period. During this period, I started to read the standard codes for designing the fire suppression systems for better understanding the details and limitation of the process. In addition, I read the manuals of different fire suppression systems and learnt their calculating software. My next step was to study the jobs that have been done by proposal and engineering department and try to understand and recalculate them by helping of my knowledge.

3.4.1.2 Proposing & Engineering

As it explained before, the main responsibility of proposal department is preparing the quotation regarding to client's request. Thus after reaching to proper knowledge of work, I began to assisting in some projects for preparing the quotation in all steps that have been explained in previous part (fire suppression system quotation). However, usually my most concentration was on the preparing design data of the systems by using various software, also drawing the process & instrument diagram (P&ID) and general assembly drawing (GAD).

Fortunately, my good knowledge and ability in the calculating software gave me this opportunity to help to engineering department in calculating some jobs especially for INERGEN® fire suppression systems and they were very great experience for me.

3.4.1.3 Standardization

The main result of this internship for Tyco was performing the standardization of the documents for different gaseous fire suppression systems. There was an idea for standardizing the documents in my first days at Tyco but luckily, we could make it real.

The result of this activity is not just an achievement for the fire proposal department but also it can be used in all other department from sales and marketing to engineering and even installation and services.

Further, in an independent part I will describe whole the process of standardization from its concept at the beginning to its implement at the end.

3.5 Standardization of Fire Suppression Systems

Tyco Integrated Fire & Security Company as one of the leaders in firefighting industry is always looking for innovative way to keep and even improve its position at world market.

The Italian branch of Tyco is the best Italian company in producing, designing and installation of fire suppression systems in the Italy market and also a very strong competitor for other related companies in this industry in rest of Europe and Middle East.

Due to these reasons, the first hand ideas are always welcome to the Tyco and the doors of company are open for them.

3.5.1 Concept of the Standard Documentation

The procedure of making a quotation, which has been described in previous parts, shows that it is a time consuming process and depend on the requested job, sometimes it takes many days to be done. After complete analyzing of this long process and its reasons by engineer Rossi, the chief fire proposal engineer of fire proposal department with thirty years of experience in fire suppression systems, he recognized that the most important reason is not being standardized. He found that every time for every proposal, they have to go through the existing files of requested agent and its related fire suppression system documents (standard codes, manuals and datasheets …) to could be able to prepare a quotation. He believed that it is true that every project has its own specific and unique conditions but in general, it is possible to create and introduce some main categories of each type of fire suppression systems that they consist all the probable requested systems.

Therefore, the logic and first idea of preparing standard documents has been born and the statement of "To Remain Competitive, We Need Organization" became our slogan. Next, as we went further in standardizing, we could better define our criteria and expand our work until finally reached our goal.

3.5.2 Benefits of the Standard Documentation

The idea of standardization was made at proposal department but we wanted that the results would be useful for all departments. There are many advantages for having standard documents; here will be some of them in below:

- All the departments can use them and increase their efficiencies and utilities. For example, people in marketing and sales department can use them for convincing the clients before

their request of other competitors or engineers and technicians can use them for better designing and installation.

- By having standard documents, the process time of proposing will decrease significantly. Therefore, proposal engineers can save their energies and time.
- They can help for providing much better and accurate quotations.
- Company can get more requests from clients and competes in more competition due to ability of proposal department to create more quotation in comparison with before standardization.
- These types of innovative activities can keep Tyco to stay unique and special in the market of firefighting systems in compared with similar companies.

3.5.3 Process of the Standardization

First step of this process was finding and classifying the various existing fire suppression systems that are requesting from clients to design and install.

As described in chapter 3, there are different types of fire extinguishing systems. The commercial name of the available gaseous fire suppression systems that are designed, proposed and installed by Tyco are as below:

1. SAPPHIRE™
2. FM-200®
3. INERGEN®
4. iFLOW®
5. CO_2

Any of the above systems minimum has two major producer one for its agent and one for its components. As it mentioned exising of two producers for one fire suppression system is the minimum possibility. For example for SAPPHIRE™ fire suppression system, the Tyco Fire Protection Production (TFPP) is the only system components producer and HYGOOD is the only producer of its agent (NOVEC™ 1230) while for INERGEN® fire suppression system there are 3 possibility of request that in any of them there are 2 possible independent producer. In one INERGEN® system, TFPP produces the components and LPG is the supplier of the agent, in the other one again TFPP is component producer and ANSUL produces the agent and in third system the whole system is produced and supplied by Fire Eater.

Thus, we found and then classified all the existing fire suppression at Tyco systems with their available and possible producer and supplier that you can see in Table 3.2 in below.

SAPPHIRE	FM-200	FM-200	INERGEN	INERGEN	INERGEN	iFlow	CO_2	CO_2
TFPP	TFPP	TFPP	TFPP	TFPP	FIRE EATER	TFPP	TFPP	TFPP
HYGOOD	HYGOOD	LPG	LPG	ANSUL	FIRE EATER	LPG	LPG	ANSUL

Table 3-2: Different Supplier and Producer of Fire Suppression Systems for Tyco

As you can see in the table, the variety of the available firefighting systems and their producers are very high. Therefore, without having good standard document for each of these systems, preparing a proper quotation would be very hard and even in some cases due to information dispersal, it can be impossible.

Next step of our task was to prepare a list of all the documents that we must provide for each system. We were looking for the documents, which are common between all the each types of fire suppression systems without caring to what or where the project is or even what are the specific details of the hazardous area. These questions are just guide and help for providing the bill of material and price list not for designing the system. Here are our final consequence[2] that we have provided for each types of fire suppression systems:

1. Product Overview
2. Warranty
3. Approvals and Certificates
4. Application Sheet
5. Data Sheet
6. Process & Instrument Diagram (P&ID)
7. General Assembly Drawing (GAD)
8. Design Manual

[2] All the rights of these standard documents are for Tyco Italy and they are available both in digital version at their internal intranet and in hard copy in their paper docs.

Most of the above mentioned are the documents that are released by the producer company under the supervision of standard and approval organizations.

Our mission was first to find and gather them by asking from their supplier companies or in some cases by searching in Tyco's branches all over the world from USA to England, Spain or even Australia and then classify them by our provided cover for Tyco of Italy with the complete information of their released datasheet number, description and revision.

The important part of providing standard documents was to prepare the items, which were not available and they did not exist. In addition, the point is that the difference between the sub-categories of one type of fire suppression system is exactly in these items. Thus, I focused and concentrated on these parts and tried to do my best for preparing them.

Here are these documents with a brief description about them:

Data Sheet

Every data sheet is started with general information about the agent that is used in system and after that, there is material safety data sheet of the agent. These two information are the same in all sub-categories of one type of fire suppression system. Next, depending on the sub-category of the system that we want to describe, there are all the information – technical and commercial – about all the components that would exist in the system like cylinders, discharge valves, hoses, manifold, actuators, nozzles etc.

Process & Instrument Diagram (P&ID)

These types of diagrams are different from each other regarding to the sub-categories of the systems and are useful for both technical and commercial departments. There is a schematic drawing of the requested fire suppression system with the legends of all the components, general information of the system and brief technical description of the main component like cylinders, actuators and nozzles.

General Assembly Drawing (GAD)

In these documents, there are technical drawing of the systems with more technical details. They are useful for calculating and planning the systems also, they are very useful for technical department both for installation and for services and maintenance.

3.5.4 Standard Documentation of INERGEN® Fire Suppression Systems

As it described before, Tyco has possibility to design and sell five different types of gaseous fire suppression systems and each of them has some general sub-categories and various producer and supplier. However, during this stage most of my concentration was on the INERGEN® Fire Suppression Systems. Therefore, in this part I will present my standardization process on these systems.

STEP NO.1

First step was dividing this system to sub-categories that could consist all the probable requests for INERGEN® fire suppression systems. We found four below categories:

1. Single Cylinder System
2. Multiple Cylinders System
3. System with Back-up
4. System with Selector Valve

STEP NO.2

At this step, I collected all the available documents – Product Overview, Warranty, Approvals and Certificates, Application Sheet and Design Manual – for the INERGEN® and standardized them under the cover and label of Tyco Italy. The result of this step is utilizable for all the four above categories.

STEP NO.3

Unlike the previous step that all the prepared documents were useful for all the categories of INERGEN® Fire Suppression Systems, now it was the time to create the documents – Data Sheet, Process & Instrument Diagram (P&ID) and General Assembly Drawing (GAD) – that are usable just for each particular system.

The consequences of our job are part of the classified documents of Tyco Italy, due to this reason I am not allowed to publish and release all the results, but by company's permission, I will put some sample of our outputs in the appendix of my thesis. However if it was allowed to publish all the results, again it was not possible to put hundreds of pages here in my thesis.

3.5.5 Next Step of Standardization

We have gathered the entire available documents – Product Overview, Warranty, Approvals and Certificates, Application Sheet and Design Manual – for all types of the fire suppression system that have been mentioned before and standardized them under the cover and label of Tyco Italy.

Then, we went particularly to INERGEN® Fire Suppression Systems and as it described in previous part, we created the Data Sheet, Process & Instrument Diagram (P&ID) and General Assembly Drawing (GAD) for each sub categories of this system that took a long time from us.

The next step of standardization for Tyco Italy can be creating the unavailable documents – Data Sheet, Process & Instrument Diagram (P&ID) and General Assembly Drawing (GAD) – for all the other gaseous fire suppression systems. However, already we have done some good steps for other types of fire suppression systems but they are not finished and still there are a lot of steps and revision that has been remained unfinished and incomplete.

3.6 Conclusion

In this chapter, after describing the fire proposal department and then responsibilities of proposal engineers at Tyco Italy, complete procedure of preparing a quotation for fire suppression system has been presented.

Next, the internship stage of Tyco fire proposal department has been described and I have explained all of my activities during these six months of training.

Finally, there are complete explanation about standardizing the documents of all types of gaseous fire suppression systems that I have done during the stage for the company.

Chapter 4

4 Standards & Approvals

4.1 Standards Organization

A standards[3] organization, standards body, standards developing organization (SDO), or standards setting organization (SSO) is any organization whose primary activities are developing, coordinating, promulgating, revising, amending, reissuing, interpreting, or otherwise producing technical standards that are intended to address the needs of some relatively wide base of affected adopters.

Most standards are voluntary in the sense that they are offered for adoption by people or industry without being mandated in law. Some standards become mandatory when they are adopted by regulators as legal requirements in particular domains [33].

Normally, the term standards organization is not used to refer to the individual parties participating within the standards developing organization in the capacity of founders, benefactors, stakeholders, members or contributors, who themselves may function as the standards organizations.

It is mandatory for all the Fire Suppression Systems to obey and implement one of these rules in their designing and installing construction regarding to the safety regulations of the project's local government.

It is necessary to mention, as we have two major categories of applications – Landing & Marine – so there are standard codes for Fire Suppression Systems both in Landing and in Marine Applications. In the following, there are the most important and useful international standard codes for designing firefighting systems with their brief description in the firefighting industry both for landing and marine applications.

[3] A standard (French: Norme, German: Norm) is a technical document designed to be used as a rule, guideline or definition. It is a consensus-built, repeatable way of doing something.

4.1.1 National Fire Protection Association (NFPA)

The National Fire Protection Association (NFPA) is a United States trade association, albeit with some international members, that creates and maintains private, copyrighted, standards and codes for usage and adoption by local governments. This includes publications from model building codes to the many on equipment utilized by firefighters while engaging in hazardous material (hazmat) response, rescue response, and some firefighting [2].

The NFPA was formed in 1896 by a group of insurance firms with the stated purpose of standardizing the new and burgeoning market of fire sprinkler systems. The scope of the NFPA's influence grew from sprinklers and fire extinguishers to include building electrical systems (another new technology), and then into almost all aspects of building design and construction.

Its original membership was limited to insurance underwriting firms and there was no representation from the industries the NFPA sought to control. This changed in 1904 to allow other industries and individuals to participate in the development of the standards to be promulgated by the NFPA. The first fire department to be represented in the NFPA was the New York City Fire Department in 1905, though their participation has declined steadily since then. Today, the NFPA includes representatives from some fire departments, many fire insurance companies, many manufacturing associations, some trade unions, many trade associations, and engineering associations.

Today NFPA defines its mission as follows: "To reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education". NFPA membership totals more than 65,000 individuals around the world [13].

Figure 4-1: NFPA Logo

4.1.1.1 NFPA Codes and standards

NFPA is responsible for 380 codes and standards that are designed to minimize the risk and effects of fire by establishing criteria for building, processing, design, service, and installation in the United States, as well as many other countries. Its more than 200 technical code- and standard-development committees have over 6,000 volunteer seats. Volunteers vote on proposals and revisions in a process that is accredited by the American National Standards Institute (ANSI) [2].

Some of the most widely used codes are:

- NFPA 1, Fire Code: Provides requirements to establish a reasonable level of fire safety and property protection in new and existing buildings.
- NFPA 54, National Fuel Gas Code: The safety benchmark for fuel gas installations.
- NFPA 70, National Electric Code: The world's most widely used and accepted code for electrical installations.
- NFPA 85: Boiler and Combustion Systems Hazards Code
- NFPA 101, Life Safety Code Establishes minimum requirements for new and existing buildings to protect building occupants from fire, smoke, and toxic fumes.
- NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response Defines the colloquial "fire diamond" used by emergency personnel to quickly and easily identify the risks posed by hazardous materials.
- NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems

4.1.1.2 Access to NFPA Codes and Standards

As part of its commitment to enhancing public safety through the adoption and enforcement of key ANSI codes and standards, NFPA makes all of its codes and standards available for review online by the public. The complete texts of standards documents are available on the NFPA Web site, with restrictions, for viewing, but not printing, by citizens, interested manufacturers and others with computer access. NFPA codes and standards are widely adopted, because they are developed using an open, consensus-based process. All NFPA codes and standards are developed and periodically reviewed by approximately 7,000 volunteer committee members with a wide range of professional expertise.

4.1.2 International Standard Organization (ISO)

The International Organization for Standardization (ISO) is an international standard setting body composed of representatives from various national standards organizations. Founded on 23 February 1947, the organization promotes worldwide proprietary, industrial and commercial standards. It is headquartered in Geneva, Switzerland, and as of 2013 works in 164 countries. It was one of the first organizations granted general consultative status with the United Nations Economic and Social Council [14].

ISO, the International Organization for Standardization, is an independent, non-governmental organization, the members of which are the standards organization of the 163 member countries. It is the world's largest developer of voluntary international standards and facilitates world trade by providing common standards between nations. Nearly twenty thousand standards have been set covering everything from manufactured products and technology to food safety, agriculture and healthcare.

Use of the standards ensures that products and services are safe, reliable and of good quality. The standards help businesses increase productivity while minimizing errors and waste. By enabling products from different markets to be directly compared, they facilitate companies in entering new markets and assist in the development of global trade on a fair basis. The standards also serve to safeguard consumers and the end-users of products and services, ensuring that certified products conform to the minimum standards set internationally.

ISO is a voluntary organization whose members are recognized authorities on standards, each one representing one country. Members meet annually at a General Assembly to discuss ISO's strategic objectives. The organization is coordinated by a Central Secretariat based in Geneva. A Council with a rotating membership of 20 member bodies provides guidance and governance, including setting the Central Secretariat's annual budget. The Technical Management Board is responsible for over 250 technical committees, who develop the ISO standards [3].

Figure 4-2: ISO Logo

4.1.3 European Committee for Standardization (CEN)

CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 33 European countries.

CEN is one of three European Standardization Organizations (together with CENELEC and ETSI) that have been officially recognized by the European Union and by the European Free Trade Association (EFTA) as being responsible for developing and defining voluntary standards at European level.

CEN provides a platform for the development of European Standards (EN) and other technical documents in relation to various kinds of products, materials, services and processes [15].

CEN supports standardization activities in relation to a wide range of fields and sectors including: air and space, chemicals, construction, consumer products, defence and security, energy, the environment, food and feed, health and safety, healthcare, ICT, machinery, materials, pressure equipment, services, smart living, transport and packaging.

They concentrate most of their efforts on one major deliverable: the European Standard (EN). This document shall be given the status of national standard in all CEN member countries, who must therefore withdraw any conflicting national standards [4].

Besides European Standards, they produce other deliverables with specific characteristics and objectives. These are Technical Specifications (TS), Technical Reports (TR), Guides and CEN and/or CENELEC Workshop Agreements (CWA). These various products differ in their methods of development, approval processes and implementation, offering flexible means to meet different market needs for requirements and information.

Figure 4-3: CEN Logo

4.1.3.1 European Standards (EN)

A standard is a document that provides rules, guidelines or characteristics for activities or their results, for common and repeated use. Standards are created by bringing together all interested parties including manufacturers, users, consumers and regulators of a particular material, product, process or service. Everyone benefits from standardization through increased product safety and quality as well as lower transaction costs and prices.

Each European Standard is identified by a unique reference code, which contains the letters 'EN'. A European Standard is a standard that has been adopted by one of the three recognized European Standardization Organizations (ESOs): CEN, CENELEC or ETSI. It is produced by all interested parties through a transparent, open and consensus based process.

European Standards are a key component of the Single European Market. Although rather technical and mostly unknown to the public and media, they represent one of the most important issues for businesses. Often perceived as boring and not particularly relevant to some organizations, they are actually crucial in facilitating trade and hence have high visibility among manufacturers inside and outside Europe. Standards provide individuals, businesses and all kinds or organizations with a common basis for mutual understanding. A standard represents a model specification, a technical solution against which a market can trade. It codifies best practice and is usually state of the art.

In essence, European Standards relate to products, services or systems. Today, however, standards are no longer created only for technical reasons but have also become enablers for greater social inclusiveness and engagement with technology, as well as convergence and interoperability within growing markets across industries [15].

Figure 4-4: EN Logo

4.1.4 International Maritime Organization (IMO)

As a specialized agency of the United Nations, IMO is the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted and universally implemented.

In other words, its role is to create a level playing field so that ship operators cannot address their financial issues by simply cutting corners and compromising on safety, security and environmental performance. This approach also encourages innovation and efficiency.

Shipping is a truly international industry, and it can only operate effectively if the regulations and standards are themselves agreed, adopted and implemented on an international basis and IMO is the forum at which this process takes place.

International shipping transports about 90 percent of global trade to peoples and communities all over the world. Shipping is the most efficient and cost-effective method of international transportation for most goods. It provides a dependable, low-cost means of transporting goods globally, facilitating commerce and helping to create prosperity among nations and peoples. The world relies on a safe, secure and efficient international shipping industry and this is provided by the regulatory framework, then developed and maintained by IMO. International Maritime Organization measures cover all aspects of international shipping – including ship design, construction, equipment, manning, operation and disposal – to ensure that this vital sector for remains safe, environmentally sound, energy efficient and secure [16].

Figure 4-5: IMO Logo

4.2 Approvals and Certifications

Type Approval or Certificate of Conformity is granted to a product or system that meets a minimum set of regulatory, technical and safety requirements. Generally, type approval is required before a product is allowed to be sold in a particular country, so the requirements for a given product will vary around the world [33].

The same as all other industries, there are many different organizations and institutes in the Firefighting Industry, which their responsibility is approving the fire suppression systems by testing and supervising on all the procedure from engineering and designing the systems to all the used components.

In general, there are two main categories for approvals and certifications which refers to two major type of consumption, one for Landing applications and the other one for Marine applications.

Similar to the standard codes, the type of the approvals and certifications will be chosen first regarding to the type of application – landing or marine – and second to the project's country regulations and work owner request.

In the following, we will see with the most important and useful International Approvals and Certifications Organizations under the two main categories of Landing and Marine Applications.

4.2.1 Landing Applications

4.2.1.1 FM Approval

FM Global provides comprehensive global commercial and industrial property insurance, engineering-driven underwriting and risk management solutions, groundbreaking property loss prevention research and prompt, professional claims handling. As a mutual company, their products and services directly support their clients' overall risk management objectives through [17]:

- Understanding the nature and reality of their specific risks
- Establishing sound loss prevention solutions that safeguard against loss
- Developing cost-effective insurance and risk transfer solutions backed by stable capacity
- Providing the claims and loss mitigation support to minimize business disruption

Figure 4-6: FM Approved Logo

4.2.1.2 UL Approval

UL is a global independent safety science company with more than a century of expertise innovating safety solutions from the public adoption of electricity to new breakthroughs in sustainability, renewable energy and nanotechnology. Dedicated to promoting safe living and working environments, UL helps safeguard people, products and places in important ways, facilitating trade and providing peace of mind [18].

Figure 4-7: UL Approved Logo

4.2.1.3 Loss Prevention Certification Board (LPCB)

The Loss Prevention Certification Board (LPCB) is the landing international certification body in the fields of security and fire protection. LPCB approval is recognized by governments and regulatory authorities across the world, especially in the Asia Pacific, Middle East and Europe.

The LPCB approval process involves assessment and testing of products to ensure that they meet quality standards set by a team of experts who may be regulators, insurers, designers, manufacturers, installers, engineers and scientists. Approval of products is usually based on testing undertaken by their world-renowned testing laboratories. This approval is maintained by regular audits to ensure that the product continues to meet the approval criteria.

Figure 4-8: LPCB Approved Logo

Once they are satisfied that a product, service or company meets the necessary standards, they issue a certificate and list them in the 'Red Book' which is available free of charge for specifiers and other users throughout the world.

When they first started issuing approvals, they were often based on their own Loss Prevention Standards. Over the years, many of these have been incorporated into other British, European and International Standards [19].

At its simplest, the LPCB approval process uses existing standards as the basis for listing. However, where no standards exist, they can still approve innovative products by drawing on the experience of their scientists and expert groups to devise a suitable assessment regime for the product or service concerned.

4.2.1.4 VdS Approval

As one of Germany's leading independent testing institutions for fire protection and security, VdS enjoys the trust of all groups involved in the safety and security markets. Its customers include risk-conscious industrial and commercial companies, leading manufacturers, systems houses, specialized firms and specialist trades. On the operational side, VdS offers an innovative range of services in the fields of fire protection, security, training and publishing. VdS is a fully owned subsidiary of the German Insurance Association (GDV) and, through its owner, has more than 100 years of experience in its core area of business, namely fire protection.

Figure 4-9: VdS Approved Logo

VdS can call on experts in all fields of fire protection and combines the various specialists for matters of constructional fire protection and fire protection installations. Its hundred years of expertise, its focus on fire protection testing and its close cooperation with its own laboratories are unique selling points of the VdS Inspection Services. It is an internationally recognized innovation and technology leader [20].

Numerous accreditations not only document the outstanding competence and expertise of VdS, they also reflect its independence and objective assessments. A VdS certificate therefore gives commercial and private consumers an important orientation aid in distinguishing between high-quality and mediocre products and services. Manufacturers and service providers benefit from the consumers' growing need for safety, as a result of which buying decisions are becoming increasingly dependent on safety aspects.

VdS operates a number of well-equipped laboratories in which type and system tests can be conducted on products for fire and intruder protection. A fundamental requirement for this – apart from using state-of-the-art technologies and innovative testing procedures – is that the staff have a sound knowledge base and long-time experience. The laboratories cover the entire value chain from prototype testing to the VdS approved end product, which means that manufacturers enjoy considerable competitive advantages. To round off the range of services offered by the VdS laboratories, the engineers can also be called on in a consulting capacity, for example when selecting and applying the relevant standards and guidelines.

4.2.1.5 Certificate of Conformity (EC)

A COC (Certificate of Conformity) is a declaration of the conformity with the type approval of EC. The purpose of this document is to ensure the free movement of goods within the European Union, specifically for those goods that are subject to homologation and registration.

A COC is a producer's declaration that the product complies with the given approved type. This document contains information about the product and its producer's identification, type approval number, technical specifications and other data. The content of a COC is defined by EU regulation (Amendment IX, Regulation 92/53). Products without the EU specification (e.g. vehicle manufactured for the U.S. or Japanese market) and older products that have not been given the type approval of the EC yet, do not have an existing COC. Similarly, it is not possible to issue a COC for converted products [21].

Figure 4-10: EC Approved Logo

4.2.2 Marine Applications

4.2.2.1 American Bureau of Shipping (ABS)

Since its founding in 1862, the American Bureau of Shipping (ABS), a New York not-for-profit corporation, has been committed to setting standards for safety and excellence as one of the world's leading ship classification societies.

The mission of ABS is to serve the public interest as well as the needs of their members and clients by promoting the security of life and property and preserving the natural environment.

ABS has been at the forefront of marine and offshore energy innovation for more than 150 years. In a constantly evolving industry, ABS works alongside its partners tackling the most pressing technical, operational and regulatory challenges so the marine and offshore industries can operate safely, securely and responsibly [22].

Figure 4-11: ABS Approved Logo

The surveyors, engineers, researchers and regulatory specialists who form the ABS team work in more than 200 offices in 70 countries around the world providing traditional classification services as well as on-the-ground technical services in asset performance, energy efficiency, environmental performance and life cycle management. With a passion for making the world a safer place, while also delivering practical and innovative solutions, ABS stands ready to assist and advance the marine and offshore energy industries.

4.2.2.2 Der Norske Veritas (DNV)

DNV GL is the world's leading classification society and a recognized advisor for the maritime industry. They enhance safety, quality, energy efficiency and environmental performance of the global shipping industry – across all vessel types and offshore structures. They invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.

The merger between DNV and GL was cleared by competition authorities and the new company became operational from September 12, 2013. DNV GL then became and still is the world's leading ship and offshore classification society and a world-leader of independent assurance and expert advisory services [23].

DNV GL rules, standards and guidelines are developed and based on the competence and experience of their engineers, extensive research and development programs and in close cooperation with their customers worldwide.

Figure 4-12: DNV & GL Approved Logo

4.2.2.3 Lloyd's Register (LR)

Lloyd's Register marine business is a leading provider of classification services around the world, helping ensure that internationally recognized safety and environmental standards are maintained at every stage of a ship's life.

Lloyd's Register provides quality assurance and certification for ships, offshore structures, and shore based installations such as power stations and railway infrastructure. However, Lloyd's Register is known best for the classification and certification of ships, and inspects and approves important components and accessories, including life-saving appliances, marine pollution prevention, fire protection, navigation, radio communication equipment, deck gear, cables, ropes, and anchors [24].

Figure 4-13: Lloyd's Register Approved Logo

LR's Rules for Ships are derived from principles of naval architecture and marine engineering. They also govern safety and operational standards for numerous merchant, military and privately owned vessels. LR's Rules govern a number of topics including:

- Materials used for construction of the vessel
- Ship structural requirements and minimum scantlings, depending on ship type
- Operation and maintenance of main and auxiliary machinery
- Operation and maintenance of emergency and control systems

Specific editions of the rules are available to cater for merchant ships, naval ships, trimarans, special purpose vessels and offshore structures. A ship is known as being in class if it meets all the minimum requirements of LR's Rules, and such a status affects the possibility of a ship getting insurance. Class can be withdrawn from a ship if it is in violation of any regulations and does not maintain the minimum requirements specified by the company. However, exceptional circumstances may warrant special dispensation from Lloyd's Register. Any alteration to the vessel, whether it is a structural alteration or machinery, must be approved by Lloyd's Register before it is implemented.

4.2.2.4 Registro Italiano Navale (RINA)

Registro Italiano Navale (RINA) Group business activities consist in offering certification, verification, control, assistance and consultancy services to economic and institutional operators, aimed at improving the safety and quality of their products, processes and services.

Figure 4-14: RINA Approved Logo

The role they intend to perform is that of guiding the qualitative development of the market, promoting awareness that the adoption of measures to protect safety and the environment and, in general, attention to quality are attitudes which lead to advantages and increase the value of the organisations which pursue them. RINA distinctive feature is application leadership, that is to say, the ability to understand the needs of individual customers and offer a customised and effective service in full compliance with the applicable standards and rules [25].

RINA provides quality assurance and certification for important ship's components and accessories, including life-saving appliances, marine pollution prevention, fire protection, navigation, radio communication equipment, deck gear, cables, rodes, and anchors.

4.2.2.5 United States Coast Guard (USCG)

The U.S. Coast Guard is one of the five armed forces of the United States and the only military organization within the Department of Homeland Security. Since 1790 the Coast Guard has safeguarded their Nation's maritime interests and environment around the world. The Coast Guard is an adaptable, responsive military force of maritime professionals whose broad legal authorities, capable assets, geographic diversity and expansive partnerships provide a persistent presence along their rivers, in the ports, littoral regions and on the high seas. Coast Guard presence and impact is local, regional, national and international. These attributes make the Coast Guard a unique instrument of maritime safety, security and environmental stewardship.

Figure 4-15: USCG Approved Logo

Type Approval is the primary process for equipment and materials to receive Coast Guard approval. For equipment or materials to receive Type Approval, they must be demonstrated to comply with the relevant requirements in the regulations, successfully complete the specified tests, and be enrolled in a quality control or follow up program as required. The quality control or follow up program monitors product uniformity to ensure that it does not deviate from the approved

design. Depending on the type of equipment, the follow up program is generally arranged with the same laboratory that conducted the initial testing or in some cases is carried out by Coast Guard marine inspectors. Since the Coast Guard does not have its own certification laboratory, it relies on Accepted Independent Testing Laboratories to test materials for compliance with the applicable criteria. Such acceptance is given for each approval category and test apparatus individually [26].

4.3 Conclusion

In all the industries, always there are some standard codes for designing and installation of the systems which are developed by related Standard Organizations for those industries. And after that, also there are many Approval Organizations which approve those systems in all aspects from their safety to the quality of the components of those systems.

This chapter has presented the most important and useful Standard Codes and Approvals with their related organizations in the field of Fire Protection, first those who develop Standard Codes and then those who approve the Fire Suppression Systems by applying different tests on them.

Chapter 5

5 Gaseous Fire Suppression Agents

5.1 General Information

Gaseous fire suppression is a term to describe the use of inert gases and chemical agents to extinguish a fire. Also called Clean Agent Fire Suppression. These Agents are governed by the NFPA Standard for Clean Agent Fire Extinguishing Systems – NFPA 2001 – with different standards and regulations in other parts of the world. The system typically consists of the agent, agent storage containers, agent release valves, fire detectors, fire detection system (wiring control panel, actuation signaling), agent delivery piping, and agent dispersion nozzles. Less typically, the agent may be delivered by means of solid propellant gas generators that produce either inert or chemically active gas [33].

This chapter will introduce and compare different gaseous fire suppression agents according to their usage area, acting theory, type of application and safety precaution.

5.1.1 Acting Theory

There are four means used by the agents to extinguish a fire. They act on the "fire tetrahedron":

- Reduction or isolation of fuel. Representative agents: No agents currently use this as the primary means of fire suppression.
- Reduction of heat. Representative agents: Clean agent FS 49 C2 (NAF S 227, MH227, FM-200®), Novec™ 1230, pentafluoroethane (NAF S125, ECARO-25).
- Reduction or isolation of Oxygen. Representative agents: Argonite / IG-55 (ProInert), CO_2 Carbon dioxide, IG-541 INERGEN®, and IG-100 (NN100).
- Inhibiting the chain reaction of the above components. Representative agents: FE-13, Haloalkanes, Bromotrifluoromethane, Trifluoroiodomethane, NAF P-IV, NAF S-III, NAF S125, NAF S227, 1,1,1,2,3,3,3-Heptafluoropropane and Triodide.

5.1.2 Type of Application

Broadly speaking, there are two methods for applying an extinguishing agent:

- Total Flooding

  Systems working on a total flooding principle apply an extinguishing agent to a three dimensional enclosed space in order to achieve a concentration of the agent (volume percent of the agent in air) adequate to extinguish the fire. These types of systems may be operated automatically by detection and related controls or manually by the operation of a system actuator.

- Local Application

  Systems working on a local application principle apply an extinguishing agent directly onto a fire (usually a two dimensional area), or into the three dimensional region immediately surrounding the substance or object on fire. The main difference in local application from total flooding design is the absence of physical barriers enclosing the fire space.

In the context of automatic extinguishing systems, local application generally refers to the use of systems that have been emplaced some time prior to their usage rather than the use of manually operated wheeled or portable fire extinguishers, although the nature of the agent delivery is similar and many automatic systems may also be activated manually. The lines are blurred somewhat with portable automatic extinguishing systems, although these are not common.

5.1.3 Safety Precautions

An extinguishing system which primarily is based on inert gases in enclosed spaces presents a risk of suffocation. Numerous incidents have occurred where individuals in these spaces have been killed by Carbon dioxide agent release. To prevent such occurrences, additional life safety systems are typically installed with a warning alarm that precedes the agent release. The warning, usually an audible and visible alert, advises the immediate evacuation of the enclosed space. After a preset time, the agent starts to discharge. Accidents have also occurred during maintenance of these systems, so proper safety precautions must be taken beforehand.

The positive pressure caused by these gases may be sufficient to break windows and walls. Humans and structures must be adequately protected and ventilation/blow-off must be considered when designing the system [33].

