MARINE FIXED AEROSOL FIRE SUPPRESSION SYSTEM

DESIGN, OPERATION & MAINTENANCE MANUAL

April 2008

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## Document Revision Control Schedule

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FOREWORD

This Manual is intended for use with Pyrogen Marine Fire Suppression Systems. The systems are designed as total flooding, pre-engineered fixed systems for normally unoccupied areas and to meet the requirements of the Codes of Practice for the Safety of Small Commercial Motor or Sailing Vessels of up to 24 metres Load Line length, The Code of Practice for the Safety of Small Workboats and Pilot Boats, The Code of Practice for Police Boats and The Fishing Vessels (Safety Provisions) Rules 1975 for Craft less than 24.4 metres Registered Length.

Pyrogen Marine Systems for total flooding applications shall comply with the requirements of the following Standards:

- AS/NZS 4487:1997 Australia/New Zealand Standard Pyrogen Fire Extinguishing Systems; and


- NFPA 2010 Standard for Fixed Aerosol Fire Extinguishing Systems

- CEN/TC 191 Fixed firefighting systems – Condensed aerosol extinguishing systems – Part 1: Requirements and test methods for components (WI00191148)

- CEN/TC 191 Fixed firefighting systems – Condensed aerosol extinguishing systems – Part 2: Design, Installation and Maintenance (WI00191149)

Those who design, operate, own and maintain these systems should read the entire Manual. Specific sections would be of particular interest depending on one's responsibility. If there should be any questions regarding this manual, please contact our representatives from a Pyrogen office over, or contact the nearest Pyrogen Authorised Representative.

Where required, persons who install and commission Pyrogen systems must be approved by Pyrogen. Marine System Design Approval Certificates must be completed and sent to a Pyrogen office for endorsement prior to supply and installation of a Pyrogen Fire Suppression System.

Approved companies may also be required to supply details to the Marine Approval Authority prior to each installation and provide a Commissioning Certificate upon completion of the installation in the specified risk areas.

The Pyrogen Marine Fire Suppression System requires minimal maintenance, mainly supervision of electrical circuitry, however the system should be inspected at regular intervals to provide maximum assurance that your fire suppression system will operate effectively and safely. Inspection and maintenance should be conducted in accordance with the inspection and maintenance schedule included in this Manual.

This Manual is limited for use with Pyrogen Marine Fire Suppression Systems and within the requirements and limitations detailed within this Manual.
Queries can be directed to Pyrogen personnel in the following Pyrogen offices:

**Pyrogen Headquarters:**

PYROGEN TECHNOLOGIES SDN. BHD.
No. 17, Jalan Pemberita U1/49,
Temasya Industrial Park,
Seksyen U1
40150 Shah Alam, Selangor Darul Ehsan,
Malaysia.
Tel.: +(60-3) 5569 9988
Fax: +(60-3) 5569 6999
Email: sales@pyrogen.com.my

**Australian Office:**

PYROGEN TECHNOLOGIES (AUSTRALIA) PTY. LTD.
18, Barry Avenue, Mortdale,
NSW 2223, Australia,
Tel.: +(61-2) 9586-3200
Fax: +(61-2) 9586-3211
Email: enquiries@pyrogen.com.au

**US Office:**

FIREPAK OIL AND GAS INDUSTRIES IIC
7171 Harwin Dr Suite 316 Houston
Texas 77036
Tel.: +(1) 713-952-1996
Fax: +(1) 713 952 1997
Email: jbrooks@pyrogen.com
## TABLE OF CONTENTS

Document Revision Control Schedule 1

Foreword 2

**SECTION 1 GENERAL** 6

1.1 Terminology.........................................................................................................................7
1.2 Pyrogen Product Standards/Testing.......................................................................................9
1.3 What is Pyrogen?....................................................................................................................9
1.4 Pyrogen Chemical Identity ....................................................................................................10
1.5 Pyrogen Extinguishing Action..............................................................................................12
1.6 Pyrogen Applications ...........................................................................................................14
1.7 Limitations of Use.................................................................................................................15
1.8 Pyrogen Safety Data..............................................................................................................16
1.8 Pyrogen Environmental Characteristics................................................................................18
1.9 Pyrogen Technical Characteristics.......................................................................................19