5.2 Total Flooding Chemical Gaseous Agents

5.2.1 FM-200®

5.2.1.1 General Information

FM-200® has been developed as an alternative to Halon 1301, production of which ceased at the end of 1993, under the agreed adjustments made to the Montreal Protocol in November 1992.

FM-200® contains no Bromine or Chlorine and has therefore an Ozone depleting potential of zero.

FM-200® systems utilize one or more storage containers arranged to provide the protected area with a pre-determined quantity of gas.

FM-200® storage containers are designed to hold FM-200® in liquid form and Nitrogen, which is used to super-pressurize the container to 25 bar (362 psi) at 20°C.

The components used in the FM-200® systems are designed and tested to operate in the temperature range 0°C to 50°C or as stated in separate component approvals. For applications outside this temperature range refer to the Product Manager.

Handling and Installation of FM-200® equipment should only be carried out by persons experienced in dealing with this type of equipment [6].

5.2.1.2 Description of FM-200® Systems

FM-200® systems are designed to suppress fires involving flammable liquids, gases and in electrical equipment.

FM-200® suppresses fires by a combination of physical and chemical means. It does not significantly deplete the Oxygen content in the room and tests have shown it to be less toxic than Halon 1301.

A system comprises one or more containers connected to a system of pipework and nozzles. FM-200® is liquefied under pressure and is stored in steel containers, each of which is fitted with a valve specially designed to allow the contents of the container to discharge rapidly. When the valve opens, FM-200® flows into the distribution pipework to the discharge nozzles where it is rapidly dispersed as a vapor [7].

Discharging FM-200® gives the appearance of a fog which may reduce visibility. This normally clears rapidly and should not obstruct the ability of personnel to safely exit the protected area.

FM-200® Fire Suppression Systems are particularly valuable in suppressing 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. Consideration should be given in the positioning of nozzles to ensure that delicate equipment is not subjected to cold shock.

5.2.1.3 Properties of FM-200®

Under normal conditions, FM-200® is an odorless colorless gas with a density around 6 times greater than air. It has a vapor pressure of approximately 4 bar at 20°C and is super-pressurized with Nitrogen to 25 bar when used in fire suppression applications.

It contains no particulates or oily residues and it is produced under ISO 9002 guidelines to strict manufacturing specifications ensuring product purity.

Present understanding of FM-200® is that fire suppression is through heat absorption and chemical means.

FM-200® decomposes at temperatures in excess of 500°C and it is therefore important to avoid applications involving hazards where continuously hot surfaces are involved. Upon exposure to the flame, FM-200® will decompose to form halogen acids. Their presence will be readily detected by a sharp, pungent odor before maximum hazardous exposure levels are reached.

It has been concluded from fire toxicity studies that decomposition products from the fire itself especially Carbon monoxide, smoke, Oxygen depletion and heat may create a greater hazard.

5.2.1.4 Toxicity of FM-200®

The following table details the toxicological data on FM-200® and compares this with Halon 1301.

	FM-200®	Halon 1301
Cardiac Sensitization No Observed Adverse Effect Level (NOAEL)	9.0%	5.0%
Cardiac Sensitization Lowest Observed Adverse Effect Level (LOAEL)	10.5%	7.5%
Design concentration (minimum)	7.9%	5.0%

Table 5-1: FM-200® Toxicological Data

It can be seen that FM-200® has extremely low toxicity and as it suppresses fires at low concentrations, it does not significantly reduce Oxygen levels [7].

5.2.2 Novec™ 1230

5.2.2.1 General Information

Novec™ 1230 has been developed as an alternative to Halon 1301, production of which ceased at the end of 1993, under the agreed adjustments made to the Montreal Protocol in November 1992.

Novec™ 1230 contains no Bromine or Chlorine and has therefore an Ozone depleting potential of zero.

Novec™ 1230 systems utilise one or more storage containers arranged to provide the protected area with a pre-determined quantity of gas.

Novec™ 1230 storage containers are designed to hold Novec™ 1230 in liquid form and Nitrogen, which is used to superpressurise the container to either 25 bar (362 psi) or 42 bar (609 psi) at 20°C.

The components used in Novec™ 1230 systems are designed and tested to operate in the temperature range -20°C to 50°C or as stated in separate component approvals. For applications outside this temperature range refer to the Product Manager.

Handling and Installation of Novec™ 1230 equipment should only be carried out by persons experienced in dealing with this type of equipment [5].

5.2.2.2 Description of Novec™ 1230 Systems

Novec™ 1230 systems are designed to suppress fires involving flammable liquids, gases and in electrical equipment.

Novec™ 1230 suppresses fires by heat absorption. It does not significantly deplete the Oxygen content in the room and tests have shown it to be less toxic than Halon 1301.

A system comprises one or more containers connected to a system of pipework and nozzles. Novec™ 1230 is stored under pressure in steel containers, each of which is fitted with a valve specially designed to allow the contents of the container to discharge rapidly. When the valve opens, Novec™ 1230 flows into the distribution pipework to the discharge nozzles where it is rapidly dispersed as a vapor.

Discharging Novec™ 1230 gives the appearance of a fog which may reduce visibility. This normally clears rapidly and should not obstruct the ability of personnel to safely exit the protected area.

Novec™ 1230 Fire Suppression Systems are particularly valuable in suppressing 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. Consideration should be given in the positioning of nozzles to ensure that delicate equipment is not subjected to cold shock.

5.2.2.3 Properties of Novec™ 1230

Under normal conditions, Novec™ 1230 is an odorless liquid with a vapor density around 12 times greater than air. It has negligible vapor pressure and is super-pressurized with Nitrogen to 25 or 42 bar when used in fire suppression applications.

It contains no particulates or oily residues and it is produced under ISO 9001 guidelines to strict manufacturing specifi cations ensuring product purity.

Present understanding of Novec™ 1230 is that fire suppression is through heat absorption.

Novec™ 1230 decomposes at temperatures in excess of 500°C and it is therefore important to avoid applications involving hazards where continuously hot surfaces are involved. Upon exposure to the flame, Novec™ 1230 will decompose to form halogen acids. Their presence will be readily detected by a sharp, pungent odor before maximum hazardous exposure levels are reached.

It has been concluded from fire toxicity studies that decomposition products from the fire itself especially Carbon monoxide, smoke, Oxygen depletion and heat may create a greater hazard.

5.2.2.4 Toxicity of Novec™ 1230

The following table details the toxicological data on Novec™ 1230 and compares this with Halon 1301.

	FM-200®	Halon 1301
Cardiac Sensitization No Observed Adverse Effect Level (NOAEL)	10.0%	5.0%
Cardiac Sensitization Lowest Observed Adverse Effect Level (LOAEL)	>10.0%	7.5%
Design concentration (minimum)	5.3%	5.0%

Table 5-2: Novec™ 1230 Toxicological Data

It can be seen that Novec™ 1230 has extremely low toxicity and as it suppresses fires at low concentrations, it does not significantly reduce Oxygen levels [5].

5.3 Total Flooding Inert Gaseous Agent

5.3.1 INERGEN®

5.3.1.1 General Information

INERGEN® 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 or the environment in general. INERGEN® agent is a mixture of three inerting (Oxygen diluting) gases: 52% nitrogen, 40% argon, and 8% Carbon dioxide (see MSDS in Section II).

INERGEN® extinguishes fire by lowering the Oxygen content below the level that supports combustion. When INERGEN® agent is discharged into a room, It introduces the proper mixture of gases that allow a person to breathe in a reduced Oxygen atmosphere. It actually enhances the body's ability to accumulate oxygen. The normal atmosphere in a room contains approximately 21% Oxygen and less than 1% Carbon dioxide. If the Oxygen content is reduced below 15%, most ordinary combustibles will not burn. INERGEN® agent will reduce the Oxygen content to approximately 12.5% while increasing the Carbon dioxide content to about approximately 3%. The increase in the Carbon dioxide content increases a person's respiration rate and the body's ability to absorb oxygen [8]. Simply stated, the human body is stimulated by the Carbon dioxide to breathe more deeply and rapidly to compensate for the lower Oxygen content of the atmosphere.

5.3.1.2 Personnel Safety

Proper INERGEN® system design requires that the design concentrations fall within a 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 in this window, no adverse effect 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. Refer to NFPA 2001, 2000 edition, Paragraph 1-

6.1.3, “Inert Gas Clean Agents,” for detailed exposure conditions. HMIS 1-0-0/very cold discharge. Contents under high pressure. Avoid direct contact of the cold, high pressure discharge and avoid direct inhalation of undiluted gas.

5.3.1.3 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.

5.3.1.4 Types of Actuation

There are three basic types of actuation for the INERGEN® systems: pneumatic, mechanical, and electrical [8].

- **Electrical**

  Automatic electrical actuation of the cylinder valve, through an approved control panel, can be accomplished by using an HF actuator for the CV-98 valve. The actuator is energized by an electric signal from the detection/control panel. When using the electric actuator, pneumatic or mechanical actuating devices can also be attached as a secondary means of actuation. When using electric actuation, a means of manual release shall also be provided.

- **Mechanical**

  Mechanical actuation is accomplished by a lever actuator mounted on top of the cylinder valve or other actuators. By rotating the lever on the actuator, either locally or from a remote pull station, the cylinder valve can be opened, allowing the INERGEN® to discharge through the piping and nozzles.

- **Pneumatic**

  Pneumatic actuation utilizes gas pressure from a cartridge located in a releasing device such as an ANSUL AUTOMAN II-C release. The gas pressure forces the piston of the pneumatic actuator down, which in turn forces the cylinder valve to open, releasing INERGEN® agent from the cylinder, through the piping and out the nozzles. On a CV-98 valve, a 1/4 in. actuation line is attached to the 1/8 in. port on the side of the valve. Pneumatic pressure, from an ANSUL AUTOMAN II-C or another pilot cylinder, opens the valve through this port.

5.3.1.5 Types of Detection

There are two approved types of detection available for the INERGEN® system: electronic control panel and electric releasing device.

- **Electronic Control Panel**

  Electric actuation of the INERGEN® system is obtained through the use of electronic control systems which monitor and control various system functions. All detection equipment must be installed according to NFPA 70 and NFPA 72. Detection devices available are: ionization smoke detectors, photoelectric smoke detectors, flame detectors, and ratecompensated heat detectors. **Note:** When designing the system, make certain the type of detector used is appropriate for the type of hazard so proper response is attained in a fire situation. When a detector senses a fire, a signal is sent to the control panel. The panel in turn sends an electrical signal to the solenoid actuator located on the pilot cylinder valve. The actuator opens the cylinder valve releasing the INERGEN® agent into the manifold. The pressure in the manifold then causes the slave valves to open and discharge INERGEN® into the piping network and out the nozzles.

- **Electric Releasing Device**

  The ANSUL AUTOMAN II-C electric releasing device uses approved thermal detectors and actuates the INERGEN® cylinders pneumatically, utilizing high pressure nitrogen to operate the cylinder valve.

5.4 Total Flooding & Local Application Gaseous Agent

5.4.1 Carbon Dioxide (CO2)

5.4.1.1 General Information

Carbon dioxide, as an extinguishing agent, has many desirable properties. It will not damage equipment and leaves no residue to be cleaned up. Since it is a gas, Carbon dioxide will penetrate and spread to all parts of the protected hazard. It does not conduct electricity and, therefore, it can be used on live electrical equipment. It can be effectively used on most combustible material.

Carbon dioxide extinguishes fire by reducing the Oxygen concentration to a point where the atmosphere will no longer support combustion. The Carbon dioxide concentration must be maintained for a sufficient period to allow the maximum temperature to be reduced below the auto-ignition temperature of the burning material. Carbon dioxide is most effective against flammable

liquid fires. For most flammable liquids, reduction of the Oxygen concentration to 15% (from the normal 21%) will be sufficient to extinguish the fire. For Class A (wood, and paper) combustibles, a reduction to 15% will control the fire. Some materials, such as acetylene and ethylene oxide, require a greater reduction of Oxygen concentration for extinguishment. Still other materials, such as cellulose nitrate and metal hydrides, which do not require Oxygen as they burn, cannot be extinguished by use of Carbon dioxide [9].

5.4.1.2 Personnel Safety

The discharge of Carbon dioxide into an enclosed space can create an asphyxiant as well as toxic environment. It can also reduce visibility to a point where exits are difficult to locate by persons attempting to evacuate the area.

Any use of Carbon dioxide in an occupied space should provide for the prompt evacuation of personnel and resuscitation of anyone trapped in the hazard area. Time delays, training, signs, alarms, and breathing apparatus should be provided to the personnel involved.

5.4.1.3 Types of Systems

There are two basic types of systems: total flooding and local application.

- **Total Flooding**

  A total flooding system normally consists of a fixed supply of Carbon dioxide connected to fixed piping with nozzles to direct the agent into an enclosed space about the hazard. In a total flooding system, the space around the hazard must be tight enough to hold the required percentage of Carbon dioxide concentration long enough to extinguish the fire.

- **Local Application**

  A local application system consists of a fixed supply of Carbon dioxide, piping, and nozzles to direct the agent at the hazard independent of any enclosure that may exist. The nozzles are arranged to discharge the Carbon dioxide directly onto the burning material.

5.4.1.4 Types of Actuation

There are three basic types of actuation for Carbon dioxide systems: pneumatic, mechanical, and electrical [9].

- **Pneumatic**

  Pneumatic actuation utilizes gas pressure from either a remote cartridge actuator or from a cartridge located in a control panel such as an ANSUL AUTOMAN II-C release. On a CV-98 valve, a 1/4 in. actuation line is attached to the pilot port on the side of the valve. Pneumatic pressure from the ANSUL AUTOMAN II-C or pilot cylinder opens the valve through this port.

- **Mechanical**

  Mechanical actuation is accomplished by a lever actuator mounted on top of the cylinder valve. By manually rotating the lever, the cylinder valve can be opened, allowing the Carbon dioxide to discharge through the piping and nozzles.

- **Electrical**

  Electrical automatic actuation of the CV-98 cylinder valve can be accomplished by using an HF and booster actuator. The actuators are energized by an electric signal from the detection control panel.

5.4.1.5 Types of Detection

There is one type of automatic detection available for Carbon dioxide systems, electric (control panel) [9].

- **Electric**

  Electric operation of the Carbon dioxide system is obtained through the use of electronic control systems which monitor and control various system functions. Detection devices available are: ionization smoke detectors, photoelectric smoke detectors, fixed temperature detectors, rate-of-rise heat detectors, flame detectors, or combustible vapor detectors. When a detector senses a fire, a signal is sent to the control panel. The panel in turn sends an electric signal to the actuator located on the cylinder valve. The actuator opens the cylinder valve causing the Carbon dioxide to be released into the piping network and discharged out the nozzles.

5.5 Comparison of Gaseous Agents

5.5.1 Environment

	FM-200®	NOVEC™ 1230	INERGEN®	CO_2
Ozone Depletion Factor	0	0	0	0
Global Warming Potential	3500	1	0	0
Atmospheric Lifetime (years)	33	0.014 (5 days)	0	0

Table 5-3: Environmental Impact of Gaseous Agents

5.5.2 Human Safety

	Design Concentration	NOAEL[4]	LOAEL[5]
FM-200®	6.4% - 9.0%	9%	10.5%
NOVEC™ 1230	4.2% - 5.9%	10%	>10%
INERGEN®	34.2% - 41.2%	43%	52%
CO_2	35% - 65%	5%	n.a.

Table 5-4: Human Safety of Gaseous Agents

5.5.3 Extinguishing Capacity

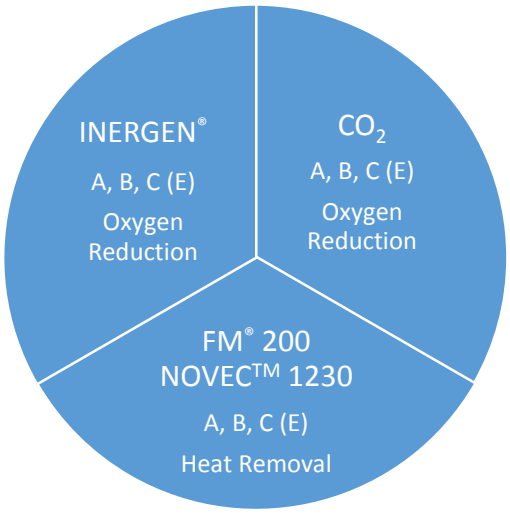

Figure 5-1: Extinguishing Capacity of Gaseous Agents

[4] NOAEL: No Observable Adverse Effect Level
[5] LOAEL: Lowest Observable Adverse Effect Level

Note: All of them are suitable for occupied spaces except CO_2.

They are not effective on...

- ✓ Class A deep-seated fires
- ✓ Chemicals containing their own Oxygen (Cellulose Nitrate)
- ✓ Chemicals capable of auto thermal decomposition

5.5.4 Installation Time & Complexity

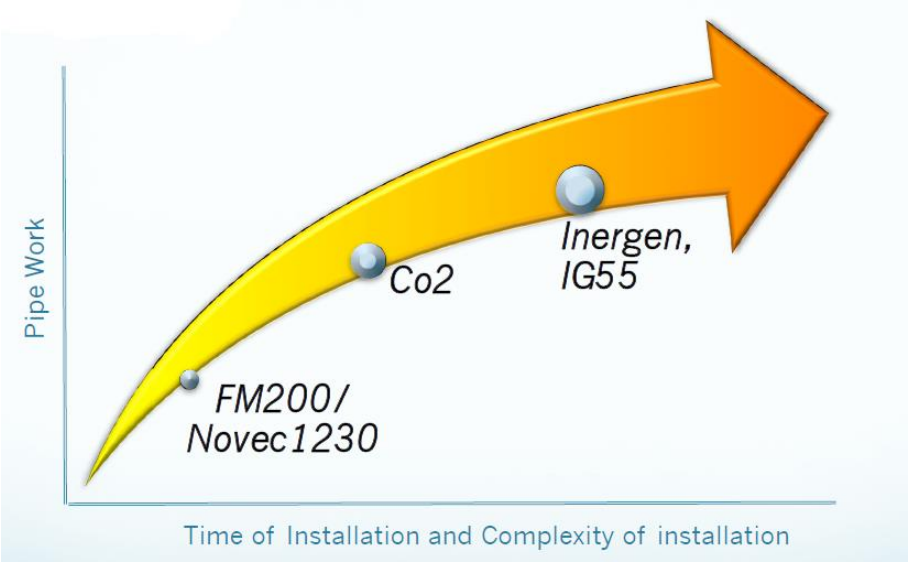

Figure 5-2: Installation Time & Complexity of Gaseous Agents

- ✓ FM200 and Novec1230 demand less space and less pipe work.
- ✓ Inert Gas cylinders can often be more complicated with larger footprints and more pipe work.

5.5.5 Working Pressure

- ✓ The installer must ensure the correct pressure rating for pipes and fittings acc. to the flow calculation result.
- ✓ Pipe pressure downstream the pressure reducing unit.
- ✓ The final peak pressure in the pipe will result from the hydraulic flow calculation.

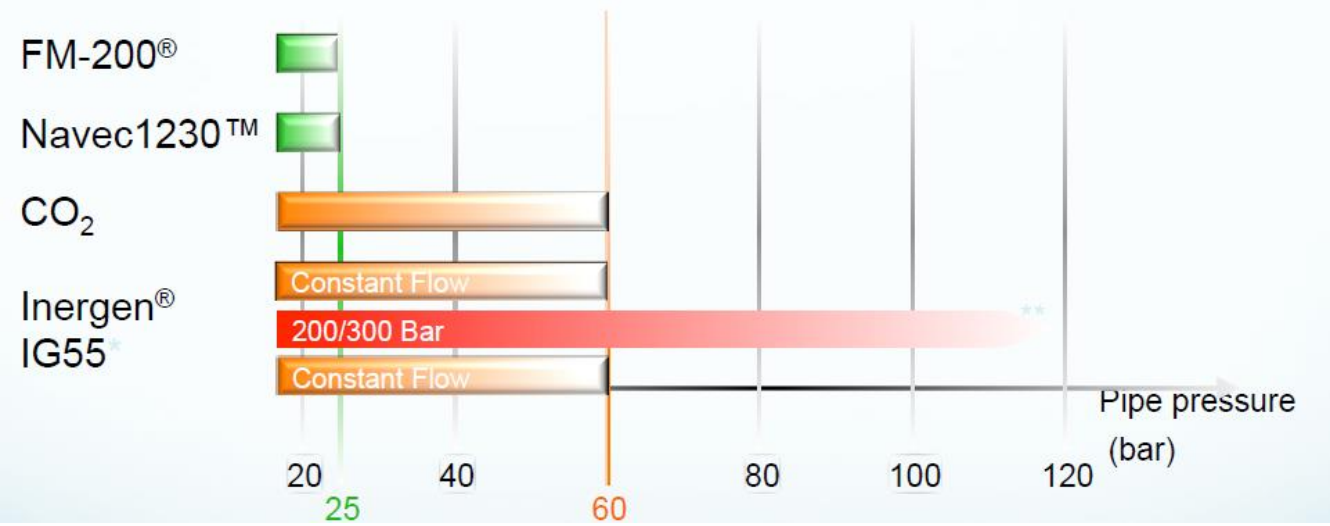

Figure 5-3: Working Pressure of Gaseous Agents

5.5.6 Cylinder Foot Print

The required quantity of each agent for a 200 m^3, class A hazard is as below:

FM-200®:	7.9% = 0.63 kg/m^3
NOVEC™ 1230:	5.3% = 0.78 kg/m^3
INERGEN®:	39.9% = 0.51 m^3/m^3
CO_2:	50% = 1.30 kg/m^3

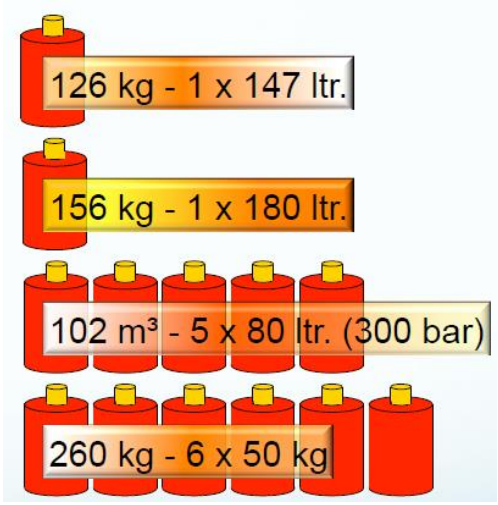

Figure 5-4: Cylinder Foot Print

Question: What is the best fire suppression agent?

Answer: Generally, there is no best! Many factors finally lead to the decision for a certain system.

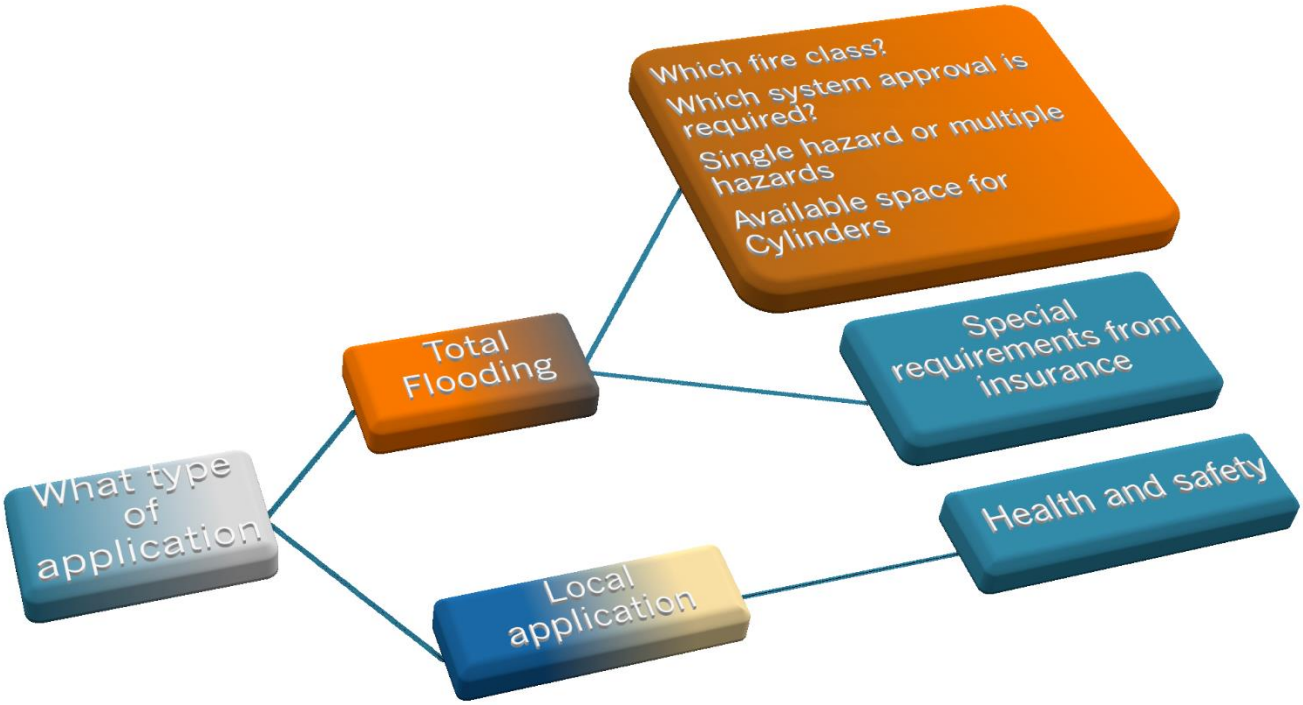

Figure 5-5: Procedure of Choosing the Best Agent

5.6 Conclusion

Gaseous fire suppression agents have been described in this chapter. As it has been explained, there are two major types of gas agents – Total Flooding and Local Application – that are completely presented with their sub-categories during the chapter.

Always there is a question that which type of these systems is the best, so there is a useful and experimental comparison part at the end of the chapter to answer this question.

Chapter 6

6 INERGEN Fire Suppression System

6.1 Introduction

In previous chapters, we got familiar with various types of Fire Standard Codes and Approvals and then the different Gaseous Fire Suppression Agents.

Now it is time to get familiar with a complete fire suppression system. As we already know, there are many different types of fire suppression system, the general concept of all of them is the same however each of them has its own specific details. Thus, here we can just present one system with all the details, components and specifications.

In this chapter, we will specifically focus on the INERGEN® Fire Suppression System as one of the most widely used systems in the world and discuss it in all aspects, from its component to its design, installation, service & maintenance. In addition, there will be a very complete explanation and systematic learning guide for INERGEN® calculating software.

6.2 Basic Components

6.2.1 INERGEN®

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).

- ✓ 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) ρr = 1.18 (T=20°C, P=1.0132 bar)

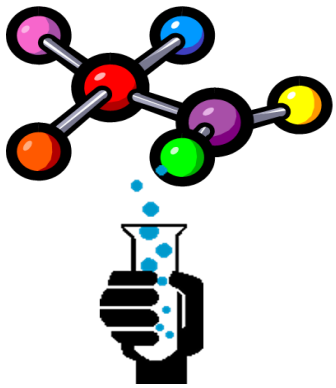

Figure 6-1: INERGEN®

This discharge mixture makes INERGEN® singularly unique. No other inert gas has the unique ability to rapidly extinguish a fire yet at the same time provide a safe environment for any person within the occupied area by actually decreasing cardiac distress and maintaining arterial blood oxygenation and mental performance in low Oxygen levels. Equally important, unlike some chemical gaseous fire suppression agents, INERGEN® does not, and could never create a reaction with a fire to create extremely harmful toxic or corrosive by-products.

6.2.2 Cylinders

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.

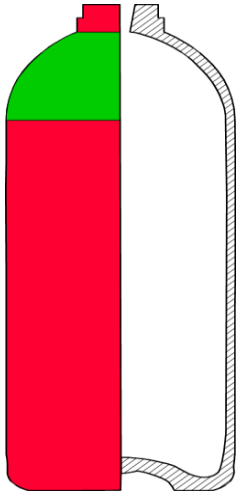

Figure 6-2: Cylinder

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 [11].

6.2.3 Cylinder Rail & Brackets

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

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 to support the load from the cylinders. Typically 1 bracket per 2 cylinders plus 1 at the end [11].

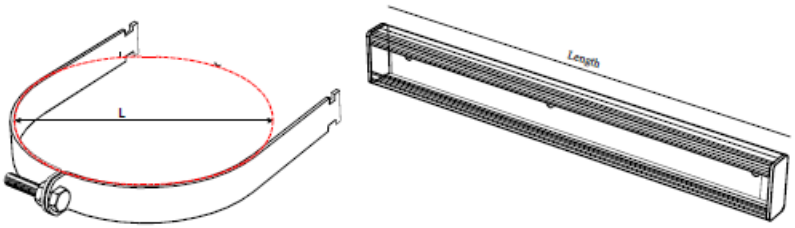

Figure 6-3: Cylinder Rail & Bracket

6.2.4 Discharge Valve

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 [11].

Figure 6-4: Discharge Valve

6.2.5 Actuators

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. 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.

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 [11].

Figure 6-5: Actuators (Manual – Electric - Pneumatic)

6.2.6 Discharge & Pilot Hose

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.

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 & pilot hose is available as standard. 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° [11].

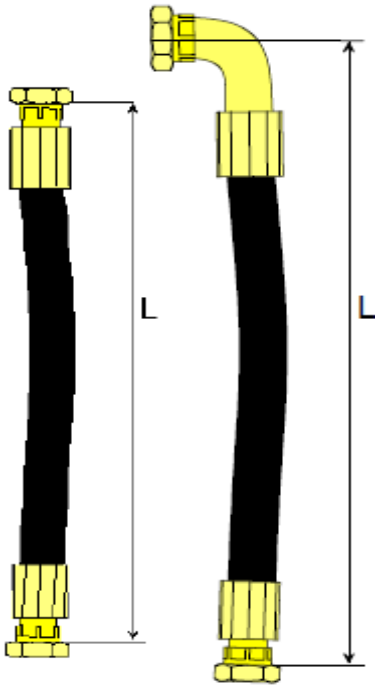

Figure 6-6: Discharge & Pilot Hose

6.2.7 Manifold & Orifice

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. 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 must be used to connect from one discharge valve on one manifold to a discharge valve on the next manifold.

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 [11].

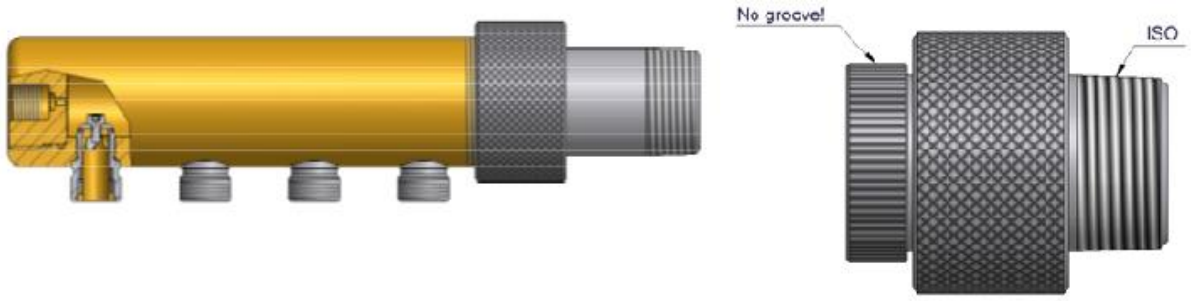

Figure 6-7: Manifold & Orifice

6.2.8 Selector Valve

The Selector Valve is used for distributing INERGEN® from a shared supply to multiple rooms.

The Selector Valve must reset manually and cannot limit the INERGEN® volume for each room. The INERGEN® volume for each room must be calculated separately.

By activating only the required quantity of cylinders for each zone it is possible to limit the INERGEN® volume to the calculated volume.

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

For Selector Valve systems, a cylinder rail is installed approximately 2.6m 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

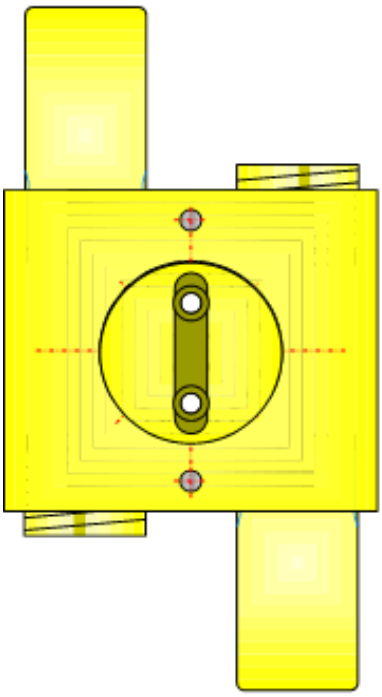

Figure 6-8: Selector Valve

valves and manifolds, except the manifold has different pipe length (space between tees). The valve is opened pneumatically by pressurizing the control ports. For correct operation both ports must be pressurized. The valve has to be reset manually by using reset tool. The pneumatic actuation circuitry must be depressurized before the valve can be reset [11].

6.2.9 Nozzles

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.

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

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

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 [11].

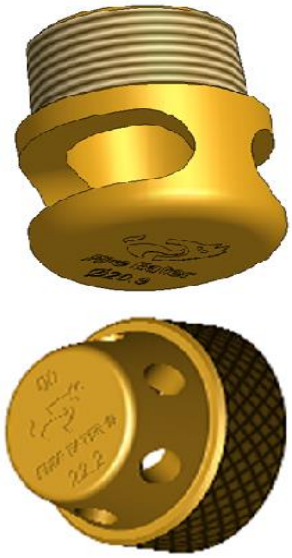

Figure 6-9: Nozzles

6.2.10 Pipe System

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.

Figure 6-10: INERGEN® Piping System

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 [11].

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

6.2.11 Fasteners & Pipe Hangers

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 [11].

Pipe Diameter (mm)	Max. Distance Between Supports (m)
< 25	*2*
25 < < 50	*3*
> 50	*4*

Table 6-1: Distance Between Pipe Supports

6.2.12 Tools & Accessories

Tools for servicing the valves, actuators etc. should only be purchased at verified companies and are only sold to authorized installers where employees have received training and education in installation & maintenance of INERGEN® systems. Ordinary tools like wrenches and screwdrivers are also available in selected qualities for the installation. Accessories are the components used to complete the installation. For example, to seal actuators, must use "fine" sealing wire and to seal hand wheel valves, "coarse" sealing wire [11].

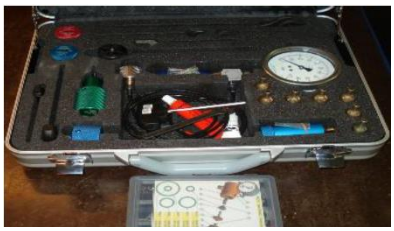

Figure 6-11: Tools Kit & Accessories Box

6.2.13 Signs & Labels

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 [11].

Figure 6-12: Caution Label

6.3 Specifications

6.3.1 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 inert (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.

6.3.1.1 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.

6.3.2 INERGEN® System

The 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 authorized organization.

The INERGEN® system is particularly useful for suppressing fire in hazards where an electrically nonconductive 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

6.3.3 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 heartbeats 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.

6.3.4 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 (Hypoxia is the medical term for the lack of Oxygen in humans) the physical performance will decrease slightly but at an 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[6]:

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

Time (min)	Agent Concentration	% Oxygen
5	43%	12.0%
3	52%	10.0%
0.5	62%	8.0%

Table 6-2: Exposure Time to Reduced Oxygen Atmosphere

6.3.5 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.

6.3.6 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.

6.3.7 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

6.4 Planning

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.

6.4.1 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)	Electrical equipment
	Not defined in EN2 2004	
Class D	Class D	Combustible metals
Class K	Class F	Cooking oil or fat

Table 6-3: Fire Classification[7]

6.4.2 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?

6.4.3 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.

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

- 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.

6.4.4 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 1920 kg/m^2 for an 80lit - 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.

6.4.5 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.
- Is automatic detection 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?

6.4.6 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.

6.4.7 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

6.5 Design

After completing the hazard analysis in 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[8] is self-explaining additional information may be found under "help". The calculation from IMT will have to be printed in order to have all the information available for the system, not all information will be displayed directly in the program. This can be performed by printing a PDF of the calculation where all output will be available.

6.5.1 Limitations on System Design

The following are limitations to a Fire Eater INERGEN® system that will ensure proper performance [11].

Max pipe length:	300m (orifice to last nozzle)
Max pipe to cylinder volume ratio:	20%
Discharge time:	40 - 600 sec for 85/95% agent mass
	40-120 sec for 95% UL & FM approved systems
Re-number:	minimum 0.4×106.
Minimum Manifold Orifice:	No limit
Manifold Orifice to Pipe ratio:	max 0.64 (ø17.6/ø22.0mm)
Nozzle Orifice:	minimum ø1.0 with filter Nozzle
	minimum ø3.0 for UL & FM approved systems
Nozzle to Pipe ratio:	max 0.7
Tee split: Bull head (min/max):	5/95 - 95/5
Tee split: Trough/Side (min/max):	5/95 - 95/5
Nozzle pressure:	min 20 bar

[8] Created and Released by Fire-Eater Company.

Nozzle pressure variance ratio:	max 2.0
Max Elevation change:	max 50m
Mach-number:	maximum 0.40
Minimum distance to first Tee:	0m
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
Elevation changes:	50m
Cylinder pressure:	20 and 30 MPa @ 15°C
Temperature:	-0°C to +65°C

Activation limitations on one solenoid

PA line (Pneumatic activation):	max 250m (app 750 cylinders)*
	UL/FM max 50m (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 ULFM 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.

6.5.2 Guide to Calculation Software IMT

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".

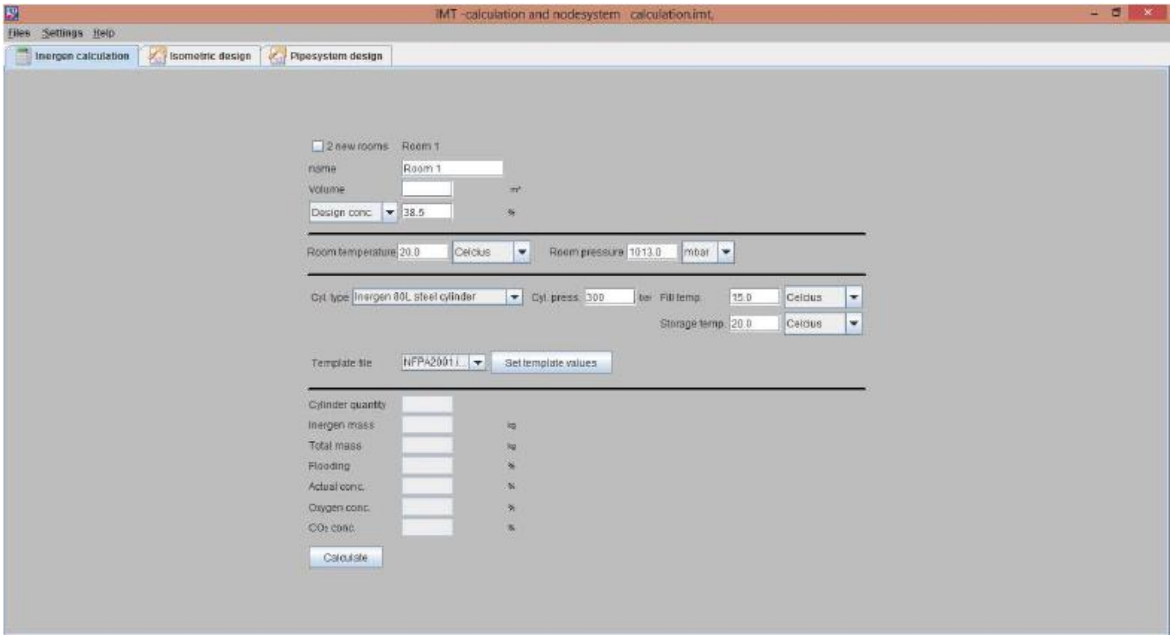

Figure 6-13: IMT Software Initial Page

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

Table 6-4: IMT Software Main Items

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:

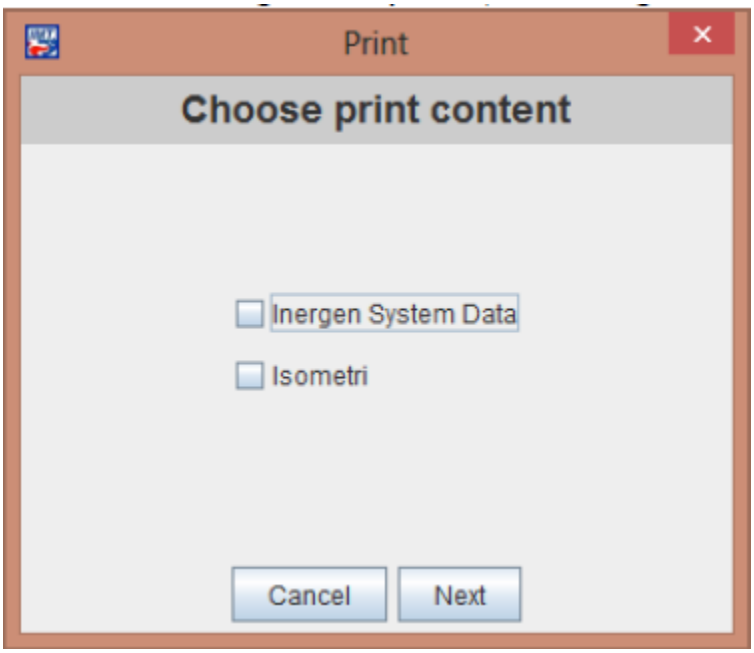

Figure 6-14: IMT Software Print Page

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.

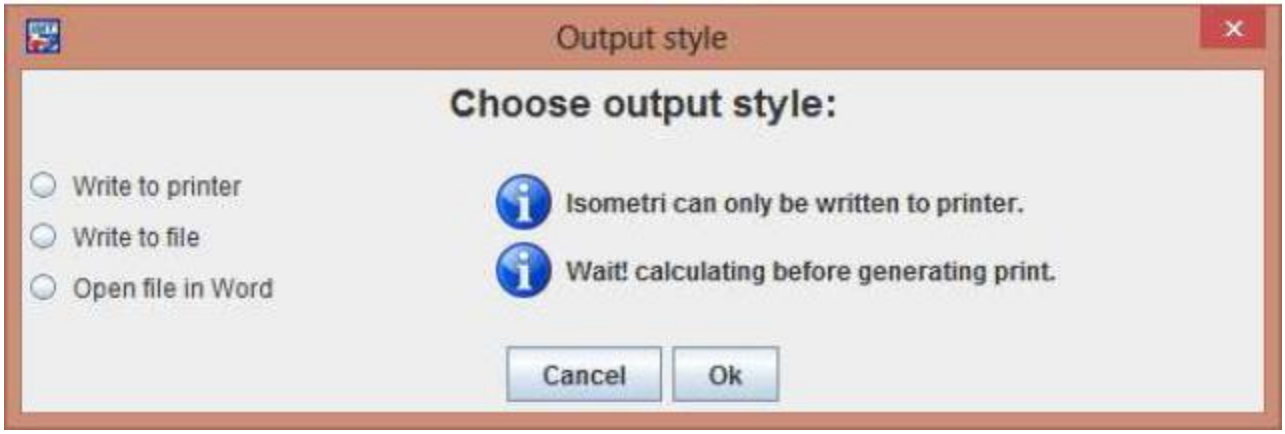

Figure 6-15: IMT Software Output Style Page

System Settings

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

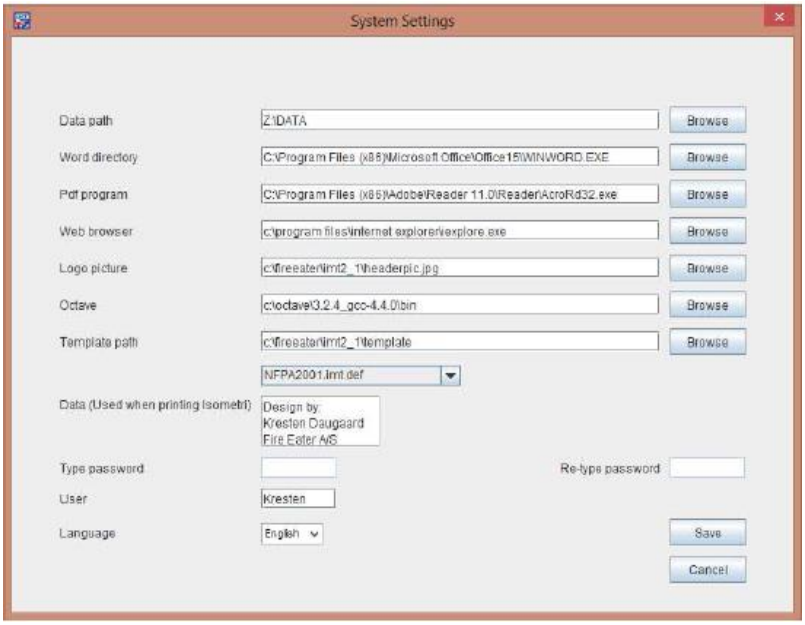

Figure 6-16: IMT Software System Settings Page

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

Table 6-5: IMT Software System Settings Items

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.

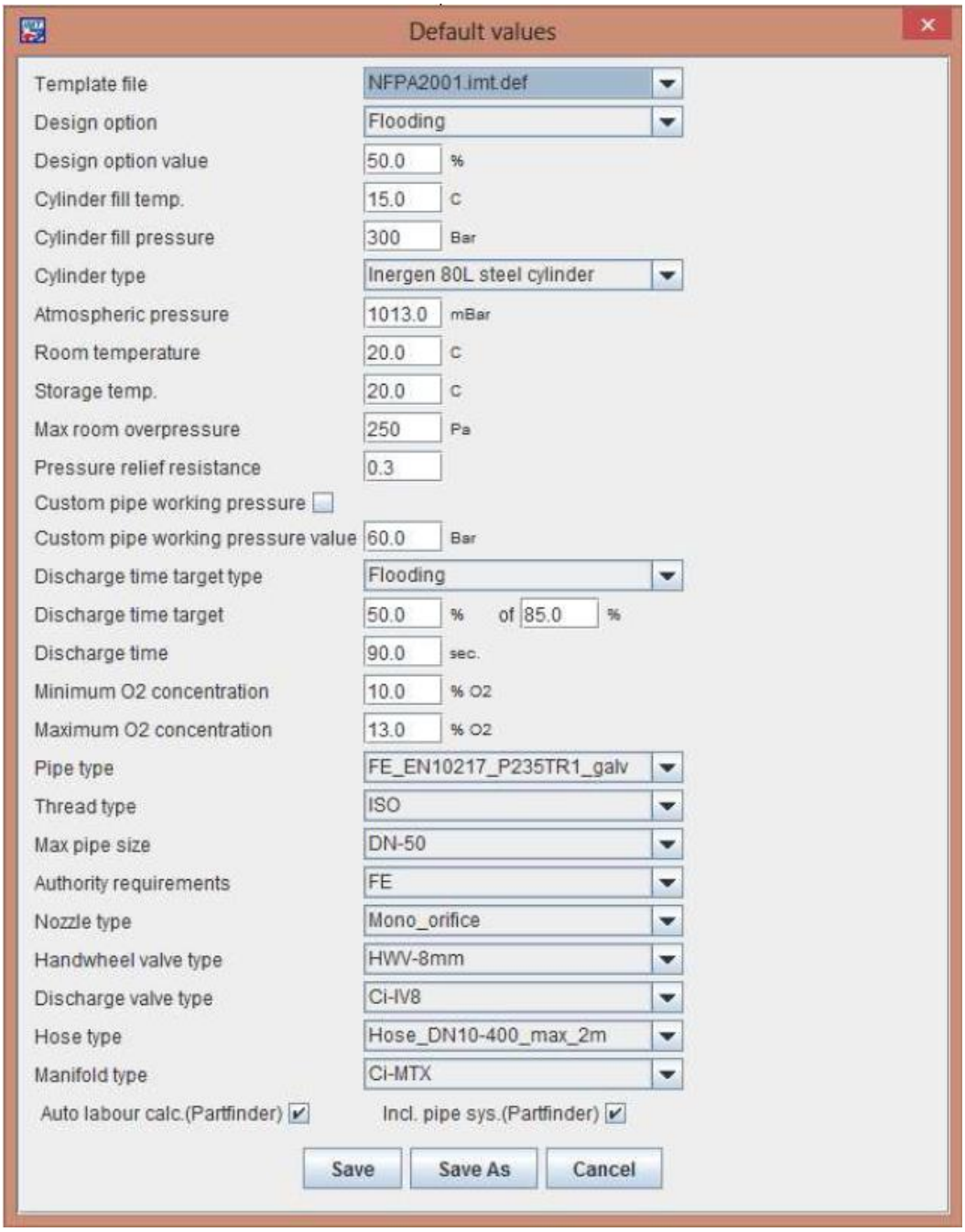

Figure 6-17: IMT Software Template Values Page

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.

Table 6-6: IMT Software Template Values Items

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

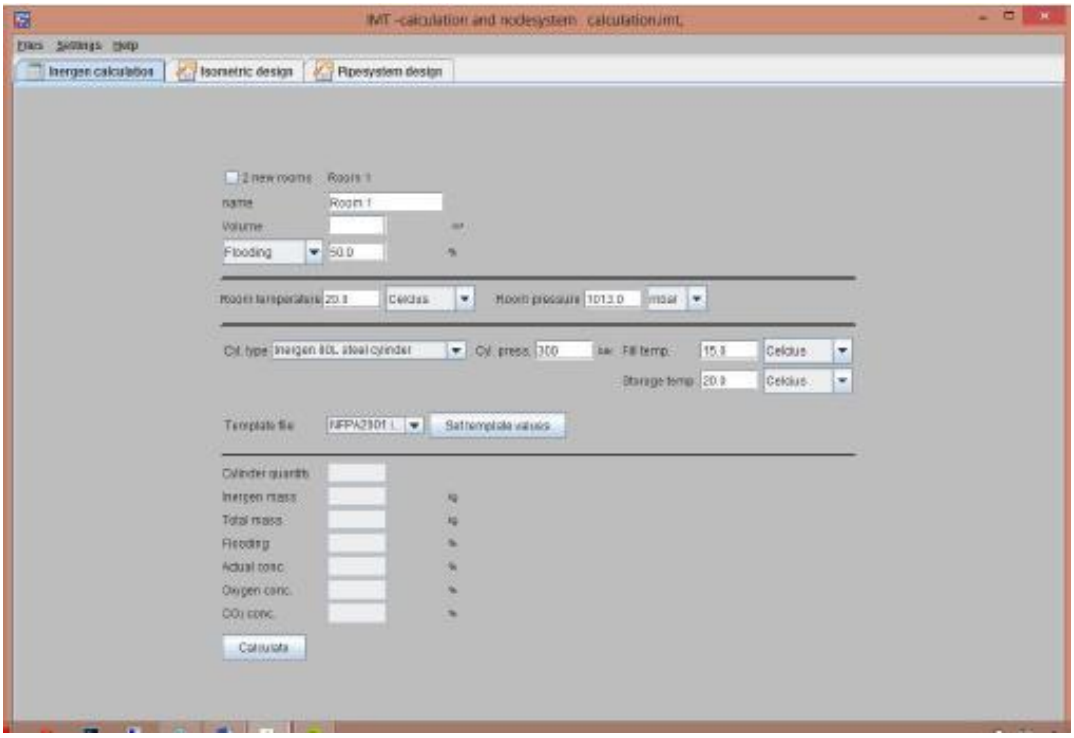

Figure 6-18: IMT Software Calculation Page

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

Table 6-7: IMT Software Calculation Items

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.

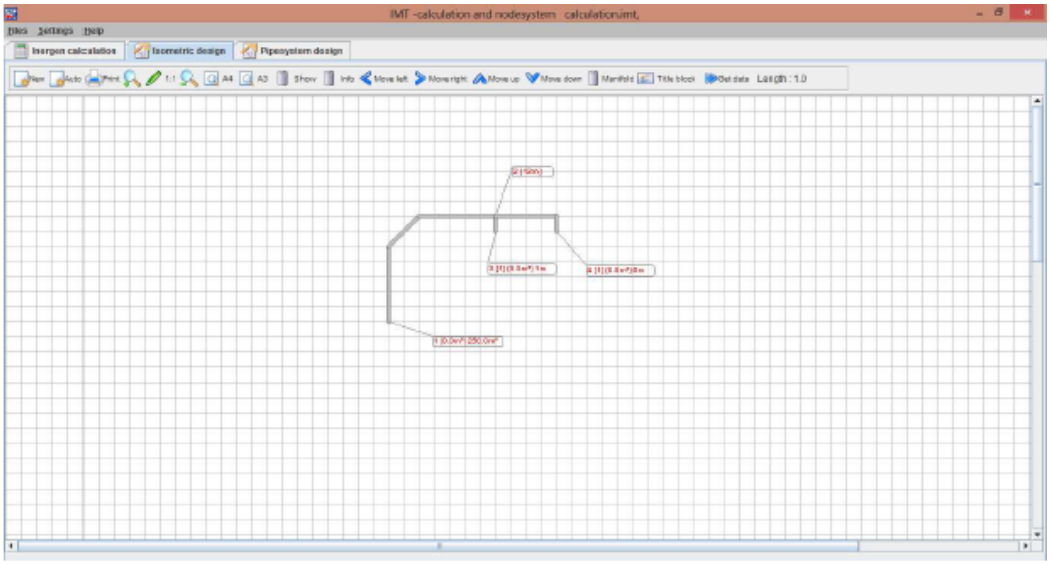

Figure 6-19: IMT Software Isometric Design Page

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".

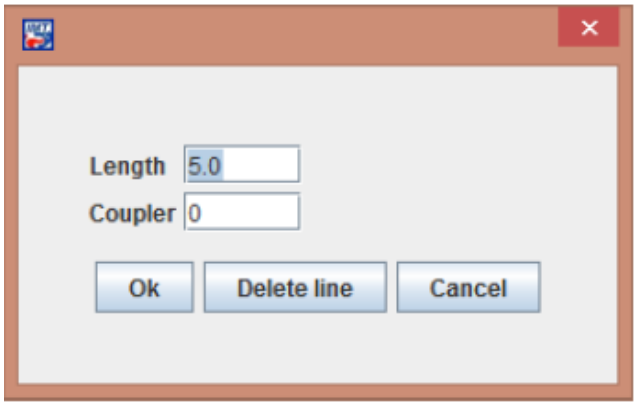

Figure 6-20: IMT Software, Defining Pipe Length

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.

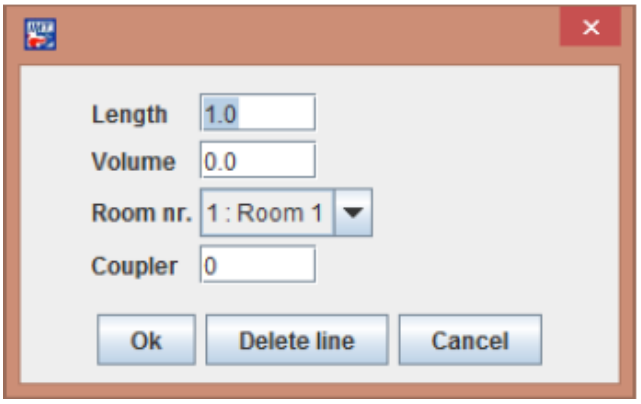

Figure 6-21: IMT Software, Defining Nozzles

Click on the Manifold 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”.

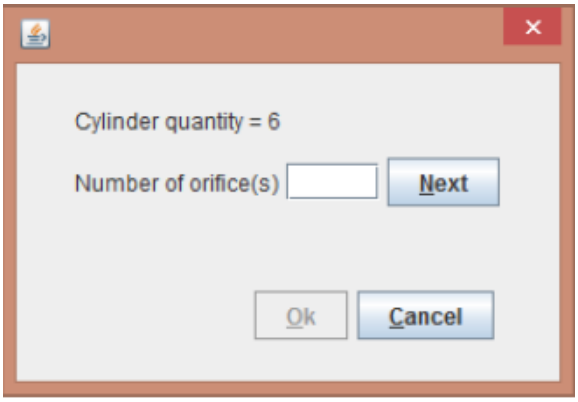

Figure 6-23: IMT Software, Defining Manifold

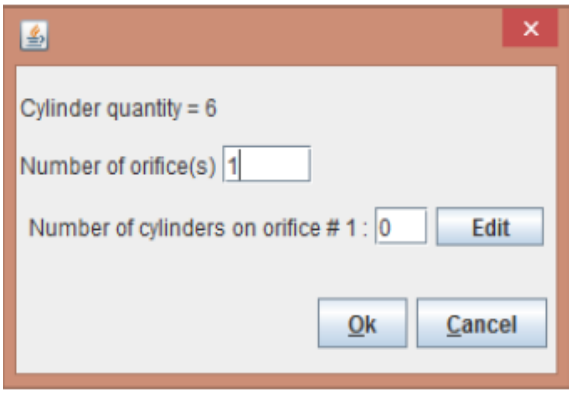

Figure 6-22: IMT Software, Defining Orifices

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.

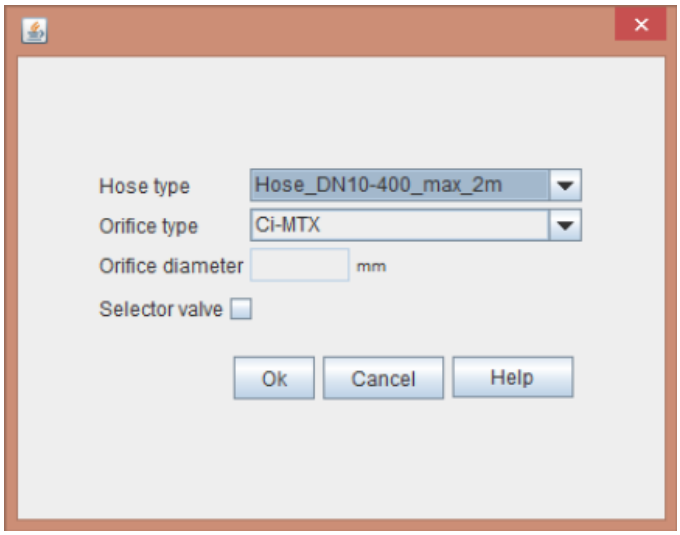

Figure 6-24: IMT Software, Defining Hose Type & Selector Valve

See the below table for the options in the taskbar.

New	Create new isometric drawing
Auto	Creates an auto isometric design. Only define the volume covered by each nozzle on average.
Print	Print the isometric
	Zoom in
1:1	Show the design in 1:1
	Zoom out
A3	Show the outline of a A3 page, with page footer
A4	Show the outline of a A4 page, with page footer
Show	Show/hide the manifold and cylinders
Info	Info regarding orifice and other data of the isometric. This is only available after calculation system on the "pipe system design" tab
Move left Move right	Move the isometric design
Move up Move down	Move the isometric design
Manifold	Insert manifold
Title block	Show the information for the title block/footer.
Get data	Get the data from the "pipe system design", when this is calculated.

Table 6-8: IMT Software Isometric Design Items

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.

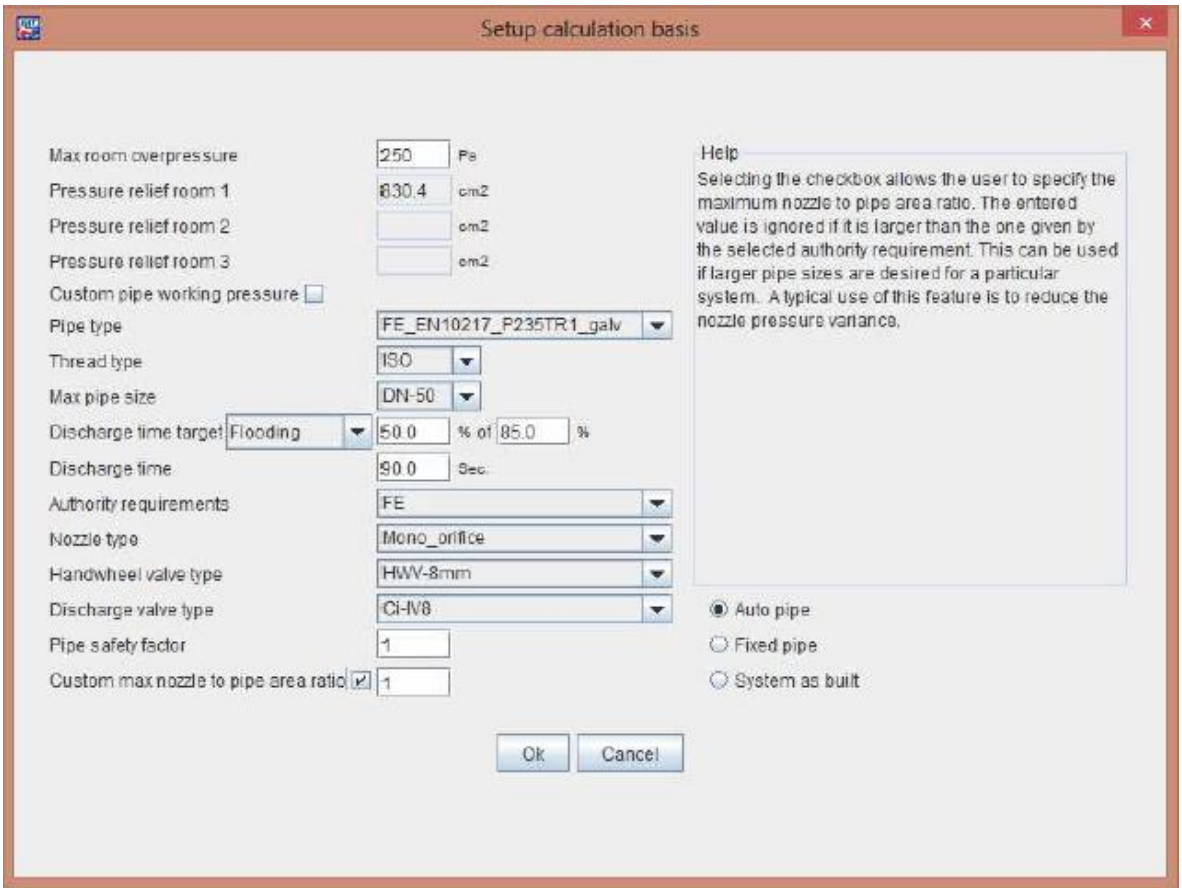

Figure 6-25: IMT Software Pipe System Design

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. Note that this can only be done after doing "Auto pipe" calculation. 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.

Table 6-9: IMT Software Pipe System Items

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".

6.5.3 IMT Software Troubleshooting

In this part, there are 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.

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 designated room.	Re-draw isometric drawing
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 fixed pipe 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 DN15/½" has been defined. Change this to be minimum DN15/½"
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 output from a tee.	Re-draw the isometric.
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.

Table 6-10: IMT Software List of Errors, Warnings and Cautions

6.5.3.1 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.

6.5.3.2 Application Method

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

6.5.3.3 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.

6.5.4 16 Steps of INERGEN® System 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.

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

Width: 5.0m

Height: 2.5m

Subfloor: $40m^3$

Length: 10.0m

Width: 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 = 2.7m3

Subfloor:

Columns: 0.6m x 0.6m x 0.8m x 3 columns = 0.8m3

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:

125m3 – 2.7m3 = 122.3m^3

Subfloor:

40m3 – 0.8m3 = 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 at 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

Table 6-11: Limitation of Actual Concentration

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: All the procedure is the same as Land system just 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.

STEP NO. 13 – Pipe System Calculation

Go to the "Pipe System 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.

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

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

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

Table 6-12: Specific Volumes of Air and INERGEN® at Standard Pressure

STEP NO. 15 - Create 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.

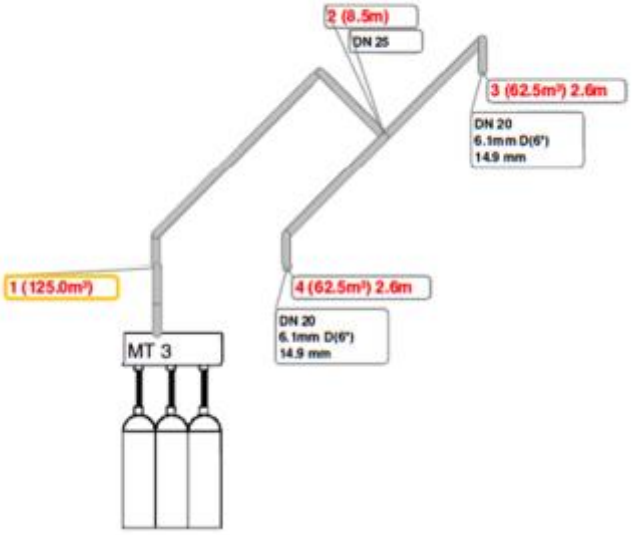

Figure 6-26: Server Room

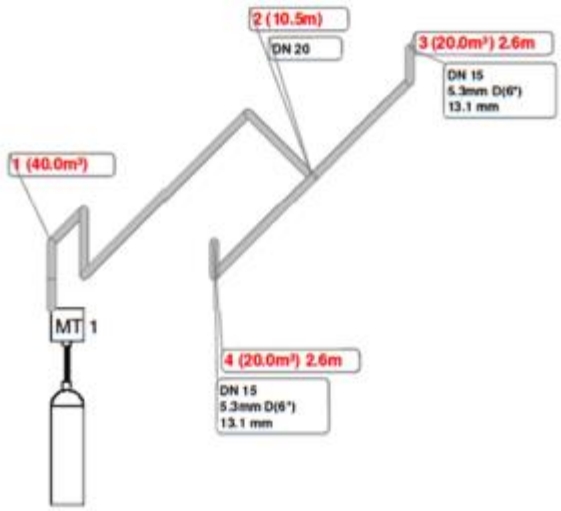

Figure 6-27: Sub-floor

6.5.5 Design of Multi-zone Systems

- 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.