**SECTION 2 SYSTEM DESIGN FOR MARINE APPLICATIONS** 20

2.1 General..................................................................................................................................21
2.2 Design Methodology.............................................................................................................21
2.3 Design Factor.........................................................................................................................22
2.4 Enclosure Volume..................................................................................................................22
2.5 Design Quantity....................................................................................................................23
2.6 Number of EXA generators ..................................................................................................23
2.7 Pyrogen Range ......................................................................................................................25
2.8 Minimum Holding Time.........................................................................................................28
2.9 Enclosure Requirements........................................................................................................28
2.10 Design Limitations...............................................................................................................29
2.11 Pyrogen Discharge...............................................................................................................30

**SECTION 3 SYSTEM OPERATION** 31

3.1 Electrical manual operation...................................................................................................32
3.2 System isolate switch.............................................................................................................32
3.3 Manual Release Point............................................................................................................32
3.4 Operating devices ..................................................................................................................32
3.5 Detection, alarm and control systems, indicating equipment, warning devices....................32
3.6 Fire Alarm...............................................................................................................................32
3.7 Operation in Fire Situation.....................................................................................................33
3.8 Post-fire procedure...............................................................................................................33
SECTION 4 SYSTEM COMPONENTS  34

SECTION 5 SYSTEM INSTALLATION  36

5.1 Prior to installation............................................................................................................... 37
5.2 Spacing and Location .......................................................................................................... 37
5.3 Mounting Methods ............................................................................................................. 38
5.4 Electric Wiring .................................................................................................................... 40

SECTION 6 SYSTEM MARKINGS  44

6.1 Pyrogen Product Label ....................................................................................................... Error! Bookmark not defined.
6.2 Pyrogen Warning & Instruction Signs .............................................................................. 46

SECTION 7 SYSTEM COMMISSIONING  47

SECTION 8 SYSTEM MAINTENANCE  50

SECTION 9 SAFETY MEASURES  A2

9.1 Personnel safety .................................................................................................................. A3
9.2 Potential hazards ................................................................................................................ A4
9.3 Re-entry ............................................................................................................................. A4
9.4 Clean-up .............................................................................................................................. A4
9.5 Hot Work ............................................................................................................................ A5
9.6 Storage and Transportation ............................................................................................... A5

SECTION 10 SYSTEM SERVICE LIFE  A6

10.1 Definitions of shelf and service life ................................................................................ A7
10.2 System service life ............................................................................................................. A7

APPENDIX 'A' APPROVAL DOCUMENTATION A8

Form 1 Marine System Design Approval Certificate ................................................................. A9
Form 2 Marine Commissioning & Acceptance Testing .......................................................... A12
Form 3 Notice of Completion ................................................................................................ A15
Form 4 Maintenance Checklist .............................................................................................. A16
Form 5 Annual Maintenance Certificate ................................................................................ A17
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 1
GENERAL
SECTION 1. GENERAL

1.1 Terminology

The following definitions apply to this document:

**Actuating mechanism**: automatic or manual activation leading to the physical discharge of the extinguishant.

**Aerosol**: an extinguishant consisting of finely divided solid particles and gaseous matter, these being combustion products of solid aerosol-forming composition.

**Aerosol generator**: same as Pyrogen generator

**Aggressive environment**: where environmental variables such as temperature and/or vibration undergo cycling at or close to the extreme limits of the Pyrogen generator. Corrosive atmosphere may also be a factor.

**Appropriate authority**: a Minister of the Crown, a government department, or other public authority having power to issue regulations, order or other instructions having the force of law in respect of any subject covered by a British Marine Standard or, in the case where none of these apply, the owner or the owner’s agent.

**Approved and approval**: approved by, or the approval of, the appropriate Marine authority.

**Automatic**: performing a function without the necessity of human intervention.

**Automatic/Manual Switch**: a device that can be operated before a person enters a space protected by Pyrogen fire suppression system to prevent automatic release of fire extinguishing aerosol. Normal detection sequence is unaffected.

**Class A fires**: fire involving solid materials, usually of organic nature. Can be further categorised into surface burning fires and deep-seated fires. Deep-seated fires smoulder and maycombust slowly beneath the surface of the hazard.

**Class B fires**: fires involving liquids or liquefiable solids, fats and cooking oils.

**Class C fires**: fires involving gases.

**Class E fires**: electrically energised fuels.

**Combustion reaction**: a reaction resulting from the ignition of a solid aerosol-forming composition, which produces fire extinguishing aerosol.

**Control device**: a device to control the sequence of events leading to the release of the extinguishant.

**Coolant**: a heat absorbing medium.

**Design concentration (g/m^3)**: the mass of Pyrogen aerosol per m^3 of enclosure volume required to extinguish a specific type of fire, including a safety factor.

**Design Factor (g/m^3)**: the mass of Pyrogen solid aerosol-forming composition per m^3 of enclosure volume required to achieve the design concentration.

**Design quantity**: the mass of Pyrogen solid aerosol-forming composition necessary to extinguish a fire in a particular risk, including a safety factor.

**Extinguishant**: aerosol produced from Pyrogen generator.
**Generator:** same as Pyrogen generator.

**Holding time:** the period during which the extinguishant is required to maintain a minimum effective concentration.

**Hot Work:** grinding, welding, thermal or oxygen cutting or heating and other related heat-producing or spark-producing operations.

**Inerting:** the prevention of ignition of a flammable or explosive atmosphere by establishing a suitable concentration of extinguishant.

**Location drawing:** a plan of the risk clearly indicating the as-installed location of all Pyrogen generators, controls and maintenance isolate switch.

**Manual:** requiring human intervention to accomplish a function.

**Monitoring:** the supervision of the operating integrity of an electrical control feature of a system.

**Normally occupied area:** an area where, under normal circumstances, humans are present.

**Normally unoccupied area:** an area that is not occupied by humans under normal circumstances but may be entered occasionally for brief periods.

**Unoccupiable area:** an area that is not occupied by humans under any circumstances.

**Operating device:** any component involved between actuation and release.

**Primary release:** release of extinguishant initiated by detection system or manual operation under normal conditions.

**Pyrogen generator:** a device capable of generating the Pyrogen aerosol extinguishant when activated either electrically or thermally. Consists of an electrical and/or thermal activation device, solid aerosol-forming element and coolant element enclosed within a corrosion-resistant casing incorporating an end-plate nozzle.

**Release:** the action leading to the physical discharge or emission of the extinguishant into the enclosure.

**Shall:** indicates that a statement is mandatory.

**Should:** indicates a recommendation.

**Smouldering:** slow combustion of material without visible light and generally evidenced by smoke and an increase in temperature.

**Solid aerosol-forming composition:** a mixture of combustible component, potassium salt based oxidant and technical admixtures producing fire-extinguishing aerosol upon ignition.

**System isolate switch:** see Automatic/Manual switch.

**Thermal activation device:** a device, which automatically activates at a rated temperature or when exposed to a naked flame and is arranged to activate the solid aerosol forming element.

**Total flooding system:** a fixed fire suppression system, which distributes the extinguishing medium throughout the protected enclosure.
1.2 Pyrogen Product Standards/Testing

Standards/Testing on Pyrogen include the following bodies:

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<th>Description</th>
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| Australian/New Zealand Standard     | AS/NZS 4487:1997 Standard for Pyrogen Fire Suppression Systems  
| US EPA                              | Listed under SNAP program for total flooding applications in normally unoccupied areas.                                                                                                                                                                                                                                                     | 21 July 1995 |
| CEN/TC 191/WG 6 N 368               | Fixed firefighting systems – Condensed aerosol extinguishing systems – Part 1: Requirements and test methods for components (WI 00191148)  
| NFPA 2010                           | Standard For Fixed Aerosol Fire Extinguishing Systems                                                                                                                                                                                                                                                                                    | July 2005  |
| CSIRO Australia Listing under ActivFire Register | afp1781 Listing                                                                                                                                                                                                                                                                                                                        | Oct.2005   |

1.3 What is Pyrogen?

Pyrogen is a self-generated Aerosol Fire Extinguishing Agent.