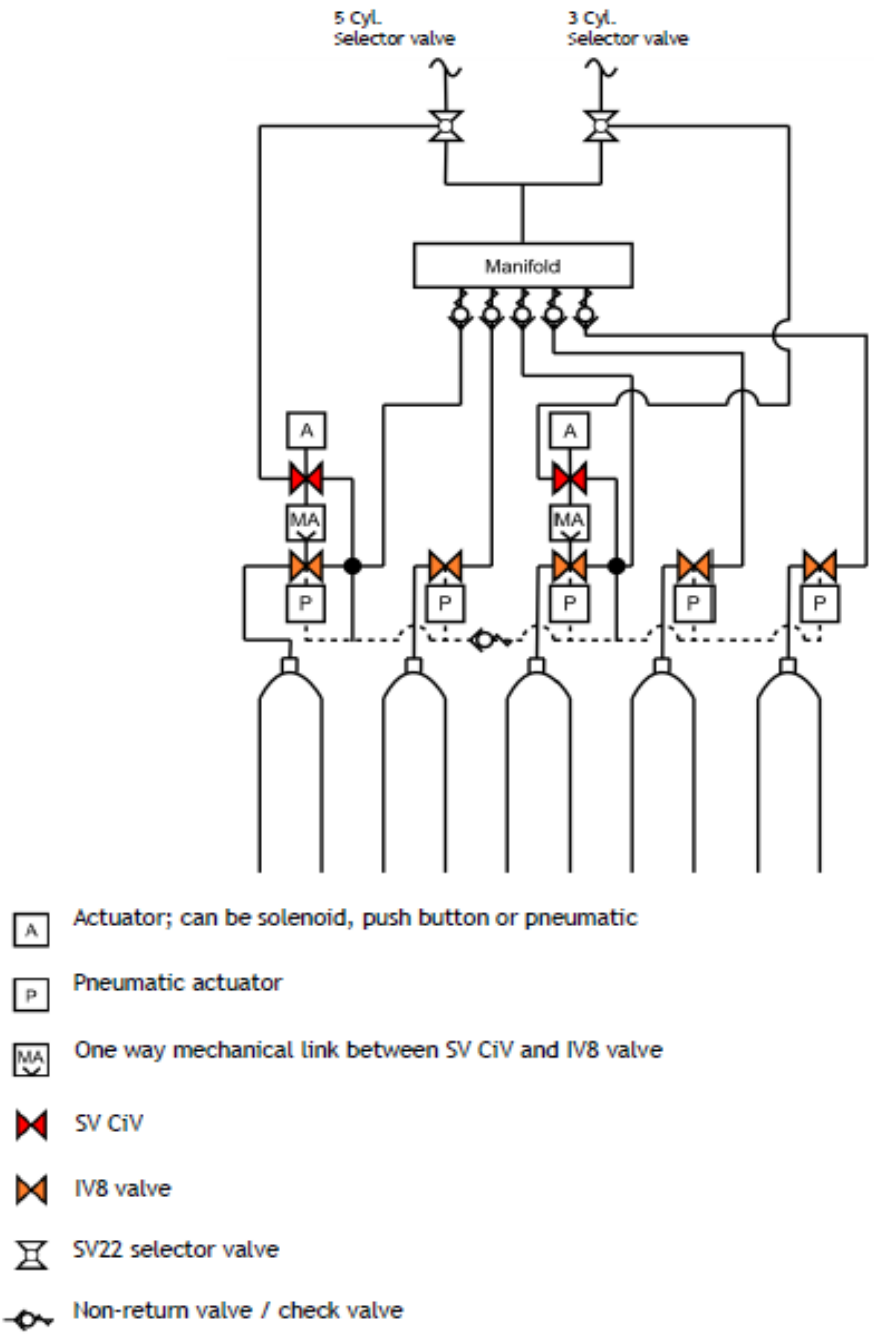

Figure 6-28: Example of Selector Valve System

6.5.6 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.

6.6 Installation

All installations are to be performed in accordance with the parameters of the 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 system components must be located within their approved temperature ranges. Only certified personnel should install INERGEN® systems.

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.

Orders in which the parts should be installed are as below:

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

6.7 Testing & commissioning

This part 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 ensuring 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.

6.7.1 System Configuration

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

6.7.2 Warning Signs & 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.

6.7.3 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.

6.8 Resetting & Recharging

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
- ✓ Selector valves
- ✓ Electrical and manual actuators
- ✓ Pneumatic actuators
- ✓ Bleed fitting
- ✓ Discharge valves

6.8.1 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).

6.8.2 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.

6.9 Inspection, Service & Maintenance

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

For components with limited service life, always refer to the engineering datasheet for information regarding replacement intervals or required service.

When working on the system always keep personal safety in mind.

6.9.1 Inspection

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.

- ✓ Room
  (Construction changes / Detection, activation and indication system / Pipe system / Signs)
- ✓ Cylinders
- ✓ Control systems
- ✓ Discharge valve
- ✓ Manoswitch
- ✓ Actuators
- ✓ Hoses

- ✓ Manifolds
- ✓ Pipe Systems
- ✓ Nozzles
- ✓ Signaling Devices
- ✓ Pressure Relief
- ✓ Selector Valves
- ✓ Non-return Valve
- ✓ Bleed Fitting

6.9.2 Service & Maintenance

Systems shall be serviced at regular intervals satisfying the authorities having jurisdiction.

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 licensed service technician.

The checklist can be used as a commissioning checklist, as well as the annual service checklist.

6.10 Conclusion

In chapter 4, an INERGEN® Fire Suppression System has been described with all the details from the system specification and basic components to planning, designing, installation, testing and recharging until the inspection, services and maintenance of it to get the better understanding of a fire suppression system.

Also in this chapter, the IMT Calculation Software – which is a very complete application for calculating and designing an INERGEN® Fire Suppression System – hast been explained step by step with a very simple example for designing an INERGEN® Fire Suppression System.

Chapter 7

7 Conclusion and Future Work

7.1 Conclusion

This thesis was done during the internship stage, by the request of fire proposal department of Tyco Italy to find an integrated approach for optimizing and speeding up the process of making a proposal for gaseous fire suppression systems. Our solution to solve this problem was Standardization the documents of gaseous fire suppression systems.

This thesis consist of seven chapters:

The first chapter is an introduction about the whole process and there is the main body list of chapters.

The second and third chapters are about the Tyco Company, their business units and different departments that are working there. Next, there are complete explanations of making a quotation and then the whole activities that have been done for standardizing the documents and its results.

The fourth chapter was dedicated to presenting the all standard and approval organizations that are related to fire protecting systems.

The fifth chapter is all about the introducing and describing different gaseous fire suppression agents and a very useful experimental comparison between these agents has been presented.

In the chapter six, you can find all the information and details about the INERGEN® Fire Suppression System that is one of the most used system in the application with high grade of importance and security. In addition, I have provided a systematic learning guide for using the designing software of this system both in calculating and in drawing.

7.2 Future Work

As it described before, the standardization has been done in two phases, the first phase was gathering and collecting all the available documents – Product Overview, Warranty, Approvals and Certificates, Application Sheet and Design Manual – related to the fire suppression systems and then generalizing and standardizing them under the cover and label of Tyco Italy, this phase was done completely. However, the second phase was creating the unavailable documents – Data Sheet, Process & Instrument Diagram (P&ID) and General Assembly Drawing (GAD) – that was done just for INERGEN® and FM-200® systems and we need to create them for all other types of fire suppression systems.

Therefore, the possible future work can be preparing the second phase of standard documents for the other available gaseous fire suppression systems like SAPPHIRE™, iFLOW® and CO_2 that their process of standardization are remained incomplete.

References

[1] Tyco Integrated Fire & Security S.p.A, Tyco corporate backgrounder and business unit fact sheet, 2012.

[2] National Fire Protection Organization (NFPA), NFPA standard reference book, 2013.

[3] International Organization of Standardization (ISO), Standardization and related activities - General vocabulary, Eighth edition, 2004.

[4] European Committee for Standardization (CEN), CEN review manual, Fourth edition, 2009.

[5] Tyco Fire Protection Products, SAPPHIRE™ TOTAL FLOOD FIRE SUPPRESSION 25 BAR & 42 BAR SYSTEMS - DESIGN MANUAL, 2013.

[6] Tyco Fire Suppression & Building Products, FM-200® TOTAL FLOOD FIRE SUPPRESSION SYSTEMS - DESIGN MANUAL, 2009.

[7] Tyco Safety Products, FM-200® TOTAL FLOOD FIRE SUPPRESSION SYSTEMS - ENGINEERED SYSTEM DESIGN AND INSTALLATION MANUAL (UL/FM VERSION), 2010.

[8] ANSUL®, INERGEN® 200 & 300 BAR SYSTEM - DESIGN, INSTALLATION, RECHARGE AND MAINTENANCE MANUAL, 2012.

[9] ANSUL®, HIGH PRESSURE CARBON DIOXIDE SYSTEMS - DESIGN, INSTALLATION, RECHARGE AND MAINTENANCE MANUAL, 2011.

[10] Tyco Fire Protection Products, iFLOW® 200/300 BAR TOTAL FLOOD FIRE SUPPRESSION SYSTEMS - DESIGN MANUAL, 2014.

[11] Fire Eater, Control Inert Ci UL Listed & FM Approved Extinguishing System, 2014.

[12] Tyco Integrated Fire & Security S.p.A, http://www.tyco.com/, Access in 2015.

[13] National Fire Protection Organization (NFPA), http://www.nfpa.org/, Access in 2015.

[14] International Organization of Standardization (ISO), http://www.iso.org/, Access in 2015.

[15] European Committee for Standardization (CEN), https://www.cen.eu/, Access in 2015.

[16] International Maritime Organization (IMO), http://www.imo.org/, Access in 2015.

[17] FM Approval, http://www.fmglobal.com/, Access in 2015.

[18] UL Approval, http://ul.com/, Access in 2015.

[19] Loss Prevention Certification Board (LPCB), http://www.bre.co.uk/, Access in 2015.

[20] VdS Approval, http://vds.de/en/certifications/, Access in 2015.

[21] Certificate of Conformity (EC), https://www.eurococ.eu/en/certificate-of-conformity/, Access in 2015.

[22] American Bureau of Shipping (ABS), http://ww2.eagle.org/, Access in 2015.

[23] Der Norske Veritas (DNV), https://www.dnvgl.com/, Access in 2015.

[24] Lloyd's Register (LR), http://www.lr.org/en/, Access in 2015.

[25] Registro Italiano Navale (RINA), http://www.rina.org/en/, Access in 2015.

[26] United States Coast Guard (USCG), http://www.gocoastguard.com/, Access in 2015.

[27] Tyco Fire Protection Products (TFPP), http://tfppemea.com/en/, Access in 2015.

[28] ANSUL, https://www.ansul.com/en/us/, Access in 2015.

[29] Kidde Fire Safety Products, http://www.kidde.com/home-safety/en/us/, Access in 2015.

[30] Fire Eater Group, http://www.fire-eater.com/en/corporate-fire-eater/, Access in 2015.

[31] 3M Company, http://www.3m.com/3M/en_US/company-us/, Access in 2015.

[32] Tyco Italy, http://www.tycofs.it/home-it/, Access in 2015.

[33] Wikipedia, https://www.wikipedia.org/, Access in 2015.

Appendix A

Data Sheet Sample

tyco Integrated Fire & Security

INERGEN® TOTAL FLOODING
FIRE SUPPRESSION SYSTEM

DATA SHEET

INERGEN®
Single Cylinder System Components

TFE-INE-DS-001, rev. 00, FEBRUARY 2015
P.TAHERI-02/2015

INERGEN® TOTAL FLOODING
FIRE SUPPRESSION SYSTEM

DATA SHEET

Single Cylinder System Components

ITEM	DATA SHEET No.	DESCRIPTION	Rev.
1.1	200500	INERGEN GENERAL INFORMATION	08.07.2010
1.2	MSDS INERGEN-UK	MATERIAL SAFETY DATA SHEET	11.08.2011
1.3	200xxx	CYLINDERS W. INERGEN	25.04.2014
1.4	4001xx	CYLINDER BRACKET	02.02.2010
1.5	4003xx	CYLINDER RAIL	05.01.2010
1.6	3054xx	Ci IV8 DISCHARGE VALVE	01.06.2012
1.7	3053xx	MANOSWITCH	29.07.2014
1.8	54036x	MANOSWITCH DUAL-RESISTOR CABLE START KIT	26.03.2007
1.9	303xxx	Ci DISCHARGE HOSES	10.12.2013
1.10	30570x	Ci MT MANIFOLD	04.12.2013
1.11	2102xx	INERGEN MONO ORIFICE NOZZLE	24.05.2011
1.12	210xxx	NOZZLE FOR INERGEN MARINE SYSTEM	02.06.2014
1.13	210xxx	IN NOZZLE SILENCER	24.05.2011
1.14	305442	Ci-IM8 MANUAL ACTUATOR	23.12.2008
1.15	30545x	Ci IS8B SOLENOID ACTUATOR	18.04.2013
1.16	305448	Ci PA8A PNEUMATIC ACTUATOR	09.07.2013
1.17	308284	PDS II-C 80MS PILOT	05.03.2014
1.18	308286	PDS II-C 80MS ATEX PILOT	01.12,2014
1.19	308287	PDS II 80MS IECEX SIL	13.01.2015
1.20	305623	CI MT PRESSURE SWITCH KIT	04.12.2012

INERGEN

General

INERGEN is an odourless colourless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% nitrogen, 40% argon and 8% carbon dioxide and works by lowering the concentration of oxygen of the protected area to a point that cannot support combustion.

INERGEN is non toxic and no decomposition products are created from INERGEN when exposed to heat or fire.

INERGEN is a mixture of gases naturally occurring in the earth's atmosphere. It exhibits no ozone depleting potential and does not contribute to global warming.

INERGEN systems should not be used below -56°C as the CO_2 will solidify. The gas has no temperature upper limit of use. Limitations will come from the hardware due to pressure increase with temperature.

Designation: INERGEN, IG541, 52/40/08

Pressures and temperature

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

Safety

INERGEN works by displacing the oxygen in the protected space and the carbon dioxide level is increased to 2-4% in order to stimulate the respiratory functions and to ensure sufficient oxygen flow to the human brain.

During discharge of the INERGEN system there will be turbulence in the enclosure to ensure distribution of the INERGEN. An over pressurisation of the room will occur depending on the installed pressure relief. There will be no reduction of visibility, hence escape routes will always be easy to find.

After discharge there will be no residue and ventilation of the enclosure is the only cleaning up necessary.

Please refer to the separate safety datasheet for INERGEN for information in accordance with 91/58 EEC.

Properties

Composition (% volume)

Nitrogen	48.8 - 55.2 %
Argon	37.2 - 42.8 %
Carbon dioxide	7.6 - 8.4%

Molar mass 34.08 g/mol

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

INERGEN/Air (relative) ρr = 1.18
(t = 20°C, p = 1.0132 bar)

Triple point of CO_2 at 5.2 atm and -56.4°C

FIRE EATER

Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
Fax +45 7023 2769

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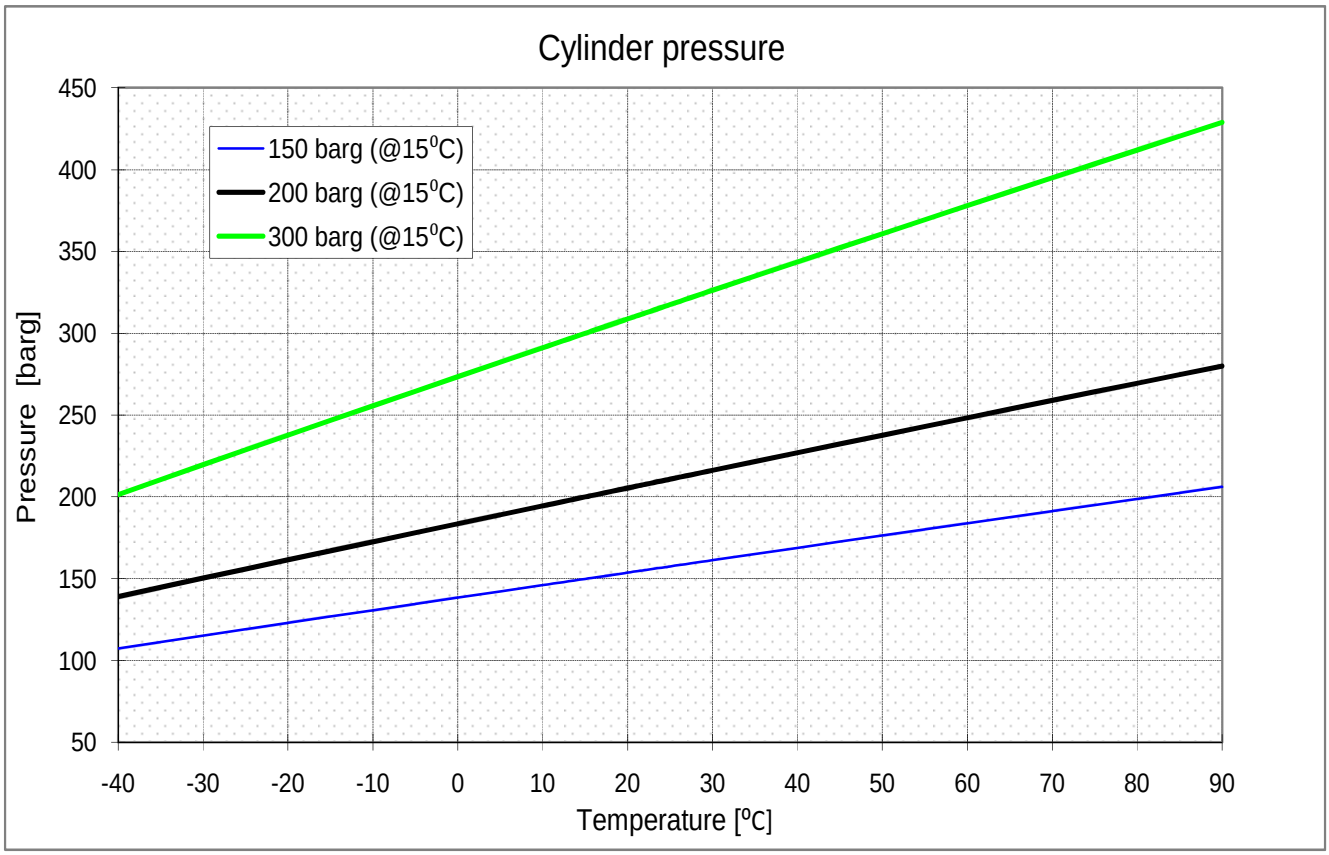

Temperature [°C]	Cylinder pressure [barg]		
	150 barg (@15°C)	200 barg (@15°C)	300 barg (@15°C)
-40	107.4	139.2	201.4
-35	111.4	144.8	210.5
-30	115.3	150.4	219.6
-25	119.2	156.0	228.7
-20	123.1	161.6	237.7
-15	126.9	167.1	246.7
-10	130.8	172.6	255.7
-5	134.7	178.1	264.6
0	138.5	183.6	273.5
5	142.4	189.1	282.4
10	146.2	194.6	291.2
15	**150.0**	**200.0**	**300.0**
21	**154.6**	**206.5**	**310.5**
25	157.6	210.8	317.5
30	161.4	216.3	326.3
35	165.2	221.6	335.0
40	169.0	227.0	343.7
45	172.7	232.4	352.3
50	176.5	237.7	360.9
55	**180.2**	**243.0**	**369.5**
60	184.0	248.3	378.0
65	187.7	253.6	386.6
70	191.4	258.9	395.1
75	195.1	264.2	403.6
80	198.8	269.4	412.1
85	202.5	274.7	420.5
90	206.2	279.9	428.9

Document: 200500 INERGEN

Product: Inergen®

Id: HDN

Rev: 08.07.10

FIRE EATER ½

Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
Fax +45 7023 2769

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Safety data sheet

According to EU directive 2001/58/EC

File: MSDS INERGEN -UK.doc
version: 2011-08-11

FIRE EATER A/S

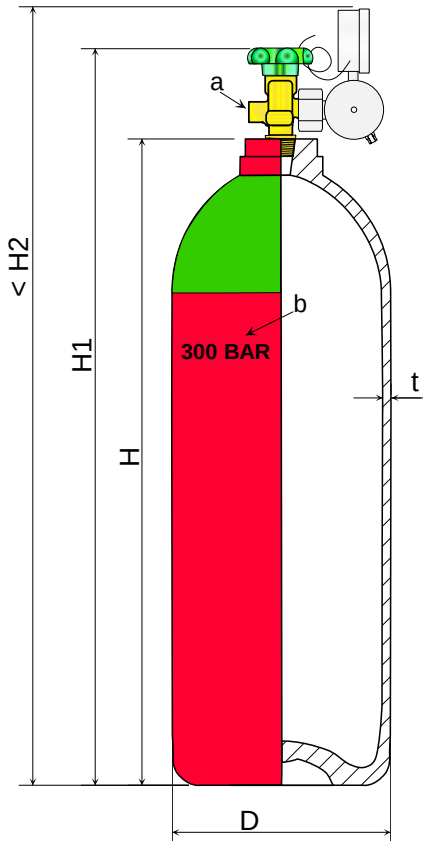
01	Identification Use Company	**INERGEN, IG541** Fire extinguishing in enclosures. Fire Eater A/S, Vølundsvej 17, 3400 Hillerød Tel: +45 7022 2769, www.fire-eater.com
02	Composition	Gas mixture consisting of: 52%N_2, 40% Ar, 8% CO_2 CAS RN / ACX No / EINECS/ELINCS Nitrogen: 77727-37-9 / X1003258-9 / 231-783-9 Argon: 7440-37-1 / X1002784-0 / 231-147-0 CO_2: 124-38-9 / X1056802-4 / 204-696-9
03	Hazards identification	None of the components are on the environment ministry's list. Asphyxiation if concentrated gas is inhaled. Freezing may occur if containers are discharged quickly.
04	First aid measures	Ensure fresh air. If no breathing apply artificial respiration. If necessary deploy oxygen treatment.
05	Fire-fighting measures	The gas mixture is NOT flammable and do NOT support combustion. The gas does not produce toxic decomposition products. Containers must be removed from fire. If containers have been exposed to increased heat they must be cooled and depressurized.
06	Accidental release measures	If released in enclosures these must be ventilated. No environmental actions are required as all components are part of the atmosphere.
07	Handling and storage	There must be access to fresh air. Directions for handling of pressurised vessels must be followed. Pressure vessels must be approved by authorities.
08	Exposure control	Carbondioxid: 5000ppm ≈ 9000 mg/m^3. If poor ventilation fresh air mask must be used.

09	Physical and chemical properties	Non liquefied inert colourless odourless gas mixture. Molecular mass: 34.08 g/mol Density: 0.0014 g/cm^3 (0.087 lb/ft^3) Relative density: 1.18 (Air =1) Volume: 0.706 m^3/kg (11.31 ft3/lb) Boiling point: -120.8 °C
10	Stability and reactivity	Stable mixture of inert gasses.
11	Toxicological information	Inhaling concentrated gasses may cause asphyxiation. Long-term exposure to gas may cause headache, drowsiness, indisposition, asphyxia and breathing difficulties. No known post exposure long-term effects.
12	Ecological information	The gas mixture is a natural part of the atmosphere.
13	Disposal	Contents of containers are released in open atmosphere.
14	Transport	Transport of pressurised cylinders. Cylinders: UN1956, Compressed gas, n.o.s (Nitrogen, Argon), 2 (E) Transport / Class / Notes / Label / Limitations: ADR/RID 2.2 — 2.2 None IMDG 2.2 EmS:2-04 2.2 None Dangerous Goods transport document must follow goods (exception: Fitters & installers may transport up to 1000 l (Cylinder Water Volume in litre) without DG Transport document.
15	Regulatory	None.
16	Other information	None.

Cylinders w. INERGEN

Item numbers covered by his datasheet

200601	Cylinder 05-200 W24
200602	Cylinder 10-200 W24
200604	Cylinder 20-200 W24
200609	Cylinder 30-300 M25
200610	Cylinder 50-200 W24
200612	Cylinder 80-150 M25
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25
200642	Cylinder 140-300 M25
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV



Variants available

-00:	Pi marked
-8:	Customer specific versions
-21:	DNV approved cylinder
-23:	GOST-R cylinder
-24:	GOST-K cylinder
-25:	BV approved cylinder
-62:	CCOE approved cylinder
-27:	Australian registered cylinder
-60:	For UL listed systems (NFPA compliant)
-62:	For FM approved systems (NFPA compliant)
-71:	For LPCB approved systems (EN15004 compliant)

Not all variants are available for all cylinders, for combination of approvals and listings, please contact Fire Eater.

General

Steel cylinders with INERGEN and Ci Hand Wheel Valve for use in Fire Eater INERGEN fire suppression systems.

This datasheet is a summary of the available cylinders.

FIRE EATER

Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
www.fire-eater.com

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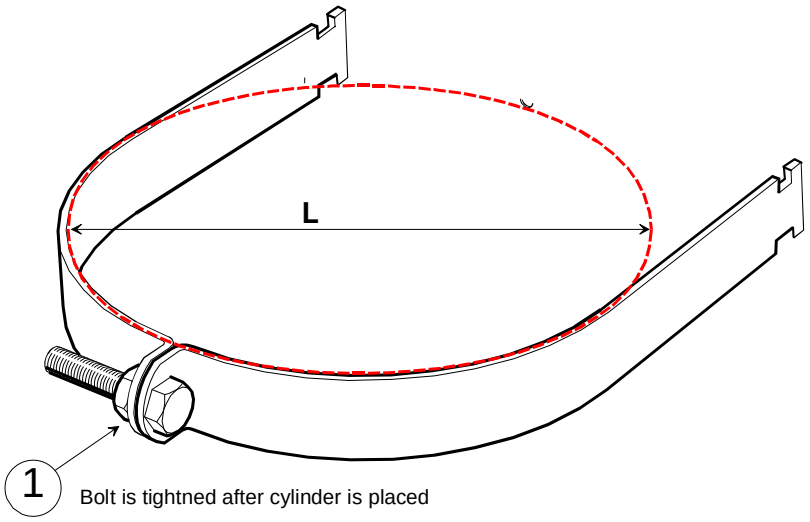
Cylinder bracket

Item numbers covered by this datasheet

400109 Cylinder bracket 80/82l (ø267/279mm)
400110 Cylinder bracket 50l+30l (ø229mm)
400111 Cylinder bracket 20l (ø204mm)
400112 Cylinder bracket 5-10l (ø140mm)
400115 Cylinder bracket 2l (ø102mm)



General

Bracket including bolt for fastening cylinder to the cylinder rail.
For marine applications 2 brackets should be used for each cylinder.
Used with 25mm profile rail (4002##).

Specifications

Materiel: Galvanised steel

Maintenance

General cleaning, inspect for corrosion.

FIRE EATER ⅘

Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
Fax +45 7023 2769

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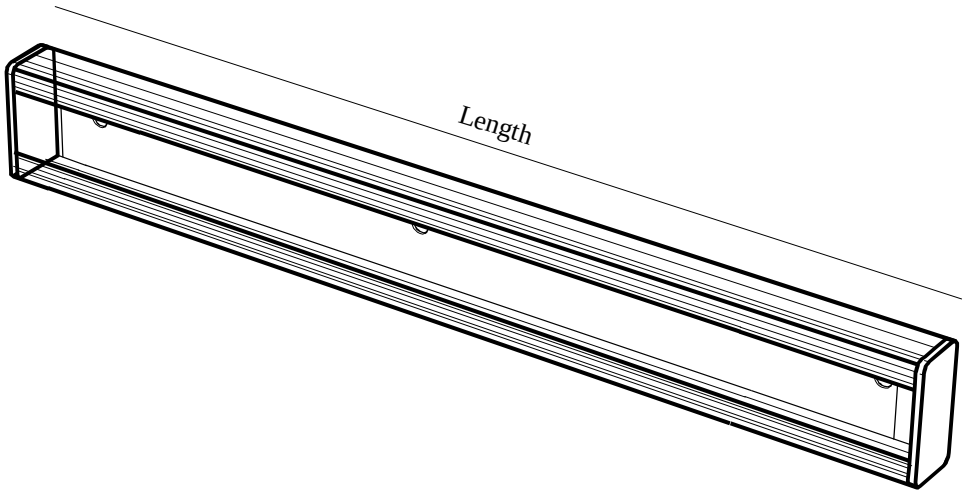
Cylinder rail for 80 l cylinders



Specifications

Cylinder diameter: 267 mm
Fastening distances: < 350 mm
Profile: P4000 series
Material: Galv. steel

Item number	No of cyl.	Lenght [mm]	Weight [kg]
400301	1	320	0.35
400302	2	640	0.70
400303	3	960	1.00
400304	4	1280	1.40
400305	5	1600	1.70
400306	6	1920	2.00
400307	7	2240	2.40
400308	8	2560	2.80
400309	9	2880	3.20
400310	10	3200	3.50

Use with bracket: 400109
Rail end cover: 400121

FIRE EATER ½
Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
Fax +45 7023 2769

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Ci IV8 discharge valve

Item numbers covered by this datasheet

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

General

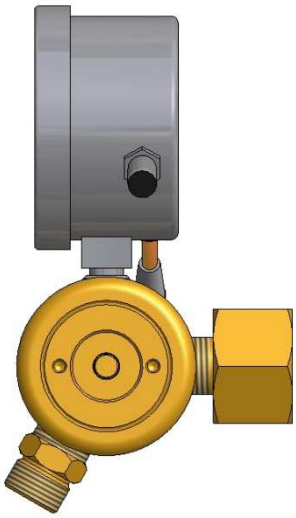
Discharge valve for use in INERGEN fire extinguishing systems.

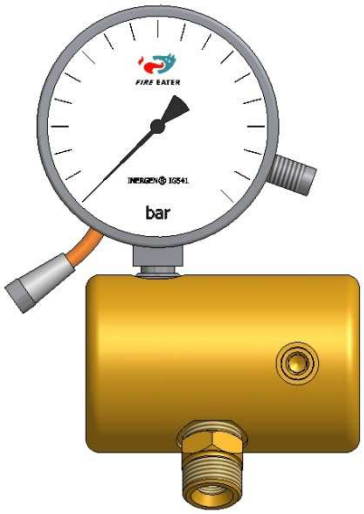
The valve has built-in pneumatic activation for inter-system activation, back pressure activation and mechanical activation interface.

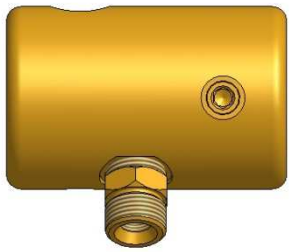
The discharge outlet is connected internally to the Pneumatic Actuator (PA) via a check valve (the check valve allows pressure from the discharge side to enter the actuator side), this allows for the discharge port to be used as activation port also (back pressure), hence eliminating the need for PA circuitry between valves connected to the same manifold. When more than one manifold is used, the PA system must be connected to at least one IV8 valve on each manifold.

The port for the PA function works as both inlet and outlet, hence the same connection is used on both pilot and slave cylinders, and the pilot cylinders can be placed anywhere in the line of IV8 valves. All equipment connected to the PA connection must be rated at 300/400 bar.

The standard valve is classified as a Type 2 valve, as it has a built-in burst disc which relieves pressure to the open.







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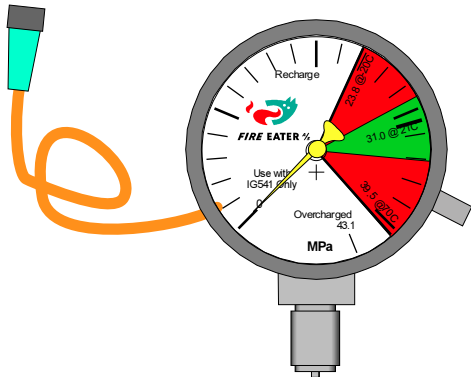
Manoswitch



Item numbers covered by his datasheet

305373 ManoSw 28.4MPa sp16.6 UL2127
305374 ManoSw 43.1MPa sp24.9 UL2127

305360 Manoswitch 0-160 bar sp 50 EN12094

Below are early or special variants

305370 Manoswitch 0-250 bar sp 166 EN12094
305375 Manoswitch 0-400 bar sp 249 EN12094

303013 ManoSw 0-250bar sp 150 conn
303014 ManoSw 0-250bar sp 166 conn
303017 ManoSw 0-400bar sp 225 conn
303018 ManoSw 0-400bar sp 249 conn

305371 ManoSw 15MPa sp12.24 GA400
305372 ManoSw 20MPa sp16.6 GA400

305375-23 ManoSw 0-40MPa sp249 GOST-R

General

Manoswitch is a combined pressure gauge and pressure switch used in Fire Eater Control Inert (Ci) system.