The principle of extinguishing action employed by Pyrogen is unique - a special solid chemical, when electrically or thermally activated, produces combustion products - micron sized dry chemical particles and gases. Dry chemical particles - mainly potassium carbonates, and gases - mainly carbon dioxide, nitrogen and water vapour, mix together into uniform aerosol, which represents an actual extinguishing medium.

Before being released into a protected area, the aerosol propels itself through a solid chemical element, which decomposes absorbing heat, thus ensuring a low temperature discharge and uniform distribution of the aerosol within the area.

As aerosol is self-generated it requires *no pressure cylinders* and does not need to be stored. The aerosol generating chemical reaction in itself provides a sufficient propellant force to ensure rapid discharge and efficient distribution of the aerosol. *No piping is required.*

The solid aerosol-generating element, together with the solid chemical element and activation devices is contained in a small non-pressurised canister with one or two end-plate delivery nozzles. The canisters are called EXA generators and vary in size depending on the mass of solid aerosol-generating element contained in the generator.

EXA canisters are very compact and normally placed inside the protected enclosure.

Operation of the generator is either electrical automatic, electrical manual or thermal automatic.

When an electric current/impulse is applied to the electric activation device, the solid aerosol-generating element undergoes a chemical reaction of combustion to produce Pyrogen aerosol. The aerosol propels itself through the chemical element and out of the delivery nozzle into the protected area.
Pyrogen aerosol is whitish gas-like medium that is close in density to air. Small particle size ensures three-dimensional distribution qualities and long suspension times.

**Pyrogen aerosol is non-conductive and non-corrosive.**

As Pyrogen aerosol stays in suspension for extended periods, it can be removed from the protected area by any airflow. Solid fraction of the aerosol that has settled can easily be brushed, blown or washed away.

### 1.4 Pyrogen Chemical Identity

The secret to Pyrogens' power is in two unique formulations contained in Pyrogen canister - the solid aerosol-generating element and the solid chemical element.

The solid aerosol-generating element is a thermoplastic mixture consisting of an oxidiser, a combustible binder and technological additives. The oxidiser is a solid potassium nitrate (KNO$_3$), the combustible binder is an organic polymer (C$_n$H$_m$N$_p$O$_q$) and technological additives include the activator of the oxidiser's decomposition, chemical and mechanical stabilisers and some other ingredients.

When ignited the solid-generating chemical undergoes a combustion reaction, which can schematically be represented as follows:

$$KNO_3 (s) + C_nH_mN_pO_q (s) = KHCO_3 (s) + K_2CO_3 (s) + CO_2 (g) + N_2(g) + H_2O (g)$$

Combustion products consist of potassium carbonates (KHCO$_3$, K$_2$CO$_3$), carbon dioxide gas (CO$_2 (g)$), nitrogen gas (N$_2 (g)$) and water vapour (H$_2$O$_g$) and represent the actual extinguishing agent.

As the reaction temperatures are high, potassium carbonates are formed in the gas phase, but as the vapour cools, the potassium carbonates condense to a liquid and then a solid. As solid potassium carbonates are produced by condensation, the particle size is very small - approximately from 1 to 10 microns. Micron sized solid particles mix with the gaseous carbon dioxide, nitrogen and water into a uniform homogeneous gas-like phase - an aerosol.

Thus, Pyrogen extinguishing aerosol is a suspension of the micron sized solid particles, mainly potassium carbonates, in the gas mix of carbon dioxide, nitrogen and water vapour.

Being a combustion product of the aerosol-generating chemical, Pyrogen aerosol is hot upon formation. Although, Pyrogen aerosol is the most effective in terms of the actual fire extinguishment when in its hottest state, the negative impacts of very high temperatures are obvious.

That is where a second unique formulation - the natural coolant - comes into action.

When the hot Pyrogen aerosol passes through the cooling element, the coolant decomposes absorbing heat.

Pyrogen cooling element is a special composition highly impregnated with endothermic ingredients - substances that decompose at 200-300 °C without melting generating gases and absorbing approximately 400 Cal of heat per one kilogram of their mass.

Application of the Pyrogen cooling element provides uniform distribution of the aerosol within the area, which certainly contributes to the reliability and safety of the extinguishment. Moreover, additional amounts of inert gases are formed due to a thermal decomposition of the coolant, which contribute to the effectiveness of the extinguishment.
PYROGEN GENERATOR : CONSTRUCTION

Diagram 1-1
1.5 Pyrogen Extinguishing Action

*Pyrogen aerosol is an exceptional fire suppressant.*

Pyrogen extinguishing action is achieved primarily by interfering chemically with the fire reaction. Two chemical mechanisms can be underlined:

1. **Removal of fire propagation radicals** - “chain carriers” OH, H and O from the fire zone:

As it has been mentioned above, the main component of Pyrogen aerosol - potassium carbonates - are formed in the gas phase. In the flame zone they dissociate producing potassium radicals K. Potassium radicals are very active and react with so called “chain carriers” OH, H and O – active radicals responsible for supporting a fire combustion reaction - removing them from the fire zone, and as such disrupting the fire reaction.

The chemical action of potassium radicals in Pyrogen is similar to that of bromine radicals in Halons and can be schematically represented as follows:

\[
\begin{align*}
K + OH &= KOH \\
KOH + H &= K + H_2O
\end{align*}
\]

2. **Recombination of fire propagation radicals** - “chain carriers” OH, H and O on aerosol particles surface:

Gaseous potassium carbonates condense to a liquid and then a solid form producing a large number of micron sized particles. Being so small, the particles produce a large surface area, where recombination of “chain carriers” takes place:

\[
\begin{align*}
O + H &= OH \\
H + OH &= H_2O
\end{align*}
\]

Secondarily, Pyrogen extinguishing action is achieved by lowering fire temperature to a temperature below which the fire reaction cannot continue (thermal cooling). Several physical mechanisms can be underlined:

1. **Heat absorption** via endothermic phase changes:

\[
K_2CO_3 (s) \rightarrow K_2CO_3 (l) \rightarrow K_2CO_3 (g)
\]

2. **Heat absorption** via endothermic decomposition reaction:

\[
2KHCO_3 (s) \rightarrow K_2CO_3 (s) + CO_2 (g) + H_2O (g)
\]

3. **Dilution of the fire combustion zone by the aerosol cloud** (additional fuel molecules cannot participate in the combustion process); **physical hindrance to flame propagation** (aerosol particles slow down velocity of a flame front propagation) and etc.

The extremely high surface area of the micron-size aerosol particles increases the likelihood of radical recombination and heat absorbing reactions, thus ensuring rapid extinguishment with a small amount of agent.

*Pyrogen has the lowest extinguishing concentration known among commercially available agents* - flammable liquids (class B fires) are extinguished at the design factor of 100 g/m³ compared to 330 g/m³ for Halon 1301.
The high rate of aerosol discharge ensures a tremendous knockdown effect. Micron sized aerosol particles exhibit gas-like three-dimensional qualities that allow the agent to rapidly distribute throughout enclosure and reach the most concealed and shielded locations. Homogeneous distribution is achieved in a matter of seconds, while long holding times all help to prevent fire re-ignition.

Pyrogen aerosol is suitable for the protection of a variety of potential fire hazards, including those involving flammable liquids, combustible solids, oils and energised electrical equipment.

Like all total-flooding agents, Pyrogen aerosol is most effective when used in an enclosed risk areas.
1.6 Pyrogen Applications

Pyrogen may be used as a total flooding fire suppressant for unoccupiable and normally unoccupied areas to fight fires of classes A, B, C and E.

For class C fires consideration should be given to the use of vapour detection, explosion venting or explosion suppression systems where an explosion potential may exist, owing to the possible presence of gaseous, volatile or atomised fuels either before or following a fire. It may be dangerous, under certain conditions to extinguish a burning jet of flammable gases without first shutting off its supply.

The design factor required to suppress normal fires involving flammable gases and liquids at atmospheric pressure shall apply if it can be shown that a potentially explosive atmosphere cannot exist in the enclosure either before or as a result of the fire.

The minimum design factor for Classes C and E fire hazards shall be determined by test as part of a listing program.