The pressure gauge is typically supplied with the IV8 valve.
The manoswitch features a change over switch allowing for indication of normal and low pressure.

Several switches can be connected in a daisy-chain with an end of line resistor at the last switch. In this way a full monitoring of all switches is possible in a nice and simple way, eliminating the risk of having short circuits or broken lines not being indicated as a fault.
If the pressure on one of the manoswitches falls, the whole circuitry will indicate low pressure.
Only two wires brown + black are needed for connection to the control panel.

Standardized units used is either Bar or MPa.
In Europe, bar is the widely used unit for pressure, and Pa (KPa or MPa at higher pressures) is the Si unit.
To convert from bar to MPa you have to divide by a factor of 10. 400 bar = 40MPa.

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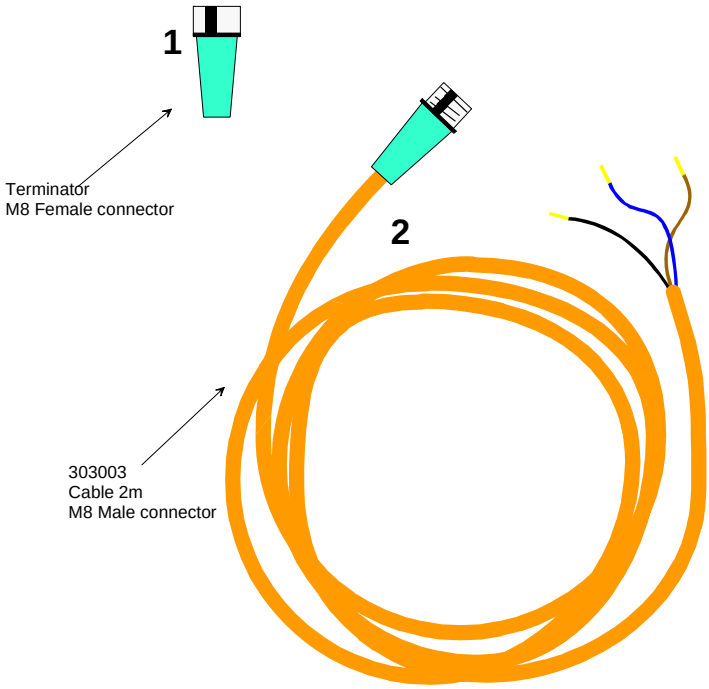
Manoswitch Dual-Resistor cable start kit

Items covered by this data sheet

540360 Manoswitch 470-5K6 Cable 2m start kit
540361 Manoswitch 680-3K3 Cable 2m start kit
540632 Manoswitch 470-10K0 Cable 2m start kit



General

The manoswitch (combined pressure gauge and pressure switch) used by Fire Eater features a single pole change over switch making it possible to monitor for normal and low pressure as well as short circuitry and open circuit.

The manoswitches are designed to be connected in a daisy chain, where low pressure on one manoswitch will indicate low pressure on the monitoring panel.

The dual-resistor terminator (part of this kit) has to be placed on the last manoswitch in the daisy chain.

In the normal position (pressure above the set point) the resistance of the circuitry is high (3K3/5K6), when pressure falls below the set point the resistance of the circuitry falls to low (680/470 ohm).

Related parts

303004 Cable 0.6m with connectors in both ends
303005 Cable 1.0m with connectors in both ends
303006 Cable 2.0m with connectors in both ends
305370 Manoswitch 0-250 bar sp. 166 Change over switch
305375 Manoswitch 0-400 bar sp. 249 Change over switch
303007 M8 female connector with solder terminals

Caution:
This start kit is not compatible with early style IV7 discharge valves.
Compatible gauges are marked "EN12094-10"
Switch limit: max: 0.1 Amp, 30 Vac/DC

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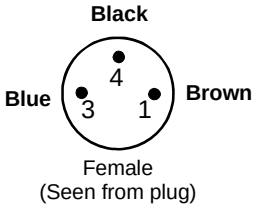
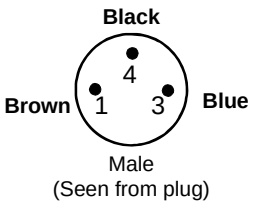
Installation instructions

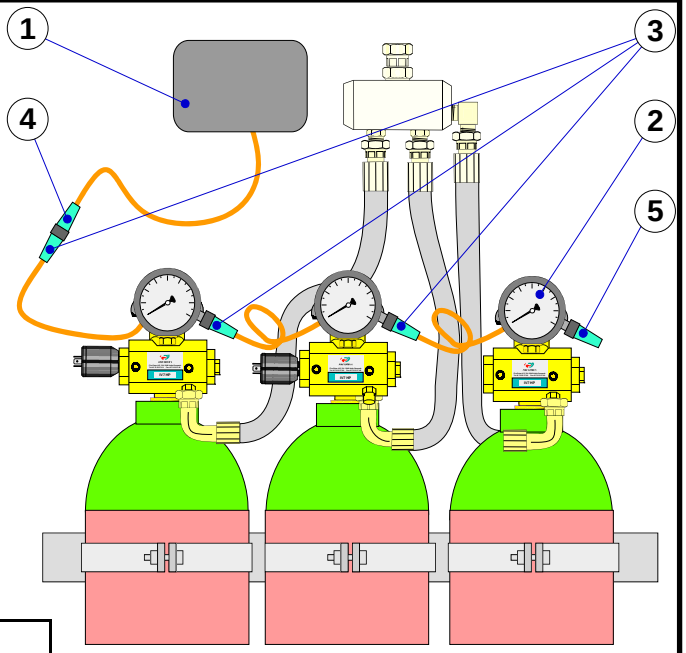
Connection:
The wire to connect is:
1: Brown
4: Black



Female
(Seen from plug)



Male
(Seen from plug)



Pos.

1: Discharge box
2: Manoswitch w. M8 connector
3: Manoswitch cable
4: Cable 2.0m w. M8 connector
5: Terminator for manoswitch w. con

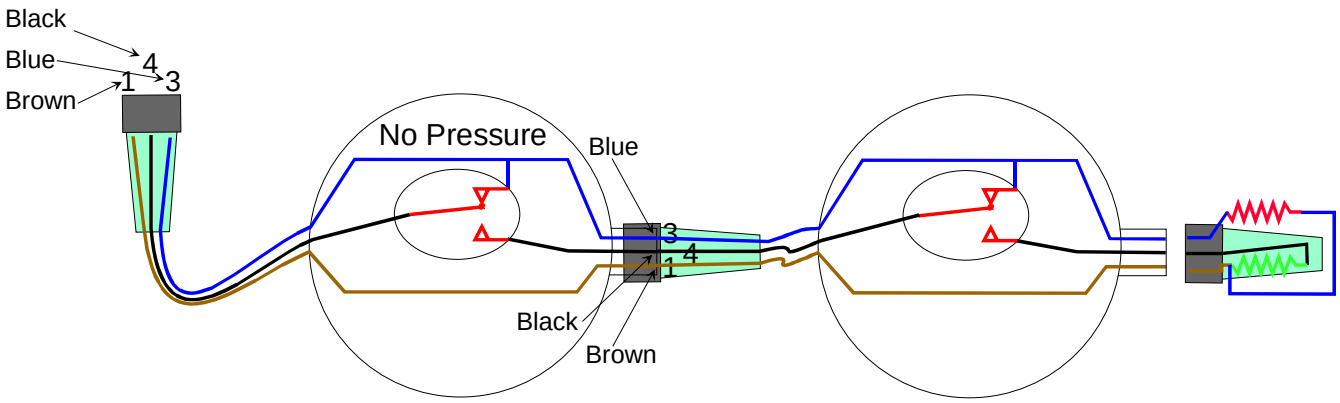
Installation:

1. The 2 m cable (303003) is connected to the monitoring circuit, by connecting the brown and the black wire. The cable may be cut to the right length before installation.
2. The Terminator is fitted to the cable (303003) plug to verify correct function of the monitoring circuitry.
3. The cables between the manoswitches are connected. If the distance between cylinders is more than 400 mm it is necessary to use cable (303004 – 303006).

Note:
Care must be shown not to damage the connector in the manoswitch

At service

Always disconnect the terminator (303002/303008) to verify the pressure monitoring circuitry.
If a pressure drop fault is indicated, move the terminator to verify which cylinder needs pressurisation.



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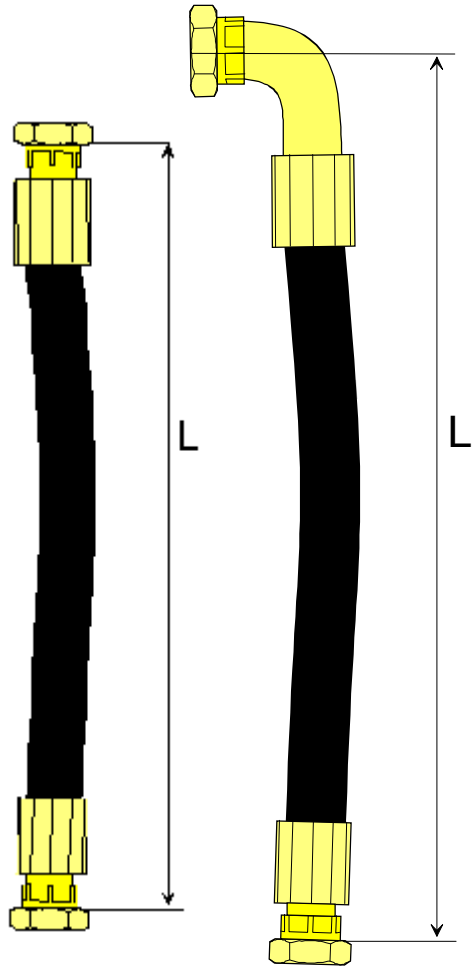
Ci Discharge Hoses

Item numbers covered by this datasheet

303102	Pressure Hose DN10-400	0.5m 0+90°
303104	Pressure Hose DN10-400	1.0m 0+90°
303106	Pressure Hose DN10-400	1.5m 0+90°
303108	Pressure Hose DN10-400	2.0m 0+90°
303109	Pressure Hose DN10-400	2.5m 0+90°
303111	Pressure Hose DN10-400	3.0m 0+90°
303113	Pressure Hose DN10-400	4.0m 0+90°
303302	Pressure Hose Dn10-400	0.5m straight
303304	Pressure Hose Dn10-400	1.0m straight
303306	Pressure Hose Dn10-400	1.5m straight
303308	Pressure Hose Dn10-400	2.0m straight
303309	Pressure Hose Dn10-400	2.5m straight
303311	Pressure Hose Dn10-400	3.0m straight
303313	Pressure Hose Dn10-400	4.0m straight



General

The DN10 pressure hose is used for connection between the discharge valve and the manifold, and qualifies as a type 1 connector in accordance with EN12094-8.

The hose is used in the Control Inert system, SV systems and older INERGEN systems.

Specifications

Fittings:

Type:	Straight union type with 60° face Elbow 90° union with 60° face
Thread:	ISO228 3/8" BSP
Flow diameter:	ø8.0mm
Materials:	Zinc plated steel (11SMnPb37)

Hose:

Outside diameter:	ø17.6mm
Inside diameter:	ø10mm (78mm^2)
Construction:	Two-ply steel wire
Temperature:	-40°C to +100°C
Bending radius:	> 130mm
Work pressure:	0 - 40 MPa (EN12094-8, Wp<1/3xBp)
Burst pressure:	> 140 MPa
Materials:	Oil and weather resistant synthetic rubber (NBR), two-ply steel
Length:	as specified in part number above

Markings

Hose:	FIRE EATER EN12094 WP 40.0MPa IG541 Hypress Hipac exceeds EN 857-2SC DN10 WP 35.0 Mpa
Fittings:	yyyy - ww, UL HG CE (on collar)

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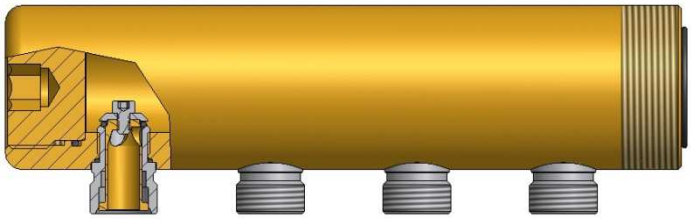
Ci MT Manifold

Item numbers covered by this datasheet



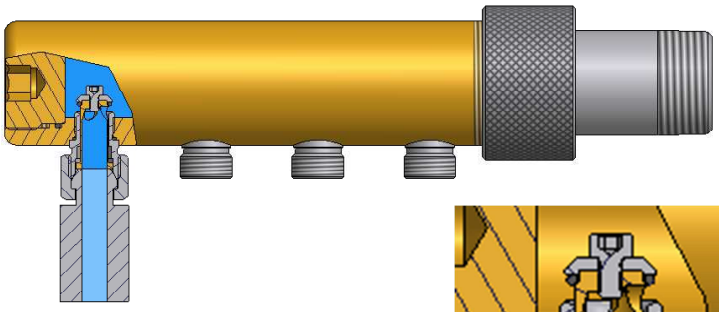
305701	Ci MT 1 Manifold (see page 3)
305701-8	Ci MT 1 Manifold calibrated
305702	Ci MT 2 Manifold
305703	Ci MT 3 Manifold
305704	Ci MT 4 Manifold
305705	Ci MT 5 Manifold
305706	Ci MT 6 Manifold
305707	Ci MT 7 Manifold
305708	Ci MT 8 Manifold
305709	Ci MT 9 Manifold
305710	Ci MT10 Manifold

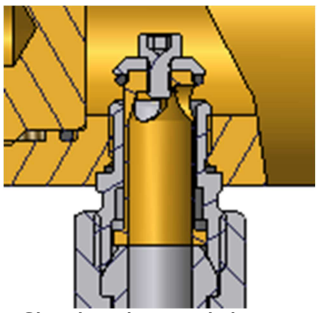
Related components

305730	Ci MT ISO Orificekit 1”
305730-8	Ci MT ISO Orificekit 1” calibrated
305731	Ci MT npt Orificekit 1”
305731-8	Ci MT npt Orificekit 1” calibrated
305670	CM MT Valve assembly (included in the manifold for each hose connection)
305623	Ci MT Pressure Switch kit

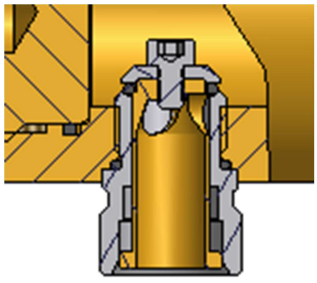
General

The manifold is as standard supplied with connectors for 1 to 10 cylinders.
Each connection features a check valve which is automatically opened when the hose is connected.
Detail picture shows closed and open check valve.
Below is a cut section view of a manifold with hose connection.
A drawing of the check valve with and without hose connection is also shown.





Check valve with hose



Check valve without hose

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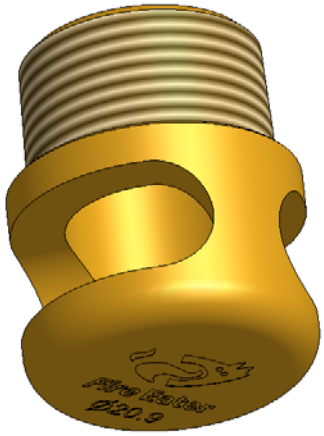
INERGEN Mono orifice nozzle

General

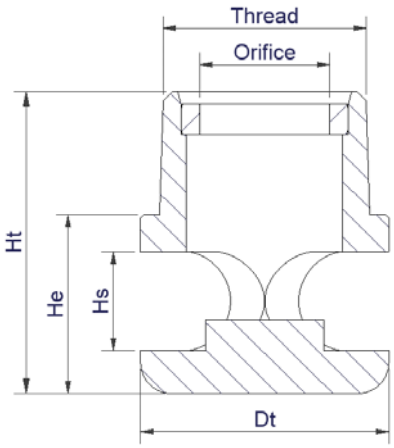


Nozzle for use in land based INERGEN-systems.
The nozzle is designed to control the flow using a single orifice with dimensions from Ø1mm to Ø36mm.

The nozzle is designed to disperse the flow laterally (360°) and slightly away from the mounting surface (ceiling/wall).
The nozzle orifice must be calculated specifically for each installation.
Each nozzle must be calibrated and marked individually and permanently with the orifice diameter.
An uncalibrated nozzle is delivered with a 3 mm orifice.
A calibrated nozzle can be ordered with a -8 after the item no.
For example 210204-8 is an IN-15 ISO Nozzle Calibrated.
IMT-calculation or info on the needed orifice diameter must follow orders for -8 item nos.

General specifications

Pressure (work max.):	75 -125 bar (pipe pressure ahead of nozzle)
Temperature:	-60 to +300°C
Material:	CuZn39Pb3
Marking:	Fire Eater logo and orifice diameter
Inter nozzle distance:	max. 7.32 m.
Height:	
Min:	0.3m
Max	4.7m



Types

Type (pipe size)	Item number (not calibrated)		Max orifice (pipe w.p. 125 bar)		Max orifice (pipe w.p. 75 bar) (extra large orifice)			Dimension				Mass
	Thread	Thread	Area	Ø	Area	Ø	Hw	Dt	Ht	He	Hs	
	ISO7/1	NPT	mm^2	mm	mm^2	mm	mm	mm	mm	mm	mm	kg
1/2" (DN15) Orifice ø1-ø3mm	210203	210223	7.1	3.0	-	-	-	24	44	18	8	0.10
1/2" (DN15)	210204	210224	130	12.9	201	16	23	24	35	18	8	0.07
3/4" (DN 20)	210206	210226	285	19.0	346	21	27	32	42	24	12	0.12
1" (DN 25)	210208	210228	500	25.2	572	27	28	40	49	29	16	0.20
5/4" (DN32)	210210	210230	800	31.9	1018	36	35	47	59	36	20	0.32

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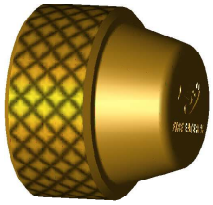
Nozzle for INERGEN Marine systems

General

Nozzle for use in INERGEN Marine systems.
Nozzle material meet the requirements in IMO regulations for used in marine fire extinguishing systems and are MED approved.
When nozzles are calibrated they must be marked with the equivalent diameter of the calibration.

When ordering calibrated nozzles "-8" is added to the part number.



Specifications

Max work pressure:	300 bar
Temperature:	-60 to +300°C
Marking:	Designation (size -Thread), 0575, Batch number, orifice diameter, Fire Eater logo,
Inter nozzle distance:	max. 8 m.
Thread:	ISO7/1 or NPT (ANSI/ASME B1)
Material:	CuZn39Pb3 or AISI 316 (see table for item numbers)

Types

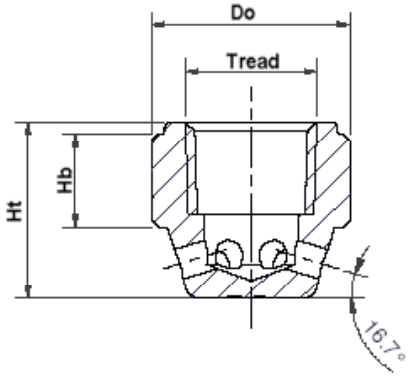
Type (pipe size)	Part number				Maximum orifice size		Dimensions				Mass
	Brass		AISI316		Area	Ø	Do	D1	Ht	Hb	
	ISO7/1	NPT	ISO7/1	NPT	mm^2	mm	mm	mm	mm	mm	kg
1/2" (DN15)	210504	210524	210404	210424	180	15	ø32	ø27	26.5	15	0.11
3/4" (DN 20)	210506	210526	210406	210426	314	20	ø38	ø34	28.5	15	0.15
1" (DN 25)	210508	210528	210408	210428	500	25	ø48	ø42	32.5	19	0.28
5/4" (DN32)	210510	210530	210410	210430	800	32	ø60	ø52	42	23	0.53

Installation

The nozzle is screwed on to the pipe system either by hand or a spanner, tightening force app. 30Nm

Operating

The nozzle is an open nozzle and there are no requirements.



Maintenance

Clean at regular intervals.
Avoid getting dirt inside the pipe system.

Routine testing

No requirements.

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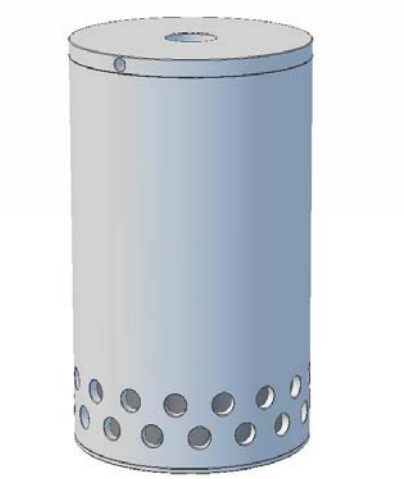
IN Nozzle Silencer



Item numbers covered by his datasheet

210125	IN-1/2" Silencer T2
210126	IN-3/4" Silencer T2
210128	IN-1" Silencer T2
210234	IN-15 Silencer T1
210236	IN-20 Silencer T1
210238	IN-25 Silencer T1

General

The IN Nozzle silencer is designed to reduce the sound pressure generated when discharging a fire extinguishing system, when this is required due to sound sensitive equipment like hard discs and similar equipment.

Performance

Flow resistance in the silencer is very small when used with in the orifice specification given below.

Flow through the nozzle orifice is always chocked in an Inert gas fire extinguishing system (Pdif > 2), hence the flow through the nozzle will not be affected by the slight increase of pressure downstream of the nozzle orifice due to the resistance in the filter.

Nozzle coverage area of the silencer is given by an inter nozzle distance of 8m or a maximum throw distance of 5m.

Pressure of the gas exiting the nozzle depends greatly on the nozzle orifice used but is for the tested limitation (given below) less than 5 bar. A minimum distance to delicate objects should be observed at this pressure.

A noise reduction of approximately 20dB is achieved by using the silencer compared to a bare nozzle. Measured noise levels with the silencer @ 2m are typically 95–110 dB.

Specifications

Temperature	-40 to + 100°C
Materials:	Aluminum & stainless steel
Dimensions:	ø130×225 mm
Weight:	2.2 kg

Flow limitations for nozzle orifice & pressure (tested, but not absolute limit)

IMT 1.2:	max ø24.9 calculated with 75bar pipe pressure
IMT 2.1:	max ø20.7 @ 50 bar (nozzle pressure)
Connections:	See table 1

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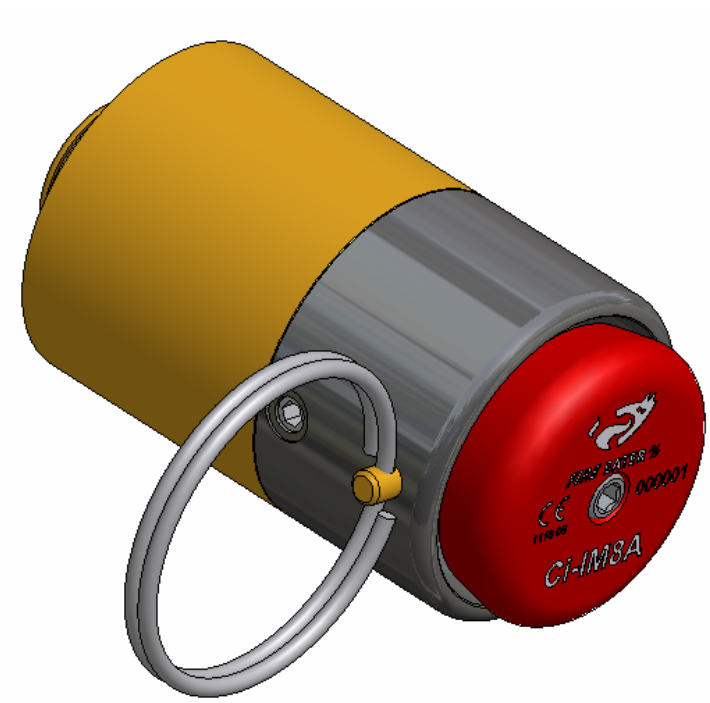
305442 Ci-IM8 Manual Actuator

General

The actuator is used with the Ci-IV8 valve for manual hand actuation of the valve.

The actuator works as a spring loaded force amplifier.
By pushing with a maximum force of 150N on the button a spring is released creating a force of 700N for actuation of the Ci-IV8 valve.



Specifications

Actuation

Method:	Hand
Force:	150N (maximum)

Materials:

Brass
Stainless steel
Viton
Silicone
Aluminium

Dimensions

D × L:	ø40 × 75 (length installed 67 mm)
Weight:	0.4 kg

Markings

Fire Eater Logo, Ci-IM8A, Serial number, CE1116, YY,

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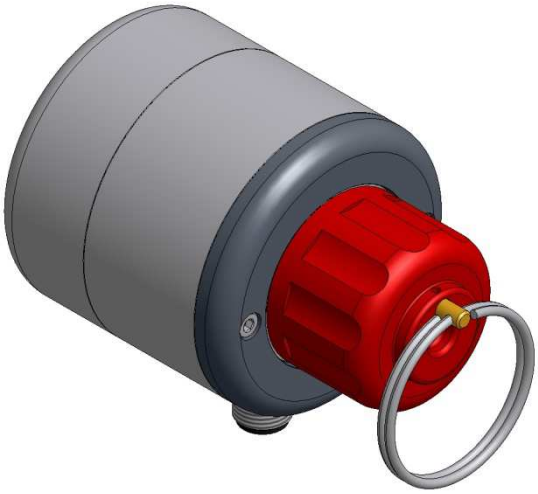
Ci IS8B Solenoid actuator

Item numbers covered by this datasheet

305450 Ci IS8B Solenoid only
305451 Ci IS8B Solenoid & Manual



General

The Solenoid actuator is part of the Control Inert (Ci) series and is designed to activate the Ci IV8 valves, either directly or with the use of either Ci PA8 or SV CiV adapter.

The Ci IS8B has superior performance with regards to shock, vibration and reliability, as it utilizes neodymium magnets, hence reducing the number of moving parts to a minimum.

The Ci IS8B is available either as a standard solenoid or as a solenoid with built-in manual activator. It features a built-in End Of Line resistor allowing monitoring of the complete activation circuit. A built-in current limiter reduces the power consumption after it has been activated.

Specifications

Voltage (Activation):	24 VDC
Max.:	36 VDC, 100% duty cycle
Min.:	21 VDC
Current (Activation):	0.9A (minimum 0.6 amp for 10 msec) 1.34 A @ 36 VDC
Max. monitoring:	20 mA
No triggering max.:	100mA 120 sec.
Power limited circuit:	The device contains a limited energy circuit
Manual activation:	Rotation < 225° clockwise, < 1 Nm
Temperature:	
Operation:	-25 to +70°C (mounted on valve)
Storage:	-60 to + 100°C (not mounted on valve)
Resistance:	
Monitoring:	6800 Ω (EOL resistor dependent), (only with “Reverse Polarity Activation”)
Activation:	27 Ω (coil only)
Valve interface:	M20×1.0 (male) Pin ø6mm, Force exceeds 350N with pin extracted.
Electrical connection:	M12 male connector (optional: Cable with cable gland M12x1.5)
Integrity:	IP67 (with cable installed)
Pin configuration:	
Activation:	pin 1+ 2 +ve, pin 3+4 -ve
Monitoring	pin 1+ 2 -ve, pin 3+4 +ve (reversed polarity)
Dimension (øD×L):	ø64× 76 mm (installed ø64×68 mm) (solenoid only) ø64× 108 mm (installed ø64×100 mm) (with manual)
Weight:	1.1 kg

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305448 Ci PA8A Pneumatic actuator

General

The actuator is used with the Ci IV8 valve for additional pneumatic actuation of the valve (this actuator is not to be mistaken for the Ci IV8 built-in pneumatic actuator).

The actuator works as a simple pneumatic piston, where the pressure applied is equivalent to the force on the piston.

The Ci PA8 interface allows for other actuators for the Ci IV8 valve to be placed in conjunction with the Ci PA8 on the Ci IV8 valve.

Specifications

Pressure:

Work:	10 - 400 bar (600N @ 10 bar)
Proof (burst):	> 1200 bar
Max no triggering	2 bar 10 sec

Temperature: -20 to +70°C

Materials: Brass, Stainless steel, PU.

Dimension:

D×L:	ø50 × 44 (installed 36) mm
Weight:	0.55 kg

Markings

Fire Eater Logo, Ci PA8A, Serial number, CE 1116, XX (year of manufacture).

FIRE EATER

Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
Fax +45 7023 2769

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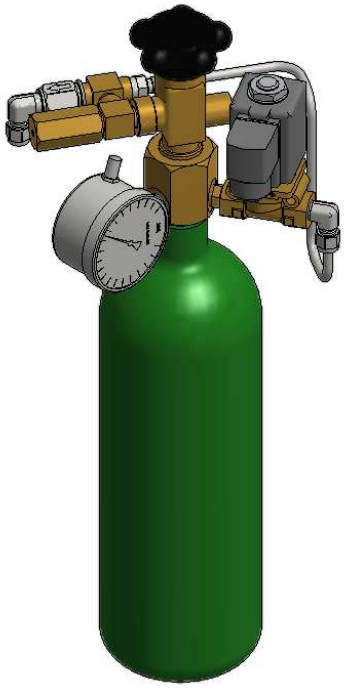
PDS II-C 80MS Pilot



General

The PDS II-C 80MS Pilot is used for remote activation of Fire Eater INERGEN systems.
It supplies pressure to activate SV22 selector valves and discharge valves either directly or via the PDS II Control Pull Unit [308382].
Activation of the valves is done by gas pressure from the PDS bottles to the valves via stainless steel pipes.
The PDS systems can be placed inside the Fire Eater PDS cabinet (items 308202, 308204, 308206)

Specifications

Outlet:

Type:	Compression fitting for ø6mm stainless steel tube
Flow way:	Ø>1.2mm

Manoswitch:

See datasheet “Ci Manoswitch” for details

Range:	0- 160 bar

Solenoid:

Power:	12 W	
Voltage:	24 ±10% VDC	
Wire connection:	Brown,	+ve
	Blue,	-ve
	Green/Yellow,	Ground

Materials:

See exploded view

Filling:

Agent:	Nitrogen
Pressure:	80 bar @ 15°C

Dimensions:

Height:	~510 mm
Diameter:	102 mm
Weight:	~5kg (empty)

Dimensioning

The maximum pipe length must satisfy the equation:

$$L \le \frac{P_{PDS} \cdot V_{PDS} - P_{act} \cdot (V_{PDS} + V_{act})}{P_{act} \cdot 100 \cdot \frac{\pi}{4} \cdot D_{in}^{\ 2}}$$

P_{act} = Required actuator pressure [bar], (SV22 = 35 bar)
P_{PDS} = Pressure in PDS system [bar]
D_{in} = Internal diameter of the tube/pipe [cm]
L = Pipe length [m]
V_{act} = Volume of actuator[cm^3], (SV22 = 8; add 1000 when using delay unit;)
V_{PDS} = Volume of PDS cylinder [cm^3], (std=2000)

FIRE EATER A/S

Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
Fax +45 7023 2769

	Text
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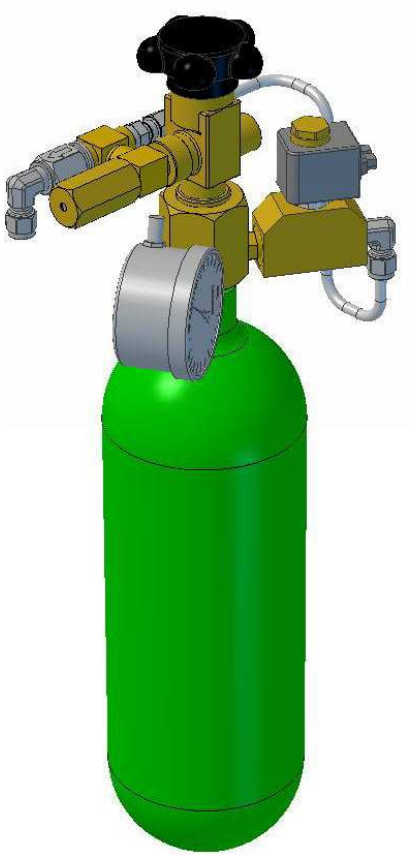
PDS II-C 80MS ATEX Pilot

General



The PDS II-C 80MS ATEX Pilot is used for activation of Fire Eater INERGEN systems, where the pilot cylinder is placed in Ex rated area.
It supplies pressure to activate SV22 selector valves and discharge valves either directly or via the PDS II Control Pull Unit [308382].
Activation of the valves is done by gas pressure from the PDS bottles to the valves via stainless steel pipes.