An unoccupied area is an area that is not occupied by humans under any conditions.

A normally unoccupied area is an area that is not occupied by humans under normal circumstances but may be entered occasionally for brief periods.

**Total Flooding Applications:** May be used where the hazard is within an enclosure that will permit the establishment of the required concentration and the maintenance of that concentration for the required period, for example, for-

- **Marine:** machinery spaces, engine rooms.
- **Transport:** engine compartments.
- **Aviation:** aircraft dry-bays, cargo compartments, engine nacelles.
- **Marine:** enclosed flammable liquid storage, storage tanks & processing areas.
- **Industrial:** enclosures such as rooms, warehouses, garages, control rooms, engine rooms, vaults.
- **Equipment:** enclosed machines, data processing equipment, mining equipment.
- **Electrical:** enclosed electrical hazards such as power stations, transformers, control cubicles, electrical cabinets, switchboards, circuit breakers & rotating equipment.

**Pre-engineered Packaged Systems:** Designed and tested for a specific application.

- **Modular package system:** up to 10 m³.
- **Four wheel drive package system:** up to 3 m³.
- **Marine package system:** up to 20 m³ with dedicated electrical manual release panel.
1.7 Limitations of Use:

Pyrogen systems are not suitable for fires involving the following:

- Certain chemicals or mixtures of chemicals such as cellulose nitrate and gunpowder, which are capable of rapid oxidation in the absence of air.
- Reactive metals such as sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium.
- Metal hydrides or metal amides.
- Chemicals capable of undergoing auto-thermal decomposition such as certain organic peroxides and hydrazine.
- Pyrophoric materials such as white phosphorous or metal-organic compounds.
- Oxidising agents such as nitric oxides and fluorine.

Limitations on Temperature of Discharge

- Temperature at the specified minimum clearance form the nozzle shall not exceed 75°C for locations where people may be present;
- Temperature at the specified minimum clearance form the nozzle shall not exceed 200°C for locations containing combustible materials.
- Temperature at the specified minimum clearance form the nozzle shall not exceed 400°C for locations containing non-combustible materials.

For other limitations please refer to Section 2.10 Design Limitations and Section 5.2 Spacing and Location.

Non Enclosed and Local Applications

Where a fire hazard requires a local application, due to the protected area being an open space or one with high leakage rates, special application and engineering of the Pyrogen product will be required. In these instances the local main Pyrogen office should be contacted.

Electrical Machinery/Equipment:

In the event of fire due to electrical hazards, power to the electrical machinery/equipment must be cut-off prior to operation of the fire protection system for effective suppression of fire.
1.8 Pyrogen Safety Data

Visibility: Pyrogen is intended to be used in unoccupiable and normally unoccupied areas. For occupied areas proper instruction for human evacuation shall be incorporated into the design, principally due to the high obscuration caused by the aerosol during and after discharge.

Oxygen Levels: Pyrogen chemically attacks the fire, breaking the flame chain reaction. It does not extinguish fires by oxygen depletion. After discharge, oxygen levels will remain at or about normal.

Toxicity: Inadvertent exposure to Pyrogen aerosol should always be avoided. Toxicological information refers to an inadvertent exposure to the aerosol in the event of accidental discharge in a non-fire situation.

The main ingredients of the Pyrogen aerosol are solid potassium carbonates, nitrogen gas, carbon dioxide gas and water vapour. At normal extinguishing concentrations these products present little health hazard to personnel. However, small amounts of potentially hazardous by-products of the aerosol-generating combustion reaction, such as carbon monoxide and nitrogen oxides will be produced. Their actual concentrations depend on Pyrogen design factor used and type of enclosure under protection. Their toxicological characteristics depend upon the actual concentrations achieved and duration of exposure.

Exposure to a Pyrogen design factor of 100 g/m$^3$, which is typical for class B fires in total flooding applications, for up to 15 minutes, is normally considered to represent a minor risk to personnel and may cause only moderate local irritation of the upper respiratory tract and to the eyes.

Post Fire Exposure: Safety requirements dictate, that unnecessary exposure to post-fire atmospheres should be avoided. CAUTION! Venting of the post-fire atmosphere should be to an open-air area, where possible, to prevent the inadvertent exposure of personnel to any combustion products of the fire and aerosol-generating reaction.