The PDS systems can be placed inside the Fire Eater PDS cabinet (items 308202, 308204, 308206)

Specifications

Outlet:

Type: Compression fitting for ø6mm stainless steel tube
Flow way: Ø>2mm

Manoswitch:

See datasheet "Ci Manoswitch" for details
Range: 0- 160 bar

The manoswitch is a "Simple Apparatus" according to the ATEX directive.

Solenoid:

Power: 5.3 W
Voltage: 24 VDC
Class: Ex mb II T4, Ex II 2 GD, Ex mD 21 T135°C

Materials:

See exploded view

Filling:

Agent: Nitrogen
Pressure: 80 bar @ 15°C

Dimensions:

Height: ~510 mm
Diameter: 102 mm
Weight: ~5kg (empty)

Dimensioning

The maximum pipe length must satisfy the equation:

$$L \le \frac{P_{PDS} \cdot V_{PDS} - P_{act} \cdot (V_{PDS} + V_{act})}{P_{act} \cdot 100 \cdot \frac{\pi}{4} \cdot D_{in}^{\ 2}}$$

P_{act} = Required actuator pressure [bar], (SV22 = 35 bar)
P_{PDS} = Pressure in PDS system [bar]
D_{in} = Internal diameter of the tube/pipe [cm]
L = Pipe length [m]
V_{act} = Volume of actuator[cm^3], (SV22 = 8; add 1000 when using delay unit;)
V_{PDS} = Volume of PDS cylinder [cm^3], (std=2000)

FIRE EATER

Vølundsvej 17
DK- 3400 Hillerød
Tel +45 7022 2769
Fax +45 7023 2769

	Text
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PDS II 80MS IECeX SIL

General

The PDS II-C 80MS IECeX SIL Pilot is used for activation of Fire Eater INERGEN systems, where the pilot cylinder is placed in Ex rated area.
It supplies pressure to activate SV22 selector valves and discharge valves either directly or via the PDS II Control Pull Unit [308382].
Activation of the valves is done by gas pressure from the PDS bottles to the valves via stainless steel pipes.

The PDS systems can be placed inside the Fire Eater PDS cabinet (items 308202, 308204, 308206)

Specifications

Outlet:

Type:	Compression fitting for ø6mmtube
Flow way:	Ø>2mm

Manoswitch:

See datasheet “Ci Manoswitch” for details

Range:	0- 160 bar

The manoswitch is a “Simple Apparatus” according to the ATEX directive.

Solenoid:

Power:	8 W
Voltage:	24 VDC
Class:	Ex db mb IIC T4, Ex tb IIIC T 130°C, II2 GD, Tamb: -40 to + 80°C
Cable entry:	M25 cable gland, Cable diameter: Ø7 – Ø9 mm
Wire:	Max. 2.5 mm²

Materials:

See exploded view

Filling:

Agent:	Nitrogen
Pressure:	80 bar @ 15°C

Dimensions:

Height:	~510 mm
Diameter:	102 mm
Weight:	~5kg (empty)

FIRE EATER A/S

Vølundsvej 17
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Fax +45 7023 2769

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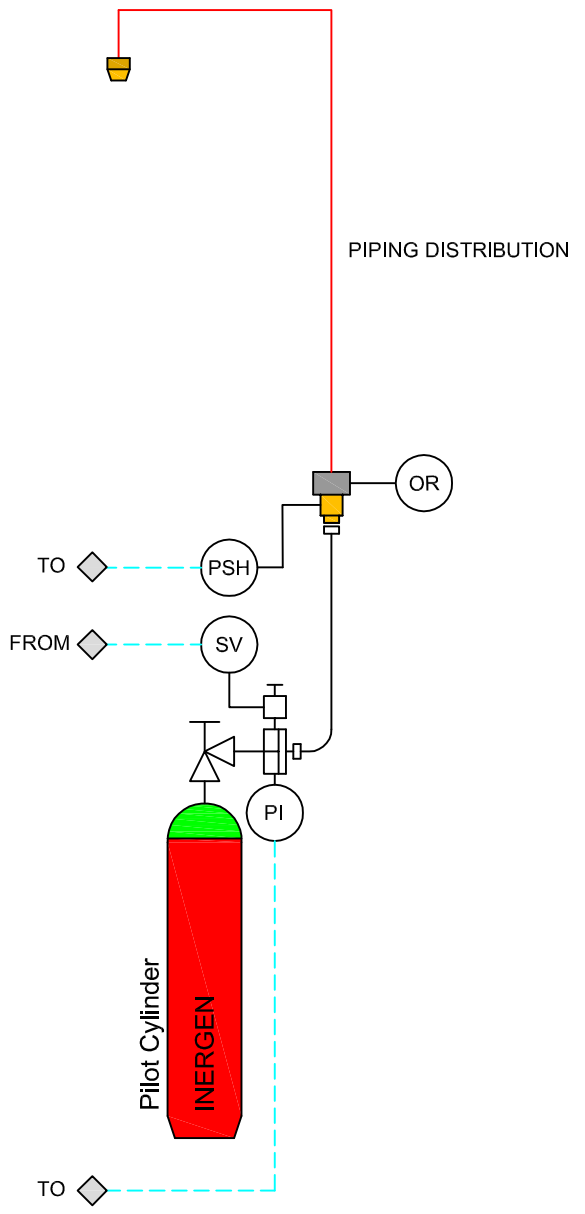
Appendix B

Process & Instrument Diagram (P&ID) Sample

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



SINGLE CYLINDER SYSTEM

HAND WHEEL VALVE
Ci IV8 DISCHARGE VALVE
PI MANOSWITCH WITH CONTACT
DETECTION LINE
PIPING DISTRIBUTION

SV Ci IS8B SOLENOID ACTUATOR
PSH Ci MT PRESSURE SWITCH
OR ORIFICE REDUCER
Ci MT DISCHARGE MANIFOLD

Ci DISCHARGE HOSE
TO ⇨ Fire Alarm Control Panel
FROM ⇨ Fire Alarm Control Panel
DISCHARGE NOZZLE

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

GENERAL INFORMATION

INERGEN is an odorless colorless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% Nitrogen, 40% Argon and 8% Carbon dioxide and works by lowering the concentration of Oxygen of the protected area to a point that cannot support combustion.
INERGEN is non toxic and no decomposition products are created from INERGEN when exposed to heat or fire.
INERGEN is a mixture of gases naturally occurring in the earth's atmosphere. It exhibits no ozone depleting potential and does not contribute to global warming.
INERGEN systems should not be used below -56°C as the CO2 will solidify. The gas has no temperature upper limit of use. Limitations will come from the hardware due to pressure increase with temperature.

PRESSURES AND TEMPERATURE

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

INERGEN CYLINDER

Cylinder type for Landing Application:

Code	Description
200610	Cylinder 50-200 W24
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25

Cylinder type for Landing Application:

Code	Description
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV

Cylinder Approval:

Code	Description
-00	Pi Marked
-21	DNV Approved Cylinder
-23	GOST-R Cylinder
-24	GOST-K Cylinder
-60	UL Approved (NFPA Compliant)
-62	FM Approved (NFPA Compliant)

Ci IS8B SOLENOID ACTUATOR

Voltage (activation):	24 VDC
Max:	36 VDC, 100% duty cycle
Min:	21 VDC
Current (activation):	0.9 A (minimum 0.6 amp 10 msec)
	1.34 A @ 36 VDC
Max monitoring:	20 mA
No triggering max:	100 mA 120 sec
Power limited circuit:	The device contains a limited energy circuit
Manual activation:	Rotation < 225° clockwise, < 1 Nm
Temperature:	
Operation:	-25 to +70°C (mounted on valve)
Storage:	-60 to +100°C (not mounted on valve)
Resistance:	
Monitoring:	6800 Ω (EOL resistor dependent)
	(only with "Reserve Polarity Activation")
Activation:	27 Ω (coil only)
Valve interface:	M20x1.0 (male)
	Pin 06mm, Force exceeds 350N with pin extracted.
Electrical connection:	M12 male connector (optional: Cable with gland M12x1.5)
Integrity:	IP67 (with cable installed)
Pin configuration:	
Activation:	pin 1+2 +ve, pin 3+4 -ve
Monitoring:	pin 1+2 -ve, pin 3+4 +ve (reserved polarity)
Dimension (DxL):	64x76 mm (installed 64x68 mm) (solenoid only)
	64x108 mm (installed 64x100 mm) (with manual)
Weight:	1.1 kg

NOZZLE FOR LANDING APPLICATION

General Specifications

Pressure (work max):	75-125 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3
Marking:	Fire Eater logo & orifice diameter
Inter nozzle distance:	max 7.32 m
Height:	
Min:	0.3 m
Max:	4.7 m

PIPE SIZE	NOZZLE CODE NPT THREAD
1/2"	210224
3/4"	210226
1"	210228
5/4"	210230

NOZZLE FOR MARINE APPLICATION

General Specifications

Pressure (work max):	300 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3 OR AISI 316
Marking:	Designation (size-thread), 0575 Batch number, orifice diameter, Fire Eater logo
Inter nozzle distance:	max 8 m

PIPE SIZE	NOZZLE CODE NPT THREAD	
	BRASS	AISI 316
1/2"	210524	210424
3/4"	210526	210426
1"	210528	210428
5/4"	210530	210430

MANOSWITCH WITH CONTACT

The manoswitch is a passive component as it is a simple switch, no electrical function or capacities.
Hence it will be considered a simple apparatus IEC 60079-11: 5.6 Simple apparatus

Ci MT PRESSURE SWITCH

Specifications

Operating pressure:	max 600 bar
Set point:	15 bar (adjustable 10 - 15 bar)
Switch rating:	250 Vac, 4 Amp / 24 VDC, 4 Amp
Material	
Adapter:	Brass CuZn39Pb3
Pressure switch:	Zinc plated steel

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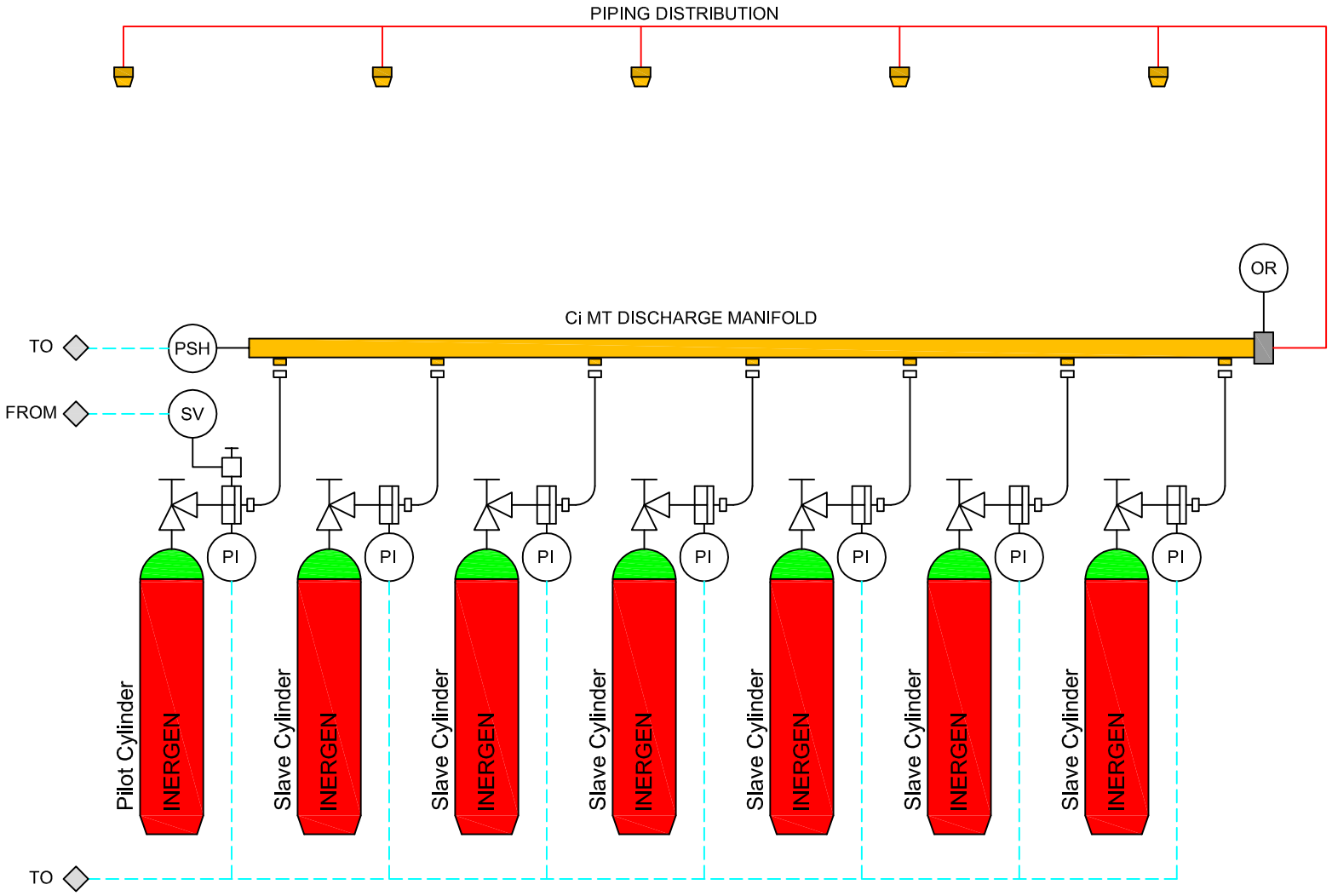
0	P. Taheri	Feb. 2015	TFE-PID-001-1-0
Rev.	Redatto Prepared	Data Date	Dwg Nr. Dwg No.

Titolo
Title

INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



FROM 2 TO 10 CYLINDERS

MULTIPLE CYLINDER SYSTEM

HAND WHEEL VALVE
Ci IV8 DISCHARGE VALVE
PI MANOSWITCH WITH CONTACT
DETECTION LINE
SV Ci IS8B SOLENOID ACTUATOR
PSH Ci MT PRESSURE SWITCH
OR ORIFICE REDUCER
PIPING DISTRIBUTION
Ci DISCHARGE HOSE
TO ⇨ Fire Alarm Control Panel
FROM ⇨ Fire Alarm Control Panel
DISCHARGE NOZZLE

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

GENERAL INFORMATION

INERGEN is an odorless colorless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% Nitrogen, 40% Argon and 8% Carbon dioxide and works by lowering the concentration of Oxygen of the protected area to a point that cannot support combustion.
INERGEN is non toxic and no decomposition products are created from INERGEN when exposed to heat or fire.
INERGEN is a mixture of gases naturally occurring in the earth's atmosphere. It exhibits no ozone depleting potential and does not contribute to global warming.
INERGEN systems should not be used below -56°C as the CO2 will solidify. The gas has no temperature upper limit of use. Limitations will come from the hardware due to pressure increase with temperature.

PRESSURES AND TEMPERATURE

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

INERGEN CYLINDER

Cylinder type for Landing Application:

Code	Description
200610	Cylinder 50-200 W24
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25

Cylinder type for Landing Application:

Code	Description
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV

Cylinder Approval:

Code	Description
-00	Pi Marked
-21	DNV Approved Cylinder
-23	GOST-R Cylinder
-24	GOST-K Cylinder
-60	UL Approved (NFPA Compliant)
-62	FM Approved (NFPA Compliant)

Ci IS8B SOLENOID ACTUATOR

Voltage (activation):	24 VDC
Max:	36 VDC, 100% duty cycle
Min:	21 VDC
Current (activation):	0.9 A (minimum 0.6 amp 10 msec)
	1.34 A @ 36 VDC
Max monitoring:	20 mA
No triggering max:	100 mA 120 sec
Power limited circuit:	The device contains a limited energy circuit
Manual activation:	Rotation < 225° clockwise, < 1 Nm
Temperature:	
Operation:	-25 to +70°C (mounted on valve)
Storage:	-60 to +100°C (not mounted on valve)
Resistance:	
Monitoring:	6800 Ω (EOL resistor dependent)
	(only with "Reserve Polarity Activation")
Activation:	27 Ω (coil only)
Valve interface:	M20x1.0 (male)
	Pin 06mm, Force exceeds 350N with pin extracted.
Electrical connection:	M12 male connector (optional: Cable with gland M12x1.5)
Integrity:	IP67 (with cable installed)
Pin configuration:	
Activation:	pin 1+2 +ve, pin 3+4 -ve
Monitoring:	pin 1+2 -ve, pin 3+4 +ve (reserved polarity)
Dimension (DxL):	64x76 mm (installed 64x68 mm) (solenoid only)
	64x108 mm (installed 64x100 mm) (with manual)
Weight:	1.1 kg

NOZZLE FOR LANDING APPLICATION

General Specifications

Pressure (work max):	75-125 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3
Marking:	Fire Eater logo & orifice diameter
Inter nozzle distance:	max 7.32 m
Height:	
Min:	0.3 m
Max:	4.7 m

PIPE SIZE	NOZZLE CODE NPT THREAD
1/2"	210224
3/4"	210226
1"	210228
5/4"	210230

NOZZLE FOR MARINE APPLICATION

General Specifications

Pressure (work max):	300 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3 OR AISI 316
Marking:	Designation (size-thread), 0575 Batch number, orifice diameter, Fire Eater logo
Inter nozzle distance:	max 8 m

PIPE SIZE	NOZZLE CODE NPT THREAD	
	BRASS	AISI 316
1/2"	210524	210424
3/4"	210526	210426
1"	210528	210428
5/4"	210530	210430

MANOSWITCH WITH CONTACT

The manoswitch is a passive component as it is a simple switch, no electrical function or capacities.
Hence it will be considered a simple apparatus IEC 60079-11:
5.6 Simple apparatus

Ci MT PRESSURE SWITCH

Specifications

Operating pressure:	max 600 bar
Set point:	15 bar (adjustable 10 - 15 bar)
Switch rating:	250 Vac, 4 Amp / 24 VDC, 4 Amp
Material	
Adapter:	Brass CuZn39Pb3
Pressure switch:	Zinc plated steel

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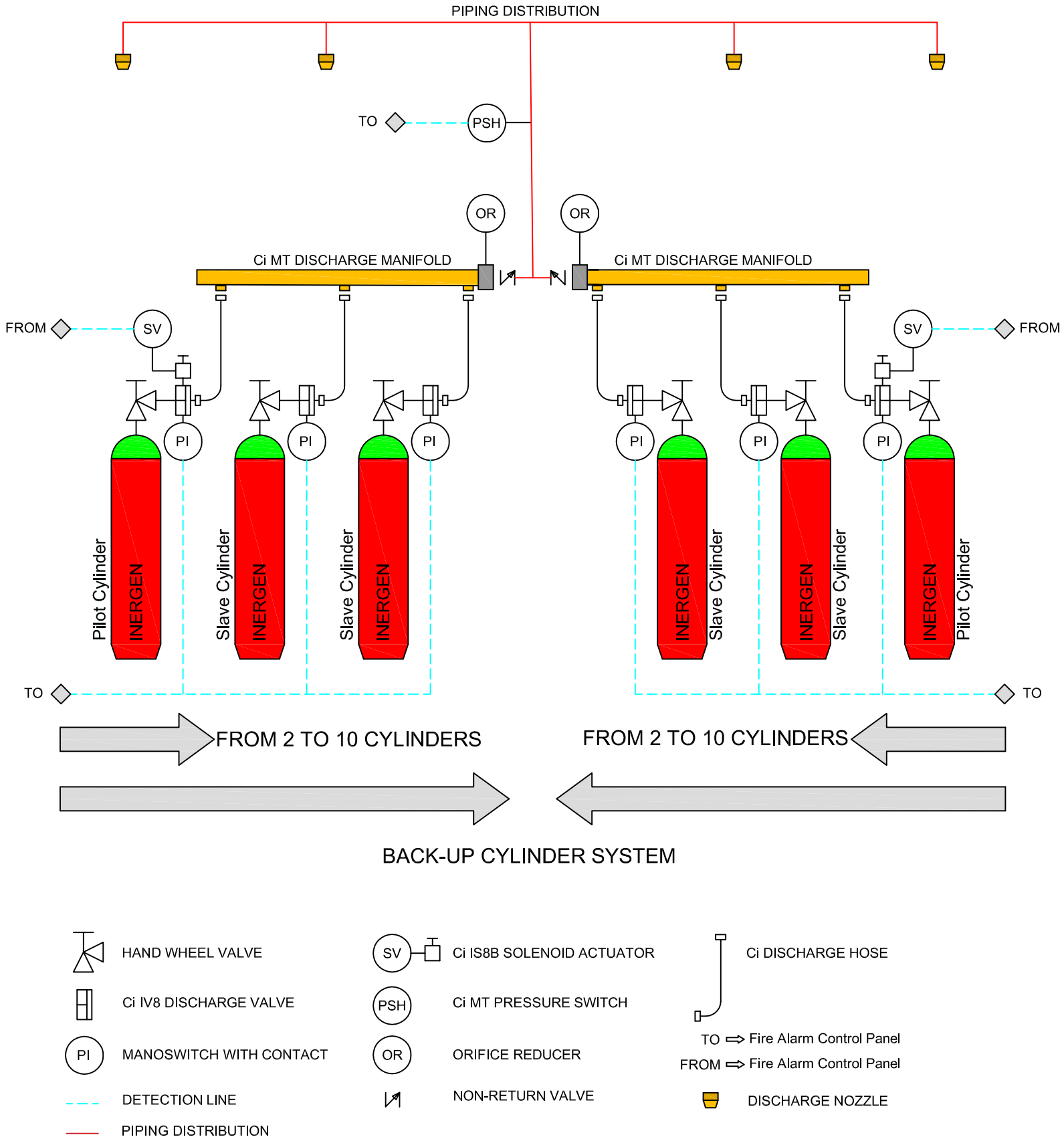
0	P. Taheri	Feb. 2015	TFE-PID-001-2-0
Rev.	Redatto Prepared	Data Date	Dwg Nr. Dwg No.

Titolo / Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



HAND WHEEL VALVE
Ci IV8 DISCHARGE VALVE
MANOSWITCH WITH CONTACT
DETECTION LINE
PIPING DISTRIBUTION
Ci IS8B SOLENOID ACTUATOR
Ci MT PRESSURE SWITCH
ORIFICE REDUCER
NON-RETURN VALVE
Ci DISCHARGE HOSE
TO ⇨ Fire Alarm Control Panel
FROM ⇨ Fire Alarm Control Panel
DISCHARGE NOZZLE

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

GENERAL INFORMATION

INERGEN is an odorless colorless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% Nitrogen, 40% Argon and 8% Carbon dioxide and works by lowering the concentration of Oxygen of the protected area to a point that cannot support combustion.
INERGEN is non toxic and no decomposition products are created from INERGEN when exposed to heat or fire.
INERGEN is a mixture of gases naturally occurring in the earth's atmosphere. It exhibits no ozone depleting potential and does not contribute to global warming.
INERGEN systems should not be used below -56°C as the CO2 will solidify. The gas has no temperature upper limit of use. Limitations will come from the hardware due to pressure increase with temperature.

PRESSURES AND TEMPERATURE

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

INERGEN CYLINDER

Cylinder type for Landing Application:

Code	Description
200610	Cylinder 50-200 W24
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25

Cylinder type for Landing Application:

Code	Description
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV

Cylinder Approval:

Code	Description
-00	Pi Marked
-21	DNV Approved Cylinder
-23	GOST-R Cylinder
-24	GOST-K Cylinder
-60	UL Approved (NFPA Compliant)
-62	FM Approved (NFPA Compliant)

Ci IS8B SOLENOID ACTUATOR

Voltage (activation):	24 VDC
Max:	36 VDC, 100% duty cycle
Min:	21 VDC
Current (activation):	0.9 A (minimum 0.6 amp 10 msec)
	1.34 A @ 36 VDC
Max monitoring:	20 mA
No triggering max:	100 mA 120 sec
Power limited circuit:	The device contains a limited energy circuit
Manual activation:	Rotation < 225° clockwise, < 1 Nm
Temperature:	
Operation:	-25 to +70°C (mounted on valve)
Storage:	-60 to +100°C (not mounted on valve)
Resistance:	
Monitoring:	6800 Ω (EOL resistor dependent)
	(only with "Reserve Polarity Activation")
Activation:	27 Ω (coil only)
Valve interface:	M20x1.0 (male)
	Pin 06mm, Force exceeds 350N with pin extracted.
Electrical connection:	M12 male connector (optional: Cable with gland M12x1.5)
Integrity:	IP67 (with cable installed)
Pin configuration:	
Activation:	pin 1+2 +ve, pin 3+4 -ve
Monitoring:	pin 1+2 -ve, pin 3+4 +ve (reserved polarity)
Dimension (DxL):	64x76 mm (installed 64x68 mm) (solenoid only)
	64x108 mm (installed 64x100 mm) (with manual)
Weight:	1.1 kg

NOZZLE FOR LANDING APPLICATION

General Specifications

Pressure (work max):	75-125 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3
Marking:	Fire Eater logo & orifice diameter
Inter nozzle distance:	max 7.32 m
Height:	
Min:	0.3 m
Max:	4.7 m

PIPE SIZE	NOZZLE CODE NPT THREAD
1/2"	210224
3/4"	210226
1"	210228
5/4"	210230

NOZZLE FOR MARINE APPLICATION

General Specifications

Pressure (work max):	300 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3 OR AISI 316
Marking:	Designation (size-thread), 0575 Batch number, orifice diameter, Fire Eater logo
Inter nozzle distance:	max 8 m

PIPE SIZE	NOZZLE CODE NPT THREAD	
	BRASS	AISI 316
1/2"	210524	210424
3/4"	210526	210426
1"	210528	210428
5/4"	210530	210430

MANOSWITCH WITH CONTACT

The manoswitch is a passive component as it is a simple switch, no electrical function or capacities.
Hence it will be considered a simple apparatus IEC 60079-11: 5.6 Simple apparatus

Ci MT PRESSURE SWITCH

Specifications

Operating pressure:	max 600 bar
Set point:	15 bar (adjustable 10 - 15 bar)
Switch rating:	250 Vac, 4 Amp / 24 VDC, 4 Amp
Material	
Adapter:	Brass CuZn39Pb3
Pressure switch:	Zinc plated steel

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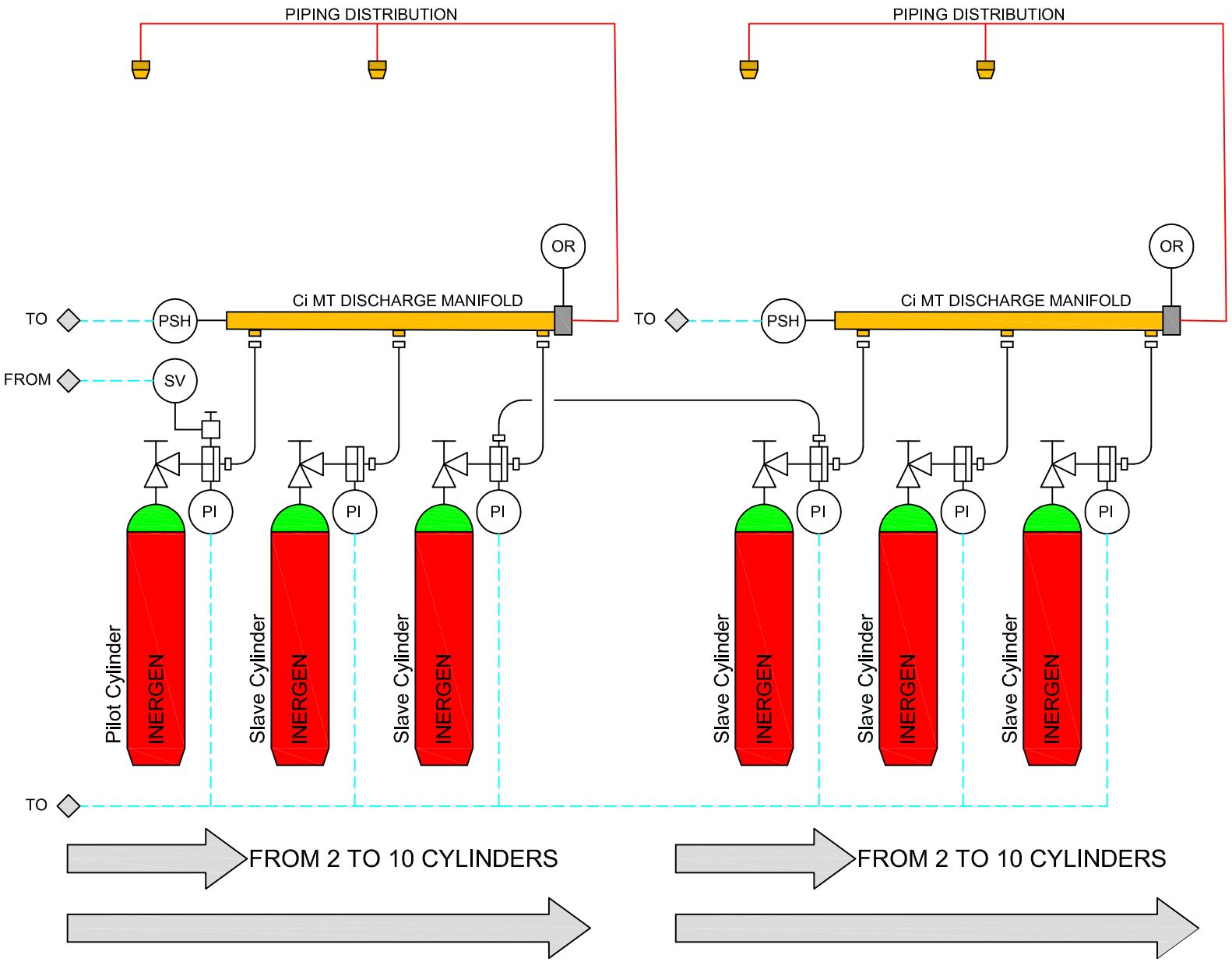
0	P. Taheri	Feb. 2015	TFE-PID-001-3-0
Rev.	Redatto Prepared	Data Date	Dwg Nr. Dwg No.

Titolo / Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems

OPTION: 1



MULTIPLE CYLINDER SYSTEM WITH TWO OR MORE CYLINDER BATTERY

HAND WHEEL VALVE
Ci IV8 DISCHARGE VALVE
MANOSWITCH WITH CONTACT
DETECTION LINE
PIPING DISTRIBUTION
SV — Ci IS8B SOLENOID ACTUATOR
PSH — Ci MT PRESSURE SWITCH
OR — ORIFICE REDUCER
NORSOK MANIFOLD NEXT KIT
Ci DISCHARGE HOSE
TO ⇨ Fire Alarm Control Panel
FROM ⇨ Fire Alarm Control Panel
DISCHARGE NOZZLE

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

GENERAL INFORMATION

INERGEN is an odorless colorless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% Nitrogen, 40% Argon and 8% Carbon dioxide and works by lowering the concentration of Oxygen of the protected area to a point that cannot support combustion.
INERGEN is non toxic and no decomposition products are created from INERGEN when exposed to heat or fire.
INERGEN is a mixture of gases naturally occurring in the earth's atmosphere. It exhibits no ozone depleting potential and does not contribute to global warming.
INERGEN systems should not be used below -56°C as the CO2 will solidify. The gas has no temperature upper limit of use. Limitations will come from the hardware due to pressure increase with temperature.

PRESSURES AND TEMPERATURE

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

INERGEN CYLINDER

Cylinder type for Landing Application:

Code	Description
200610	Cylinder 50-200 W24
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25

Cylinder type for Landing Application:

Code	Description
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV

Cylinder Approval:

Code	Description
-00	Pi Marked
-21	DNV Approved Cylinder
-23	GOST-R Cylinder
-24	GOST-K Cylinder
-60	UL Approved (NFPA Compliant)
-62	FM Approved (NFPA Compliant)

Ci IS8B SOLENOID ACTUATOR

Voltage (activation):	24 VDC
Max:	36 VDC, 100% duty cycle
Min:	21 VDC
Current (activation):	0.9 A (minimum 0.6 amp 10 msec)
	1.34 A @ 36 VDC
Max monitoring:	20 mA
No triggering max:	100 mA 120 sec
Power limited circuit:	The device contains a limited energy circuit
Manual activation:	Rotation < 225° clockwise, < 1 Nm
Temperature:	
Operation:	-25 to +70°C (mounted on valve)
Storage:	-60 to +100°C (not mounted on valve)
Resistance:	
Monitoring:	6800 Ω (EOL resistor dependent)
	(only with "Reserve Polarity Activation")
Activation:	27 Ω (coil only)
Valve interface:	M20x1.0 (male)
	Pin 06mm, Force exceeds 350N with pin extracted.
Electrical connection:	M12 male connector (optional: Cable with gland M12x1.5)
Integrity:	IP67 (with cable installed)
Pin configuration:	
Activation:	pin 1+2 +ve, pin 3+4 -ve
Monitoring:	pin 1+2 -ve, pin 3+4 +ve (reserved polarity)
Dimension (DxL):	64x76 mm (installed 64x68 mm) (solenoid only)
	64x108 mm (installed 64x100 mm) (with manual)
Weight:	1.1 kg

NOZZLE FOR LANDING APPLICATION

General Specifications

Pressure (work max):	75-125 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3
Marking:	Fire Eater logo & orifice diameter
Inter nozzle distance:	max 7.32 m
Height:	
Min:	0.3 m
Max:	4.7 m

PIPE SIZE	NOZZLE CODE NPT THREAD
1/2"	210224
3/4"	210226
1"	210228
5/4"	210230

NOZZLE FOR MARINE APPLICATION

General Specifications

Pressure (work max):	300 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3 OR AISI 316
Marking:	Designation (size-thread), 0575 Batch number, orifice diameter, Fire Eater logo
Inter nozzle distance:	max 8 m

PIPE SIZE	NOZZLE CODE NPT THREAD	
	BRASS	AISI 316
1/2"	210524	210424
3/4"	210526	210426
1"	210528	210428
5/4"	210530	210430

MANOSWITCH WITH CONTACT

The manoswitch is a passive component as it is a simple switch, no electrical function or capacities.
Hence it will be considered a simple apparatus IEC 60079-11:
5.6 Simple apparatus

Ci MT PRESSURE SWITCH

Specifications

Operating pressure:	max 600 bar
Set point:	15 bar (adjustable 10 - 15 bar)
Switch rating:	250 Vac, 4 Amp / 24 VDC, 4 Amp
Material	
Adapter:	Brass CuZn39Pb3
Pressure switch:	Zinc plated steel

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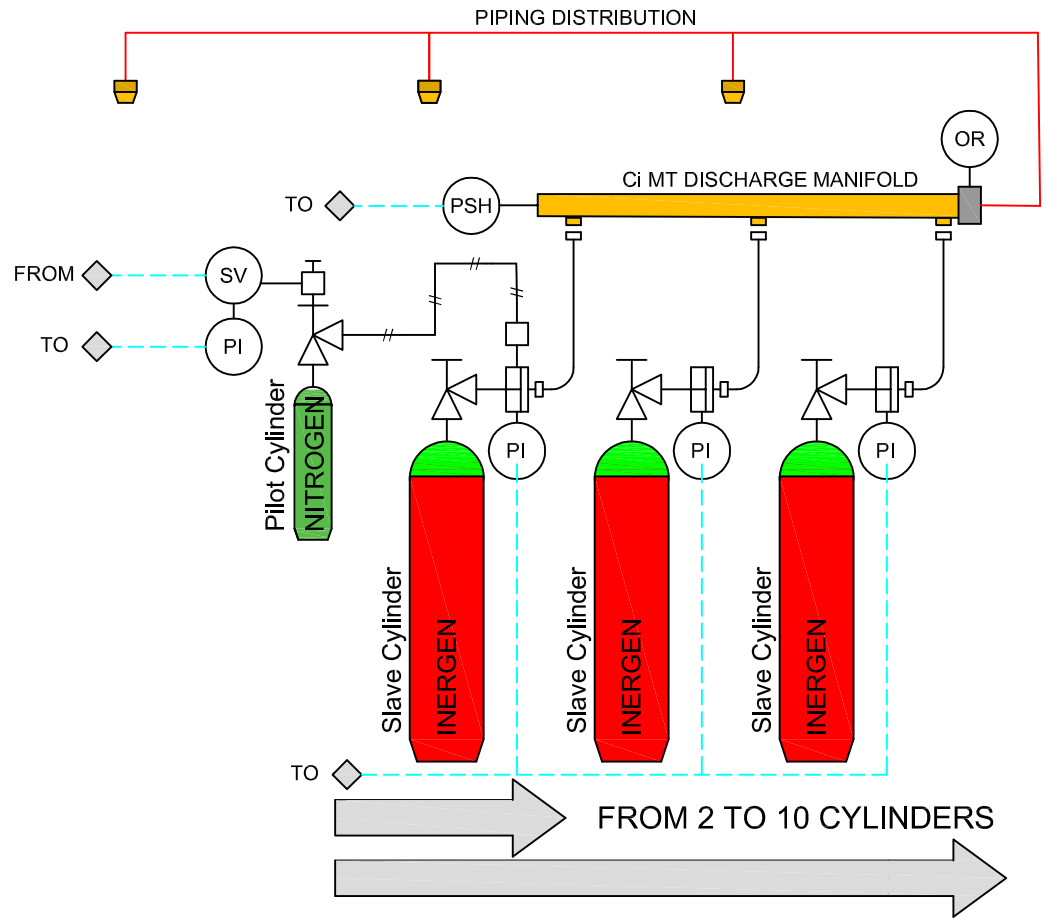
Rev.	Redatto Prepared	Data Date	Dwg Nr. Dwg No.
0	P. Taheri	Feb. 2015	TFE-PID-001-4-0

Titolo Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems

OPTION: 2



MULTIPLE CYLINDER SYSTEM WITH NITROGEN PILOT CYLINDER

NITROGEN PILOT CYLINDER

SAFE AREA APPLICATIONS:
PDS II-C 80MS PILOT:
Specifications
Outlet:
- Type: Compression fitting for 06 mm stainless steel tube
- Flow way: 0 > 1.2 mm

Manoswitch:
see datasheet "Ci Manoswitch" for details
- Range: 0 - 160 bar

Solenoid:
- Power: 12 W
- Voltage: 24 ± 10% VDC
- Wire connection:
  - Brown +ve
  - Blue -ve
  - Green/Yellow Ground

Materials:
see exploded view

Filling:
- Agent: Nitrogen
- Pressure: 80 bar @ 15°C

Dimensions:
- Height: -510 mm
- Diameter: 102 mm
- Weight: -5 kg (empty)

HAZARDOUS AREA APPLICATIONS:
PDS II-C 80MS ATEX PILOT:
Specifications
Outlet:
- Type: Compression fitting for 06 mm stainless steel tube
- Flow way: 0 > 2 mm

Manoswitch:
see datasheet "Ci Manoswitch" for details
- Range: 0 - 160 bar

Solenoid:
- Power: 5.3 W
- Voltage: 24 VDC
- Class: Ex ms II T4
  Ex II 2 GD
  Ex MD21 T135°C

Materials:
see exploded view

Filling:
- Agent: Nitrogen
- Pressure: 80 bar @ 15°C

Dimensions:
- Height: -510 mm
- Diameter: 102 mm
- Weight: -5 kg (empty)

HAZARDOUS AREA APPLICATIONS:
PDS II-C 80MS IECeX SIL:
Specifications
Outlet:
- Type: Compression fitting for 06 mm tube
- Flow way: 0 > 2 mm

Manoswitch:
see datasheet "Ci Manoswitch" for details
- Range: 0 - 160 bar
- The manoswitch is a "simple apparatus" according to the ATEX directive

Solenoid:
- Power: 8 W
- Voltage: 24 VDC
- Class: Ex db mb IIC T4, Ex tb IIIC T 130°C
  II2 GD, Tamb: -40 to +80°C
- Cable entry: M25 cable gland, Diameter: 7 - 9 mm
- Wire: Max 2.5 mm^2

Materials:
see exploded view

Filling:
- Agent: Nitrogen
- Pressure: 80 bar @ 15°C

Dimensions:
- Height: -510 mm
- Diameter: 102 mm
- Weight: -5 kg (empty)

HAND WHEEL VALVE
Ci IV8 DISCHARGE VALVE
PI MANOSWITCH WITH CONTACT
SV Ci IS8B SOLENOID ACTUATOR
PSH Ci MT PRESSURE SWITCH
OR ORIFICE REDUCER
Ci DISCHARGE HOSE
DISCHARGE NOZZLE
Ci PA8A PNEUMATIC ACTUATOR
DETECTION LINE
PIPING DISTRIBUTION
PNEUMATIC LINE
TO ⇨ Fire Alarm Control Panel
FROM ⇨ Fire Alarm Control Panel

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

GENERAL INFORMATION

INERGEN is an odorless colorless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% Nitrogen, 40% Argon and 8% Carbon dioxide and works by lowering the concentration of Oxygen of the protected area to a point that cannot support combustion.
INERGEN is non toxic and no decomposition products are created from INERGEN when exposed to heat or fire.
INERGEN is a mixture of gases naturally occurring in the earth's atmosphere. It exhibits no ozone depleting potential and does not contribute to global warming.
INERGEN systems should not be used below -56°C as the CO2 will solidify. The gas has no temperature upper limit of use. Limitations will come from the hardware due to pressure increase with temperature.

PRESSURES AND TEMPERATURE

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

INERGEN CYLINDER

Cylinder type for Landing Application:

Code	Description
200610	Cylinder 50-200 W24
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25

Cylinder type for Landing Application:

Code	Description
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV

Cylinder Approval:

Code	Description
-00	Pi Marked
-21	DNV Approved Cylinder
-23	GOST-R Cylinder
-24	GOST-K Cylinder
-60	UL Approved (NFPA Compliant)
-62	FM Approved (NFPA Compliant)

~~Ci IS8B SOLENOID ACTUATOR~~

- Voltage (activation): 24 VDC
  - Max: 36 VDC, 100% duty cycle
  - Min: 21 VDC
- Current (activation): 0.9 A (minimum 0.6 amp 10 msec)
  1.34 A @ 36 VDC
  - Max monitoring: 20 mA
  - No triggering max: 100 mA 120 sec
- Power limited circuit: The device contains a limited energy circuit
- Manual activation: Rotation < 225° clockwise, < 1 Nm
- Temperature:
  - Operation: -25 to +70°C (mounted on valve)
  - Storage: -60 to +100°C (not mounted on valve)
- Resistance:
  - Monitoring: 6800 Ω (EOL resistor dependent)
    (only with "Reserve Polarity Activation")
  - Activation: 27 Ω (coil only)
- Valve interface: M20x1.0 (male)
  Pin 06mm, Force exceeds 350N with pin extracted.
- Electrical connection: M12 male connector (optional: Cable with gland M12x1.5)
  - Integrity: IP67 (with cable installed)
- Pin configuration:
  - Activation: pin 1+2 +ve, pin 3+4 -ve
  - Monitoring: pin 1+2 -ve, pin 3+4 +ve (reserved polarity)
- Dimension (DxL): 64x76 mm (installed 64x68 mm) (solenoid only)
  64x108 mm (installed 64x100 mm) (with manual)
- Weight: 1.1 kg

NOZZLE FOR LANDING APPLICATION

General Specifications
Pressure (work max): 75-125 bar
Temperature: -60 to +300°C
Material: CuZn39Pb3
Marking: Fire Eater logo & orifice diameter
Inter nozzle distance: max 7.32 m
Height:
- Min: 0.3 m
- Max: 4.7 m

PIPE SIZE	NOZZLE CODE NPT THREAD
1/2"	210224
3/4"	210226
1"	210228
5/4"	210230

NOZZLE FOR MARINE APPLICATION

General Specifications
Pressure (work max): 300 bar
Temperature: -60 to +300°C
Material: CuZn39Pb3 OR AISI 316
Marking: Designation (size-thread), 0575 Batch number, orifice diameter, Fire Eater logo
Inter nozzle distance: max 8 m

PIPE SIZE	NOZZLE CODE NPT THREAD	
	BRASS	AISI 316
1/2"	210524	210424
3/4"	210526	210426
1"	210528	210428
5/4"	210530	210430

MANOSWITCH WITH CONTACT

The manoswitch is a passive component as it is a simple switch, no electrical function or capacities.
Hence it will be considered a simple apparatus IEC 60079-11:
5.6 Simple apparatus

Ci MT PRESSURE SWITCH

Specifications
- Operating pressure: max 600 bar
- Set point: 15 bar (adjustable 10 - 15 bar)
- Switch rating: 250 Vac, 4 Amp / 24 VDC, 4 Amp
- Material
- Adapter: Brass CuZn39Pb3
- Pressure switch: Zinc plated steel

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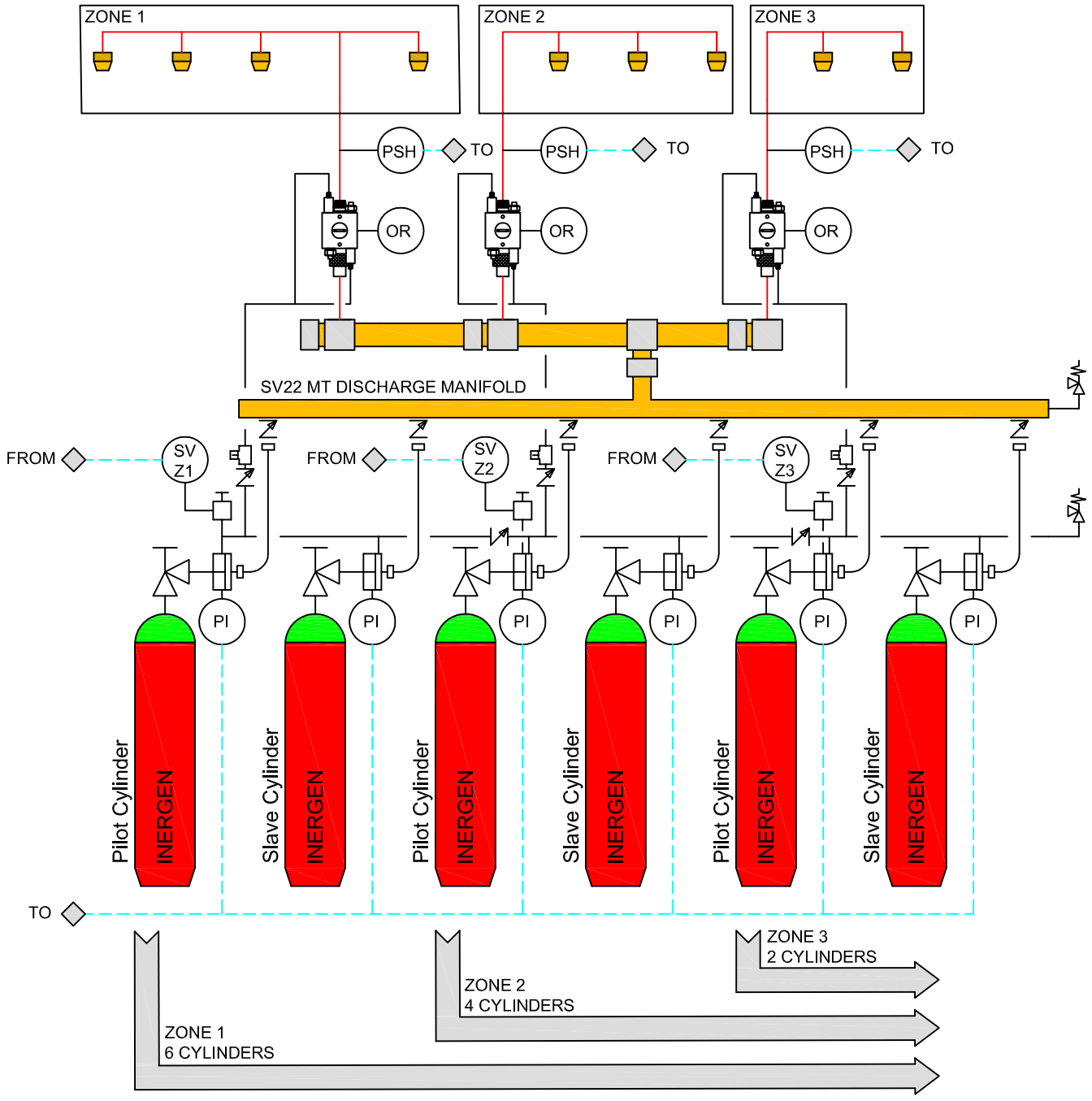
Rev.	Redatto Prepared	Data Date	Dwg Nr. Dwg No.
0	P. Taheri	Feb. 2015	TFE-PID-001-5-0

Titolo Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



SELECTOR VALVE CYLINDER SYSTEM MULTI ZONE PROTECTION

SV22 SELECTOR VALVE

Specifications

Pressure:		Activation:		Thread connection:	
Work:	0 - 400	Triggering pres.:	35 - 400 bar	Flow port (in&out):	ISO228G 1"
Proof (burst):	> 1200 bar	Min.:	35 bar	Pneum. activation:	ISO228 1/4" (60° seat)
Temperature:	-20 to +70°C	Max. no triggering:	1 bar, 10 sec	Function:	
Flow way:	400 mm²			Operation time:	< 1 sec
				Fully Open after activation.	

Material:
Brass, Electroplated steel,
EPDM, FKM, PU

Dimension:

LxHxW:	160x92x90 mm
Weight:	4.3 kg

PSH	PRESSURE SWITCH		Ci IV8 DISCHARGE VALVE		SV22 SELECTOR VALVE
OR	ORIFICE REDUCER	TO	Fire Alarm Control Panel	PI	MANOSWITCH WITH CONTACT
		FROM	Fire Alarm Control Panel		NON-RETURN VALVE
	DISCHARGE NOZZLE		PIPING DISTRIBUTION		HAND WHEEL VALVE
	SV CIV START KIT		DETECTION LINE	SV	Ci IS8B SOLENOID ACTUATOR
					Ci DISCHARGE HOSE
					BLEED FITTING

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

GENERAL INFORMATION

INERGEN is an odorless colorless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% Nitrogen, 40% Argon and 8% Carbon dioxide and works by lowering the concentration of Oxygen of the protected area to a point that cannot support combustion.
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PRESSURES AND TEMPERATURE

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

INERGEN CYLINDER

Cylinder type for Landing Application:

Code	Description
200610	Cylinder 50-200 W24
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25

Cylinder type for Landing Application:

Code	Description
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV

Cylinder Approval:

Code	Description
-00	Pi Marked
-21	DNV Approved Cylinder
-23	GOST-R Cylinder
-24	GOST-K Cylinder
-60	UL Approved (NFPA Compliant)
-62	FM Approved (NFPA Compliant)

Ci IS8B SOLENOID ACTUATOR

Voltage (activation):	24 VDC
Max:	36 VDC, 100% duty cycle
Min:	21 VDC
Current (activation):	0.9 A (minimum 0.6 amp 10 msec)
	1.34 A @ 36 VDC
Max monitoring:	20 mA
No triggering max:	100 mA 120 sec
Power limited circuit:	The device contains a limited energy circuit
Manual activation:	Rotation < 225° clockwise, < 1 Nm
Temperature:	
Operation:	-25 to +70°C (mounted on valve)
Storage:	-60 to +100°C (not mounted on valve)
Resistance:	
Monitoring:	6800 Ω (EOL resistor dependent)
	(only with "Reserve Polarity Activation")
Activation:	27 Ω (coil only)
Valve interface:	M20x1.0 (male)
	Pin 06mm, Force exceeds 350N with pin extracted.
Electrical connection:	M12 male connector (optional: Cable with gland M12x1.5)
Integrity:	IP67 (with cable installed)
Pin configuration:	
Activation:	pin 1+2 +ve, pin 3+4 -ve
Monitoring:	pin 1+2 -ve, pin 3+4 +ve (reserved polarity)
Dimension (DxL):	64x76 mm (installed 64x68 mm) (solenoid only)
	64x108 mm (installed 64x100 mm) (with manual)
Weight:	1.1 kg

NOZZLE FOR LANDING APPLICATION

General Specifications

Pressure (work max):	75-125 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3
Marking:	Fire Eater logo & orifice diameter
Inter nozzle distance:	max 7.32 m
Height:	
Min:	0.3 m
Max:	4.7 m

PIPE SIZE	NOZZLE CODE NPT THREAD
1/2"	210224
3/4"	210226
1"	210228
5/4"	210230

NOZZLE FOR MARINE APPLICATION

General Specifications

Pressure (work max):	300 bar
Temperature:	-60 to +300°C
Material:	CuZn39Pb3 OR AISI 316
Marking:	Designation (size-thread), 0575 Batch number, orifice diameter, Fire Eater logo
Inter nozzle distance:	max 8 m

PIPE SIZE	NOZZLE CODE NPT THREAD	
	BRASS	AISI 316
1/2"	210524	210424
3/4"	210526	210426
1"	210528	210428
5/4"	210530	210430

MANOSWITCH WITH CONTACT

The manoswitch is a passive component as it is a simple switch, no electrical function or capacities.
Hence it will be considered a simple apparatus IEC 60079-11: 5.6 Simple apparatus

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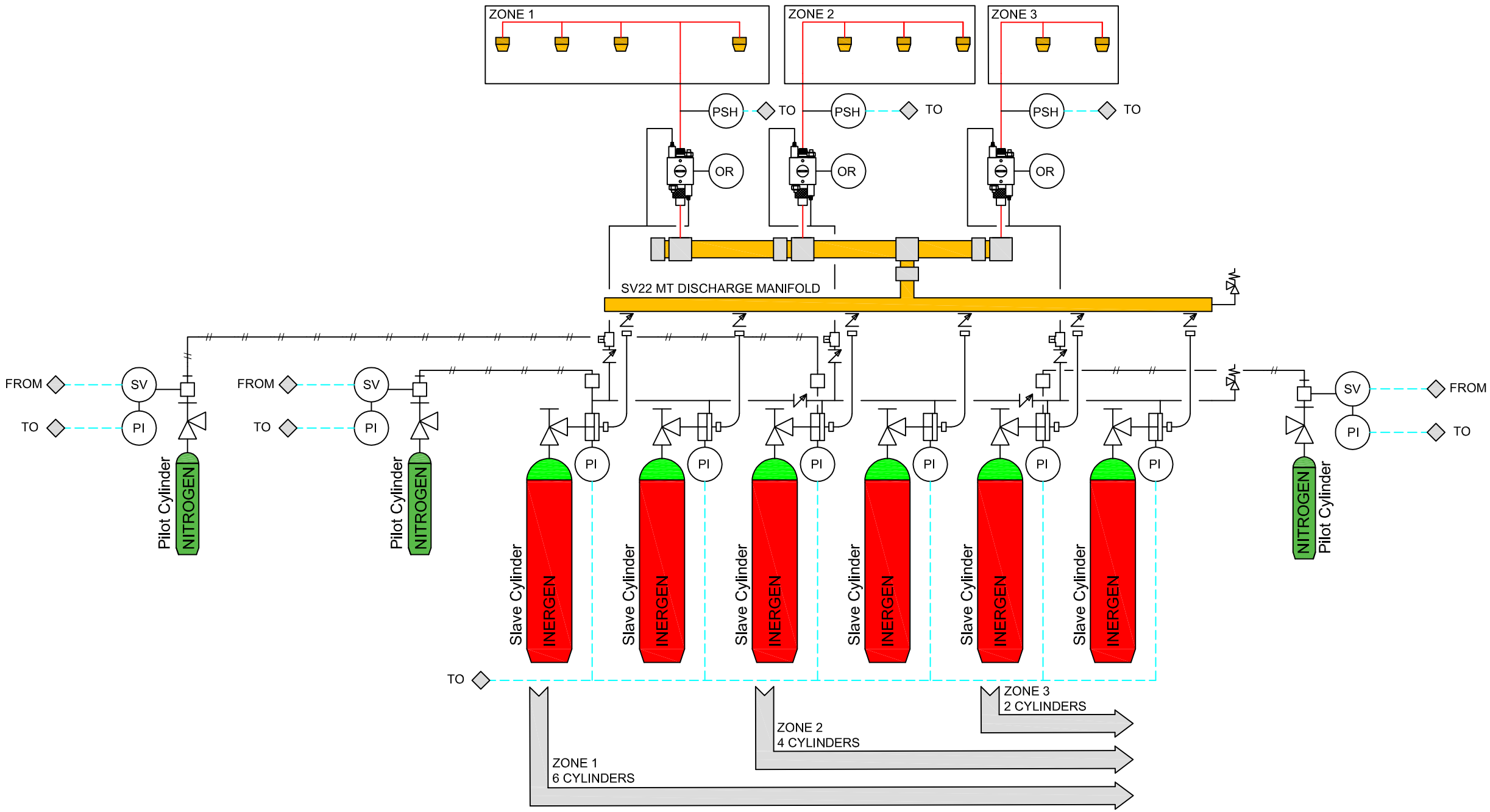
0	P. Taheri	Feb. 2015	TFE-PID-001-6-0
Rev.	Redatto Prepared	Data Date	Dwg Nr. Dwg No.

Titolo
Title

INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems

OPTION:



SELECTOR VALVE CYLINDER SYSTEM MULTI ZONE PROTECTION WITH NITROGEN PILOT CYLINDER

PI MANOSWITCH WITH CONTACT
PSH PRESSURE SWITCH
OR ORIFICE REDUCER
DISCHARGE NOZZLE
SV CIV START KIT

TO ⇨ Fire Alarm Control Panel
FROM ⇨ Fire Alarm Control Panel
PIPING DISTRIBUTION
DETECTION LINE
PNEUMATIC LINE

Ci PA8A PNEUMATIC ACTUATOR
SV22 SELECTOR VALVE
HAND WHEEL VALVE
Ci IS8B SOLENOID ACTUATOR

Ci IV8 DISCHARGE VALVE
NON-RETURN VALVE
Ci DISCHARGE HOSE
BLEED FITTING

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

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Rev.	Redatto Prepared	Data Date	Dwg Nr. Dwg No.

Titolo / Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
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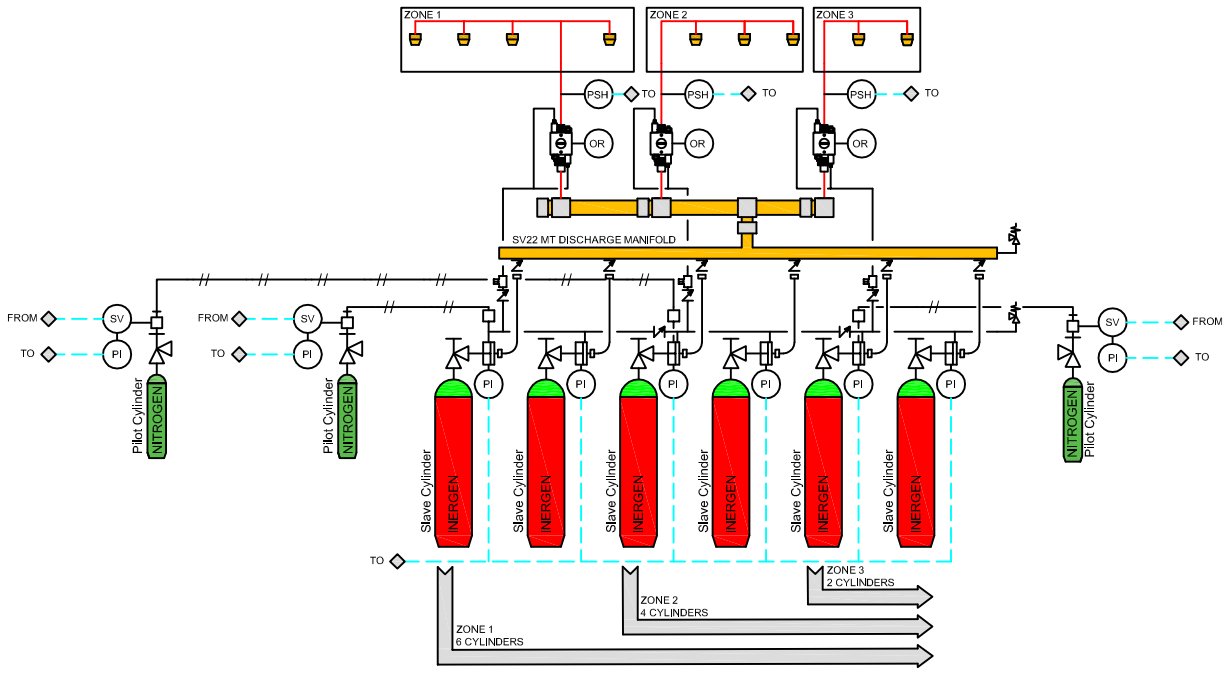
OPTION:



SELECTOR VALVE CYLINDER SYSTEM MULTI ZONE PROTECTION WITH NITROGEN PILOT CYLINDER

NITROGEN PILOT CYLINDER

SAFE AREA APPLICATIONS:
PDS II-C 80MS PILOT:
Specifications
Outlet:
- Type: Compression fitting for 06 mm stainless steel tube
- Flow way: 0 > 1.2 mm

Manoswitch:
see datasheet "Ci Manoswitch" for details
- Range: 0 - 160 bar

Solenoid:
- Power: 12 W
- Voltage: 24 ± 10% VDC
- Wire connection:
  - Brown +ve
  - Blue -ve
  - Green/Yellow Ground

Materials:
see exploded view

Filling:
- Agent: Nitrogen
- Pressure: 80 bar @ 15°C

Dimensions:
- Height: -510 mm
- Diameter: 102 mm
- Weight: -5 kg (empty)

HAZARDOUS AREA APPLICATIONS:
PDS II-C 80MS ATEX PILOT:
Specifications
Outlet:
- Type: Compression fitting for 06 mm stainless steel tube
- Flow way: 0 > 2 mm

Manoswitch:
see datasheet "Ci Manoswitch" for details
- Range: 0 - 160 bar

Solenoid:
- Power: 5.3 W
- Voltage: 24 VDC
- Class: Ex ms II T4
  Ex II 2 GD
  Ex MD21 T135°C

Materials:
see exploded view

Filling:
- Agent: Nitrogen
- Pressure: 80 bar @ 15°C

Dimensions:
- Height: -510 mm
- Diameter: 102 mm
- Weight: -5 kg (empty)

HAZARDOUS AREA APPLICATIONS:
PDS II-C 80MS IECeX SIL:
Specifications
Outlet:
- Type: Compression fitting for 06 mm tube
- Flow way: 0 > 2 mm

Manoswitch:
see datasheet "Ci Manoswitch" for details
- Range: 0 - 160 bar
  The manoswitch is a "simple apparatus" according to the ATEX directive

Solenoid:
- Power: 8 W
- Voltage: 24 VDC
- Class: Ex db mb IIC T4, Ex tb IIIC T 130°C
  II2 GD, Tamb: -40 to +80°C
- Cable entry: M25 cable gland, Diameter: 7 - 9 mm
- Wire: Max 2.5 mm^2

Materials:
see exploded view

Filling:
- Agent: Nitrogen
- Pressure: 80 bar @ 15°C

Dimensions:
- Height: -510 mm
- Diameter: 102 mm
- Weight: -5 kg (empty)

SV22 SELECTOR VALVE

Specifications
Pressure:
- Work: 0 - 400
- Proof (burst): > 1200 bar

Temperature: -20 to +70°C
Flow way: 400 mm^2

Activation:
- Triggering pres.: 35 - 400 bar
- Min.: 35 bar
- Max. no triggering: 1 bar, 10 sec

Thread connection:
- Flow port (in&out): ISO228G 1"
- Pneum. activation: ISO228 $\frac{1}{4}$" (60° seat)

Function:
- Operation time: < 1 sec
  Fully Open after activation.

Material:
Brass, Electroplated steel, EPDM, FKM, PU

Dimension:
- LxHxW: 160x92x90 mm
- Weight: 4.3 kg

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

GENERAL INFORMATION

INERGEN is an odorless colorless gas with a density similar to air. It is a clean agent for use in fire suppression applications. It contains 52% Nitrogen, 40% Argon and 8% Carbon dioxide and works by lowering the concentration of Oxygen of the protected area to a point that cannot support combustion.
INERGEN is non toxic and no decomposition products are created from INERGEN when exposed to heat or fire.
INERGEN is a mixture of gases naturally occurring in the earth's atmosphere. It exhibits no ozone depleting potential and does not contribute to global warming.
INERGEN systems should not be used below -56°C as the CO2 will solidify. The gas has no temperature upper limit of use. Limitations will come from the hardware due to pressure increase with temperature.

PRESSURES AND TEMPERATURE

INERGEN is stored in gaseous phase (it is not dissolved or liquid), hence the pressure will change with the temperature.
The designation pressure, for example 150, 200 or 300 bar, is the pressure in the cylinder at 15 °C.

INERGEN CYLINDER

Cylinder type for Landing Application:

Code	Description
200610	Cylinder 50-200 W24
200615	Cylinder 50-300 M25
200616	Cylinder 80-200 W24
200624	Cylinder 80-300 M25

Cylinder type for Landing Application:

Code	Description
200706	Cylinder 30-200 W24 DNV
200709	Cylinder 30-300 M25 DNV
200716	Cylinder 80-200 W24 DNV
200724	Cylinder 80-300 M25 DNV

Cylinder Approval:

Code	Description
-00	Pi Marked
-21	DNV Approved Cylinder
-23	GOST-R Cylinder
-24	GOST-K Cylinder
-60	UL Approved (NFPA Compliant)
-62	FM Approved (NFPA Compliant)

~~Ci IS8B SOLENOID ACTUATOR~~

- Voltage (activation): 24 VDC
  - Max: 36 VDC, 100% duty cycle
  - Min: 21 VDC
- Current (activation): 0.9 A (minimum 0.6 amp 10 msec)
  1.34 A @ 36 VDC
  - Max monitoring: 20 mA
  - No triggering max: 100 mA 120 sec
- Power limited circuit: The device contains a limited energy circuit
- Manual activation: Rotation < 225° clockwise, < 1 Nm
- Temperature:
  - Operation: -25 to +70°C (mounted on valve)
  - Storage: -60 to +100°C (not mounted on valve)
- Resistance:
  - Monitoring: 6800 Ω (EOL resistor dependent) (only with "Reserve Polarity Activation")
  - Activation: 27 Ω (coil only)
- Valve interface: M20x1.0 (male)
  Pin 06mm, Force exceeds 350N with pin extracted.
- Electrical connection: M12 male connector (optional: Cable with gland M12x1.5)
  - Integrity: IP67 (with cable installed)
- Pin configuration:
  - Activation: pin 1+2 +ve, pin 3+4 -ve
  - Monitoring: pin 1+2 -ve, pin 3+4 +ve (reserved polarity)
- Dimension (DxL): 64x76 mm (installed 64x68 mm) (solenoid only)
  64x108 mm (installed 64x100 mm) (with manual)
- Weight: 1.1 kg

NOZZLE FOR LANDING APPLICATION

General Specifications
Pressure (work max): 75-125 bar
Temperature: -60 to +300°C
Material: CuZn39Pb3
Marking: Fire Eater logo & orifice diameter
Inter nozzle distance: max 7.32 m
Height:
- Min: 0.3 m
- Max: 4.7 m

PIPE SIZE	NOZZLE CODE NPT THREAD
1/2"	210224
3/4"	210226
1"	210228
5/4"	210230

NOZZLE FOR MARINE APPLICATION

General Specifications
Pressure (work max): 300 bar
Temperature: -60 to +300°C
Material: CuZn39Pb3 OR AISI 316
Marking: Designation (size-thread), 0575 Batch number, orifice diameter, Fire Eater logo
Inter nozzle distance: max 8 m

PIPE SIZE	NOZZLE CODE NPT THREAD	
	BRASS	AISI 316
1/2"	210524	210424
3/4"	210526	210426
1"	210528	210428
5/4"	210530	210430

MANOSWITCH WITH CONTACT

The manoswitch is a passive component as it is a simple switch, no electrical function or capacities.
Hence it will be considered a simple apparatus IEC 60079-11: 5.6 Simple apparatus

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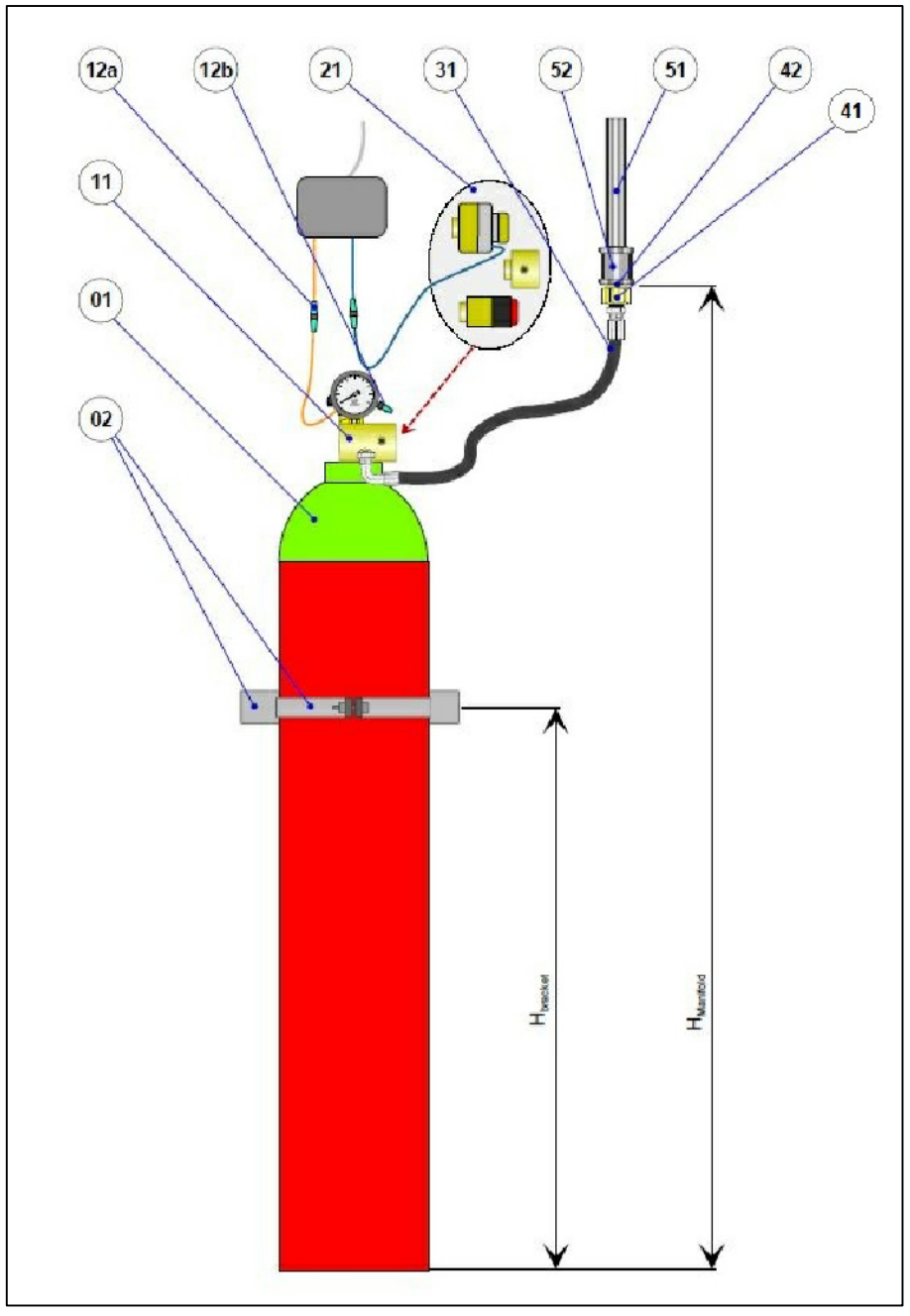
Titolo Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
PROCESS AND INSTRUMENT DIAGRAM (typical)

Appendix C

General Assembly Drawing

(GAD) Sample

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



SINGLE CYLINDER SYSTEM

POS.	CODE	DESCRIPTION	Q.ty
01	200624	Cylinder 80-300 M25	1
	200615	Cylinder 50-300 M25	
	200609	Cylinder 30-300 M25	
	200616	Cylinder 80-200 W24	
	200610	Cylinder 50-200 W24	
	200606	Cylinder 30-200 W24	
02	400301	Cylinder rail	1
	400109	Cylinder bracket 80L	1
11	305410	Ci IV8-300 Manoswitch	1
	305411	Ci IV8-300 Basic	
	305420	Ci IV8-200 Manoswitch	
	305421	Ci IV8-200 Basic	
12	540360	Manositch 470-5K6 cable 2m start kit	1
21	305442	Ci IM8 Manual actuator	
	305451	Ci IS8B w manual	
	305450	Ci IS8B Solenoid only	
	305448	Ci PA8 Pneumatic actuator	
31	303102	Hose Dn10-400, 0.5m std INERGEN	1
	303104	Hose Dn10-400, 1.0m std INERGEN	
	303106	Hose Dn10-400, 1.5m std INERGEN	
	303108	Hose Dn10-400, 2.0m std INERGEN	
	303109	Hose Dn10-400, 2.5m std INERGEN	
	303111	Hose Dn10-400, 3.0m std INERGEN	
	303113	Hose Dn10-400, 4.0m std INERGEN	
41	305701	Ci MT1 Manifold	1
	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	
42	305730	Ci MT ISO Orifice kit 1"	
	305731	Ci MT ISO Orifice kit npt 1"	
51		Pipe system	
52		Fitting for pipe system	

CYLINDER TYPE	BRACKET HEIGHT (mm)	MANIFOLD HEIGHT (mm)	DIAMETER (mm)	WEIGHT (kg)
200624 Cylinder 80-300 M25	1400	2100	267	140
200615 Cylinder 50-300 M25	1200	1850	229	85
200609 Cylinder 30-300 M25	700	1400	229	60
200616 Cylinder 80-200 W24	1400	2100	267	110
200610 Cylinder 50-200 W24	1200	1850	229	67
200606 Cylinder 30-200 W24	700	1400	229	56

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

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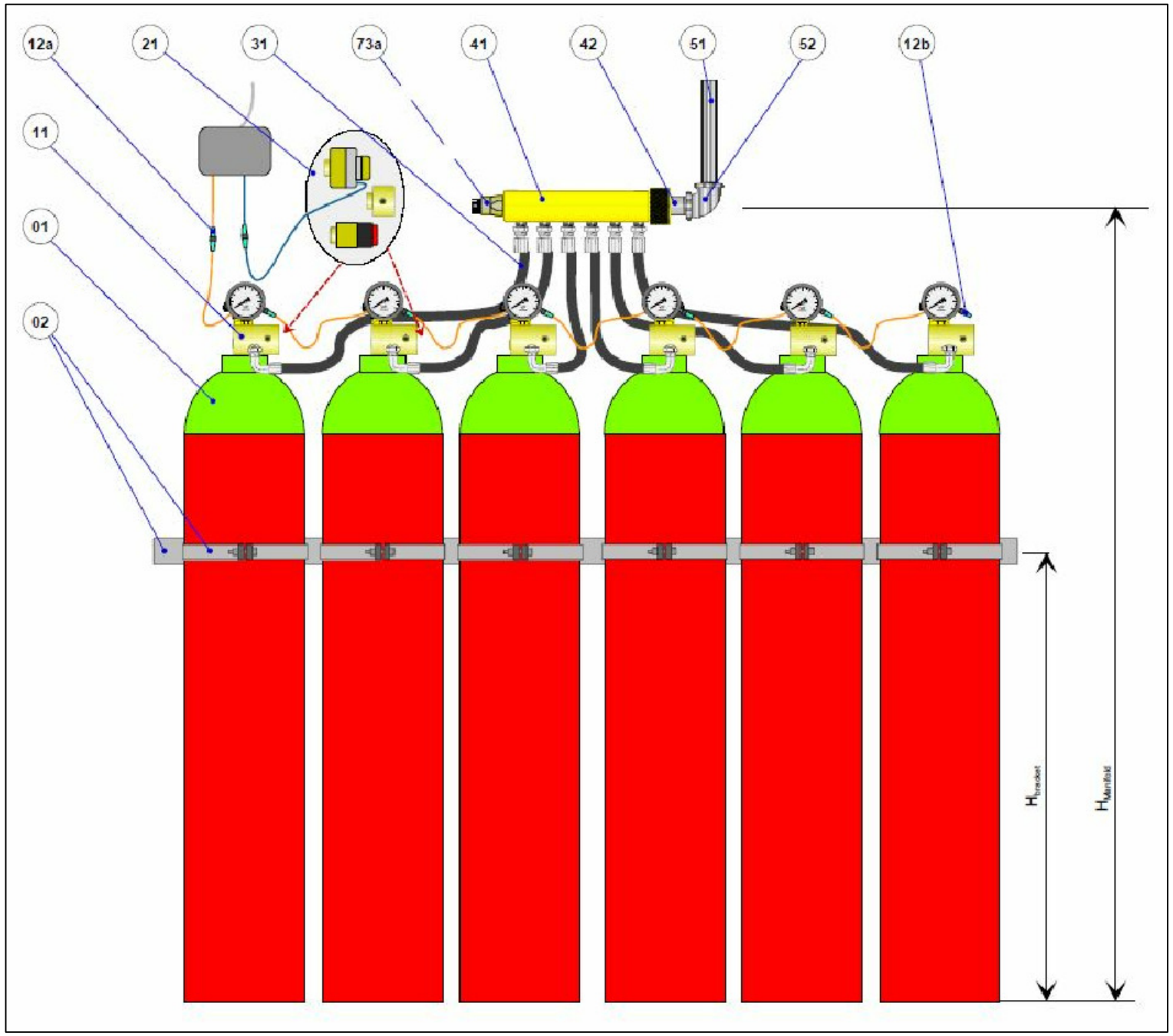
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
GENERAL ASSEMBLY DRAWING (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



MULTIPLE CYLINDER SYSTEM

CYLINDER TYPE	BRACKET HEIGHT (mm)	MANIFOLD HEIGHT (mm)	DIAMETER (mm)	WEIGHT (kg)
200624 Cylinder 80-300 M25	1400	2100	267	140
200615 Cylinder 50-300 M25	1200	1850	229	85
200609 Cylinder 30-300 M25	700	1400	229	60
200616 Cylinder 80-200 W24	1400	2100	267	110
200610 Cylinder 50-200 W24	1200	1850	229	67
200606 Cylinder 30-200 W24	700	1400	229	56

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

POS.	CODE	DESCRIPTION	Q.ty
01	200624	Cylinder 80-300 M25	1
	200615	Cylinder 50-300 M25	
	200609	Cylinder 30-300 M25	
	200616	Cylinder 80-200 W24	
	200610	Cylinder 50-200 W24	
	200606	Cylinder 30-200 W24	
02	400301	Cylinder rail	1
	400109	Cylinder bracket 80L	1
11	305410	Ci IV8-300 Manoswitch	1
	305411	Ci IV8-300 Basic	
	305420	Ci IV8-200 Manoswitch	
	305421	Ci IV8-200 Basic	
12	540360	Manositch 470-5K6 cable 2m start kit	1
21	305442	Ci IM8 Manual actuator	
	305451	Ci IS8B w manual	
	305450	Ci IS8B Solenoid only	
	305448	Ci PA8 Pneumatic actuator	
31	303102	Hose Dn10-400, 0.5m std INERGEN	1
	303104	Hose Dn10-400, 1.0m std INERGEN	
	303106	Hose Dn10-400, 1.5m std INERGEN	
	303108	Hose Dn10-400, 2.0m std INERGEN	
	303109	Hose Dn10-400, 2.5m std INERGEN	
	303111	Hose Dn10-400, 3.0m std INERGEN	
	303113	Hose Dn10-400, 4.0m std INERGEN	
41	305701	Ci MT1 Manifold	1
	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	
42	305730	Ci MT ISO Orifice kit 1"	
	305731	Ci MT ISO Orifice kit npt 1"	
51		Pipe system	
52		Fitting for pipe system	

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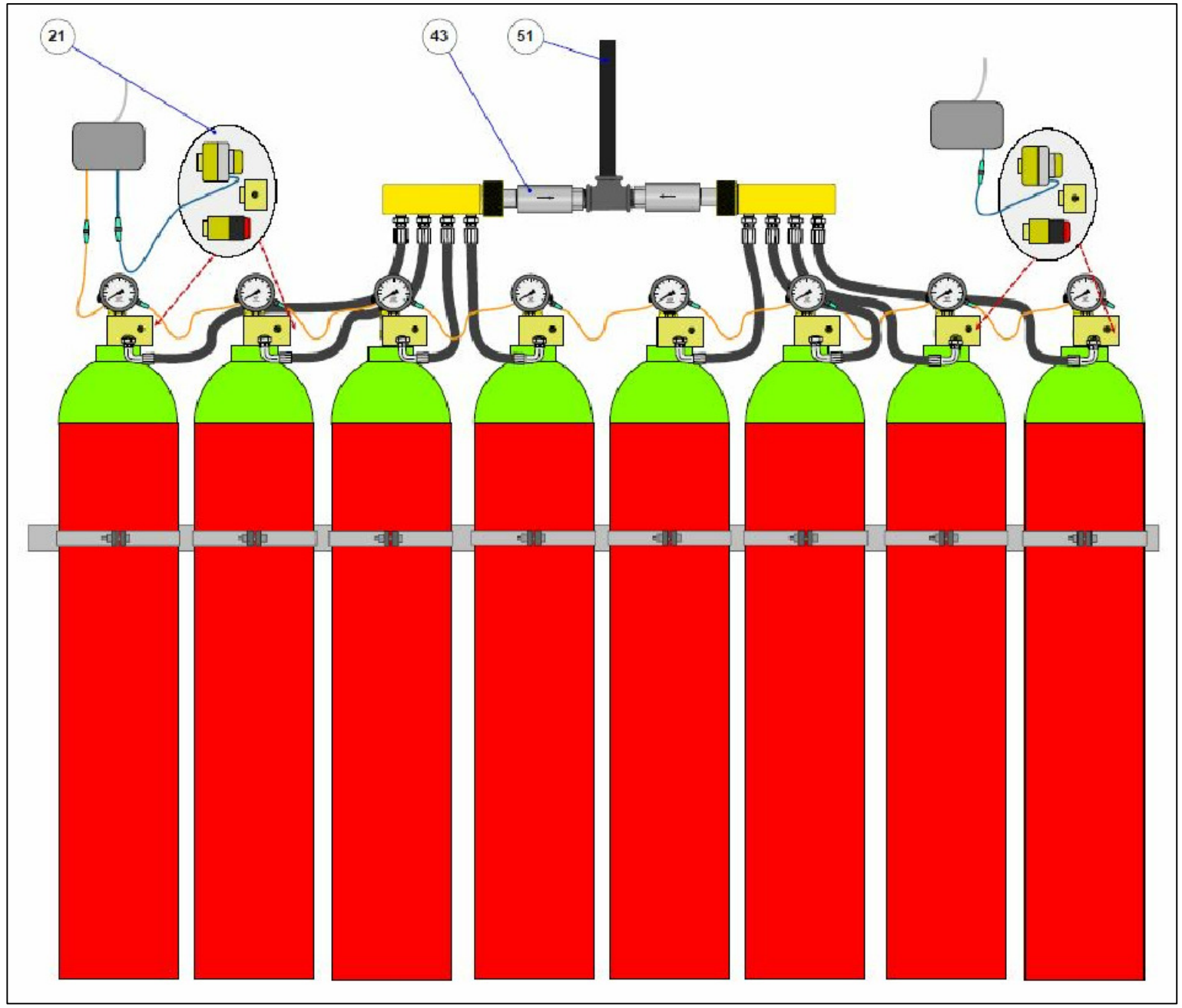
Titolo
Title

INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
GENERAL ASSEMBLY DRAWING (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



BACK-UP CYLINDER SYSTEM

CYLINDER TYPE	BRACKET HEIGHT (mm)	MANIFOLD HEIGHT (mm)	DIAMETER (mm)	WEIGHT (kg)
200624 Cylinder 80-300 M25	1400	2100	267	140
200615 Cylinder 50-300 M25	1200	1850	229	85
200609 Cylinder 30-300 M25	700	1400	229	60
200616 Cylinder 80-200 W24	1400	2100	267	110
200610 Cylinder 50-200 W24	1200	1850	229	67
200606 Cylinder 30-200 W24	700	1400	229	56

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

POS.	CODE	DESCRIPTION	Q.ty
01	200624	Cylinder 80-300 M25	1
	200615	Cylinder 50-300 M25	
	200609	Cylinder 30-300 M25	
	200616	Cylinder 80-200 W24	
	200610	Cylinder 50-200 W24	
	200606	Cylinder 30-200 W24	
02	400301	Cylinder rail	1
	400109	Cylinder bracket 80L	1
11	305410	Ci IV8-300 Manoswitch	1
	305411	Ci IV8-300 Basic	
	305420	Ci IV8-200 Manoswitch	
	305421	Ci IV8-200 Basic	
12	540360	Manositch 470-5K6 cable 2m start kit	1
21	305442	Ci IM8 Manual actuator	
	305451	Ci IS8B w manual	
	305450	Ci IS8B Solenoid only	
	305448	Ci PA8 Pneumatic actuator	
31	303102	Hose Dn10-400, 0.5m std INERGEN	1
	303104	Hose Dn10-400, 1.0m std INERGEN	
	303106	Hose Dn10-400, 1.5m std INERGEN	
	303108	Hose Dn10-400, 2.0m std INERGEN	
	303109	Hose Dn10-400, 2.5m std INERGEN	
	303111	Hose Dn10-400, 3.0m std INERGEN	
	303113	Hose Dn10-400, 4.0m std INERGEN	
41	305701	Ci MT1 Manifold	1
	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	
42	305730	Ci MT ISO Orifice kit 1"	
	305731	Ci MT ISO Orifice kit npt 1"	
43	305304	Non-return valve	2
51		Pipe system	
52		Fitting for pipe system	

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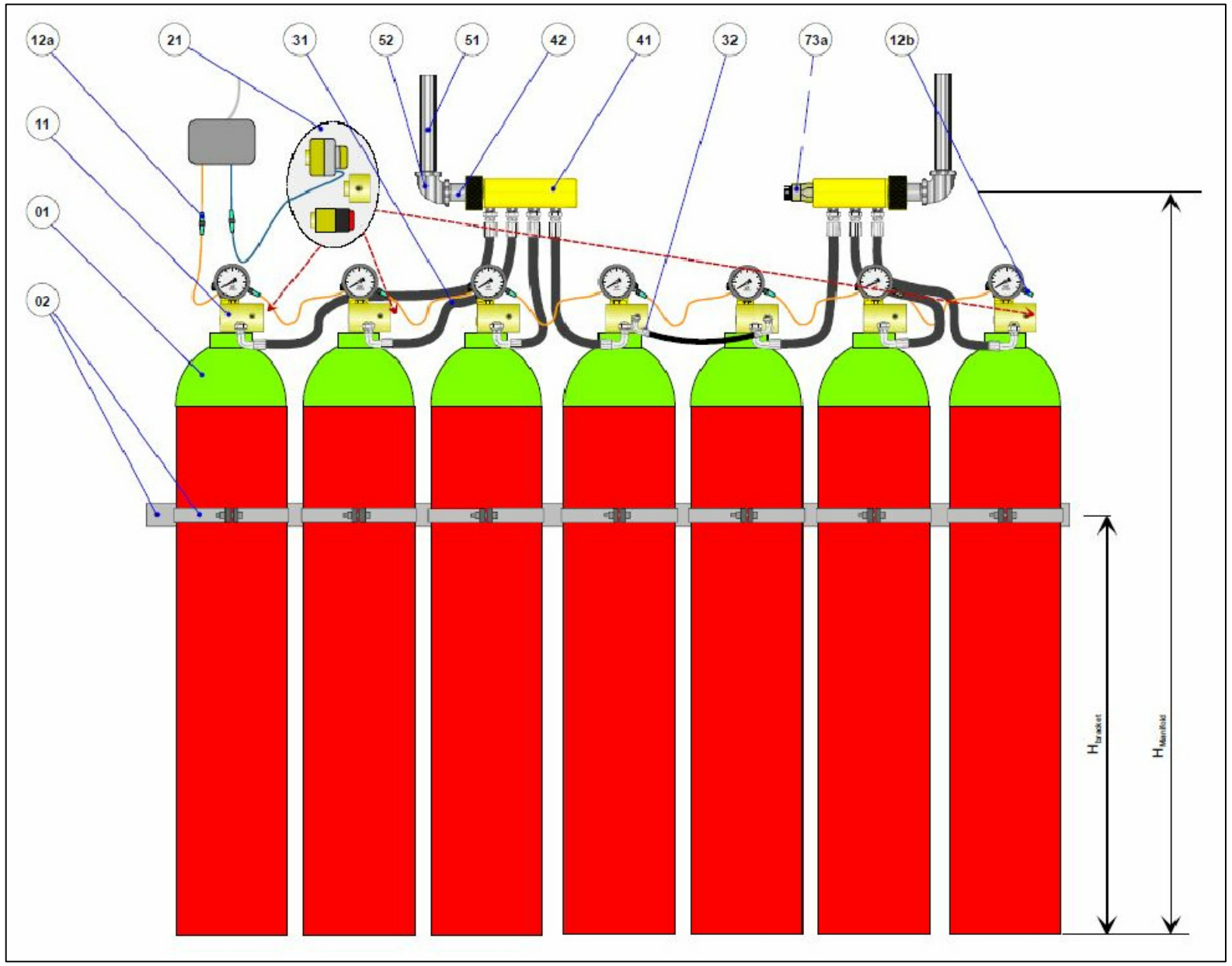
Titolo / Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
GENERAL ASSEMBLY DRAWING (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



MULTIPLE CYLINDER SYSTEM WITH TWO OR MORE CYLINDER BATTERY

CYLINDER TYPE	BRACKET HEIGHT (mm)	MANIFOLD HEIGHT (mm)	DIAMETER (mm)	WEIGHT (kg)
200624 Cylinder 80-300 M25	1400	2100	267	140
200615 Cylinder 50-300 M25	1200	1850	229	85
200609 Cylinder 30-300 M25	700	1400	229	60
200616 Cylinder 80-200 W24	1400	2100	267	110
200610 Cylinder 50-200 W24	1200	1850	229	67
200606 Cylinder 30-200 W24	700	1400	229	56
PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B			
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT			

POS.	CODE	DESCRIPTION	Q.ty
01	200624	Cylinder 80-300 M25	1
	200615	Cylinder 50-300 M25	
	200609	Cylinder 30-300 M25	
	200616	Cylinder 80-200 W24	
	200610	Cylinder 50-200 W24	
	200606	Cylinder 30-200 W24	
02	400301	Cylinder rail	1
	400109	Cylinder bracket 80L	1
11	305410	Ci IV8-300 Manoswitch	1
	305411	Ci IV8-300 Basic	
	305420	Ci IV8-200 Manoswitch	
	305421	Ci IV8-200 Basic	
12	540360	Manositch 470-5K6 cable 2m start kit	1
21	305442	Ci IM8 Manual actuator	
	305451	Ci IS8B w manual	
	305450	Ci IS8B Solenoid only	
	305448	Ci PA8 Pneumatic actuator	
31	303102	Hose Dn10-400, 0.5m std INERGEN	1
	303104	Hose Dn10-400, 1.0m std INERGEN	
	303106	Hose Dn10-400, 1.5m std INERGEN	
	303108	Hose Dn10-400, 2.0m std INERGEN	
	303109	Hose Dn10-400, 2.5m std INERGEN	
	303111	Hose Dn10-400, 3.0m std INERGEN	
	303113	Hose Dn10-400, 4.0m std INERGEN	
32	305621	Ci MT next kit (350 mm)	1
41	305701	Ci MT1 Manifold	1
	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	
42	305730	Ci MT ISO Orifice kit 1"	
	305731	Ci MT ISO Orifice kit npt 1"	
51		Pipe system	
52		Fitting for pipe system	

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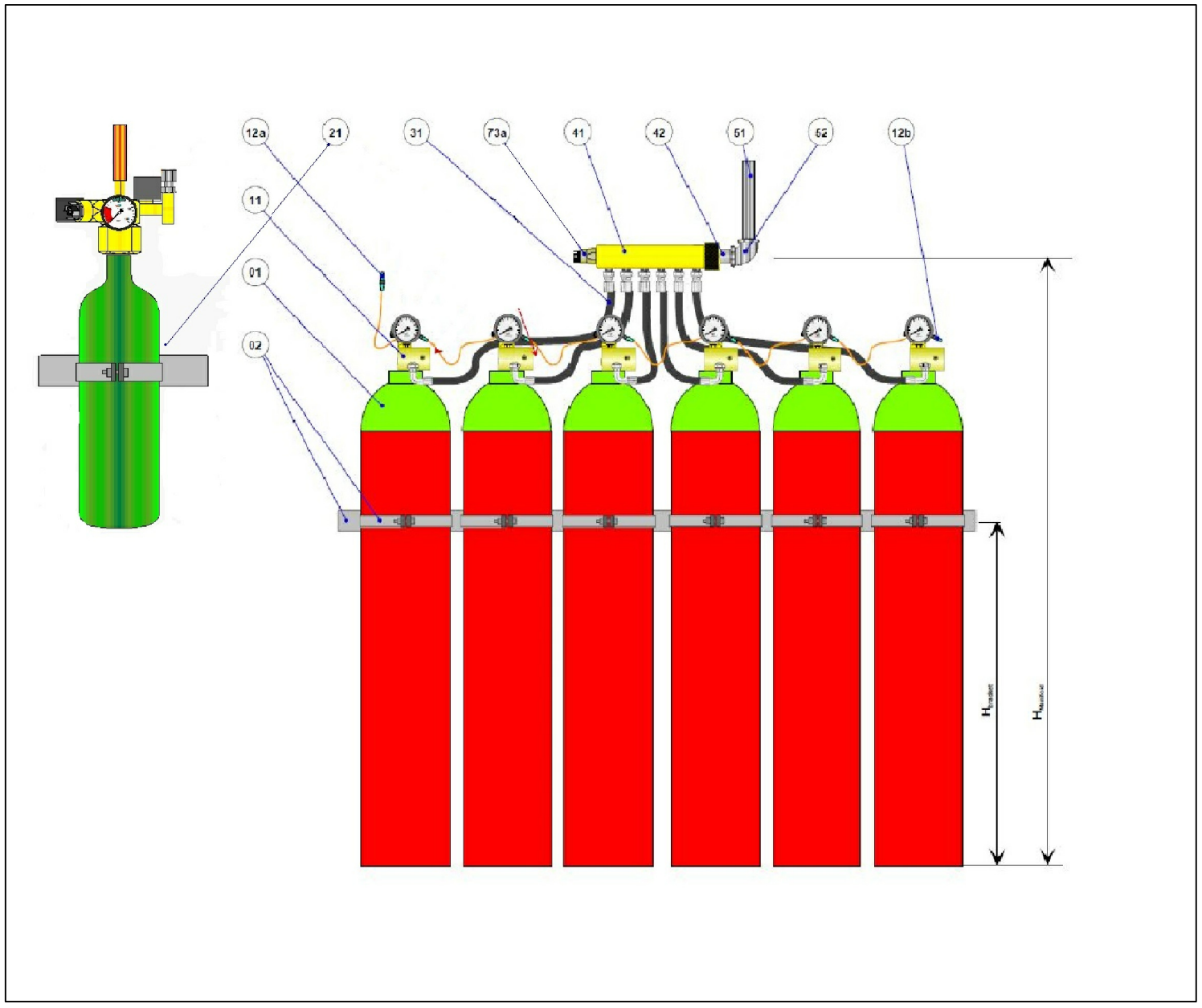
Titolo Title: INERGEN TOTAL FLOODING FIRE SUPPRESSION SYSTEM
SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
GENERAL ASSEMBLY DRAWING (typical)

STANDARD CODE:	NFPA® 2001: Standard on Clean agent Fire Extinguishing Systems
	EN 15004: Fixed Fire Fighting Systems - Gas Extinguishing Systems



MULTIPLE CYLINDER SYSTEM WITH NITROGEN PILOT CYLINDER

CYLINDER TYPE	BRACKET HEIGHT (mm)	MANIFOLD HEIGHT (mm)	DIAMETER (mm)	WEIGHT (kg)
200624 Cylinder 80-300 M25	1400	2100	267	140
200615 Cylinder 50-300 M25	1200	1850	229	85
200609 Cylinder 30-300 M25	700	1400	229	60
200616 Cylinder 80-200 W24	1400	2100	267	110
200610 Cylinder 50-200 W24	1200	1850	229	67
200606 Cylinder 30-200 W24	700	1400	229	56

PIPING:	GALVANIZED STEEL PIPE - SCHEDULE 40 - API 5L GRADE B
FITTING:	GALVANIZED STEEL - ANSI 3000# THREADED NFT

POS.	CODE	DESCRIPTION	Q.ty
01	200624	Cylinder 80-300 M25	1
	200615	Cylinder 50-300 M25	
	200609	Cylinder 30-300 M25	
	200616	Cylinder 80-200 W24	
	200610	Cylinder 50-200 W24	
	200606	Cylinder 30-200 W24	
02	400301	Cylinder rail	1
	400109	Cylinder bracket 80L	1
11	305410	Ci IV8-300 Manoswitch	1
	305411	Ci IV8-300 Basic	
	305420	Ci IV8-200 Manoswitch	
	305421	Ci IV8-200 Basic	
12	540360	Manositch 470-5K6 cable 2m start kit	1
21	308284	PDS II-C 80MS PILOT	
	308286	PDS II-C 80MS ATEX PILOT	
	308287	PDS II-C 80MS IECeX SIL	
	305448	Ci PA8 Pneumatic actuator	
31	303102	Hose Dn10-400, 0.5m std INERGEN	1
	303104	Hose Dn10-400, 1.0m std INERGEN	
	303106	Hose Dn10-400, 1.5m std INERGEN	
	303108	Hose Dn10-400, 2.0m std INERGEN	
	303109	Hose Dn10-400, 2.5m std INERGEN	
	303111	Hose Dn10-400, 3.0m std INERGEN	
	303113	Hose Dn10-400, 4.0m std INERGEN	
32	305621	Ci MT next kit (350 mm)	1
41	305701	Ci MT1 Manifold	1
	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	
42	305730	Ci MT ISO Orifice kit 1"	
	305731	Ci MT ISO Orifice kit npt 1"	
51		Pipe system	
52		Fitting for pipe system	

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SINGLE, MULTIPLE, BACK-UP AND SELECTOR VALVES SYSTEM
GENERAL ASSEMBLY DRAWING (typical)