Thermal Hazard: There is a potential hazard of high temperatures (150°C+) of Pyrogen aerosol at the end-plate nozzle, but within the minimum clearance (Xm) from the discharge nozzle as specified for every type of EXA generator for locations where humans may be present, the temperature does not exceed 75°C. Those distances should be observed during installation. For further information please see Section 2.11.

Immediately after discharge the generators can be hot, therefore, protective gloves should be worn before handling generators up to 15 minutes after discharge.
**Hot Work:** As naked flame or prolonged exposure to temperatures above 400°C may cause activation of the generators, **hot work must not be carried out within the vicinity of any generator.** If so they shall be removed prior to any hot work being carried out.

**Re-entry:** Following the use of Pyrogen, **personnel should not enter the protected area until it has been thoroughly ventilated.** Exposure to the fire by-products and extinguishant mixture should be avoided. Wearing a respirator or other available means of protection may be required should it be necessary to enter the area before it is fully ventilated.

**Clean-up:** Following a system discharge the aerosol particles that have settled should be vacuumed, blown, brushed or, if appropriate, washed away. **Protective gloves and goggles should be worn.** A respirator or mask should be worn.

Large amounts of residue that is allowed to absorb moisture may become electrically conductive over a period of time.

**Dangerous Goods Classification:** Pyrogen is a Class 4.1 article in accordance with the United Nations Dangerous Goods Classification Code.

**CoSHH Statement:** A by-product of Pyrogen aerosol-generating combustion reaction are fine potassium carbonate particles, small enough to be respired by persons not wearing RPE. **There are no known toxicological long term effects** of these soluble micron sized particles, and physiological effects of deep lung penetration are usually a concern for insoluble sub-micron particles as they can interfere with pulmonary functions.

However, there are clear European guidelines controlling the exposure of persons to fine particles, irrespective of their nature. Further information is available in BS EN 481:1993 & BS EN 451:1993, and in CoSHH supportive documents EH40/98 & EH44 and MDHS 14/2.

**Noise.** The sound output & frequency at the time of activation and during discharge is similar to that produced by other extinguishing agents. Consequently, no specific precautions need to be taken.
1.8 Pyrogen Environmental Characteristics

*Pyrogen does not affect earth’s ozone layer*, since it does not contain chlorine or bromine in its molecular structure.

Ozone Depleting Potential (ODP) is a calculated ozone depletion per unit mass of material released relative to a standard, normally CFC-11 (CCl₃F).

**Ozone Depleting Potential (ODP) of Pyrogen is zero.**

Contribution of Pyrogen to global warming is negligible, since the only component that could contribute to global warming - carbon dioxide - is present in minor quantities at normal extinguishing concentrations.

Global Warming Potential (GWP) is a calculated change in warming resulting from the emission of a unit mass of a chemical relative to that of a reference. In the past CFC-11 was often used as a reference; carbon dioxide is now typically used.

The GWP depends on three variables:

1) the integrated infrared radiation absorption spectrum band strength.

2) the location of the infrared bands; and

3) the atmospheric lifetime

**Global Warming Potential (GWP) of Pyrogen relatively to carbon dioxide is zero.**
1.9 Pyrogen Technical Characteristics

**Chemical Composition of Solid Aerosol-generating Chemical**


**Chemical Composition of Aerosol**


**Min System Design Factor**

- class B and surface class A fires: 100 g/m³
- dense cable fires: 100 g/m³

**Min Particle Size**

- 1 micron

**Min/Max Suspension of Aerosol**

- 30 / 60 min

**ODP**

- 0

**GWP**

- 0

**Obscuration**

- high

**Toxicity**

- low

**Temperature range of application**

- from -50°C to +65°C (EXA)
- from -50°C to +85°C (EXA-M)

**Humidity range of application**

- 0-98 %, non-condensing

**Electric ignition:**

- nominal resistance: 0.6 – 5.0 Ohms
- activation current: 400 milliamps
- maximum test current: ≤ 50 milliamps / 5 min
- supervisory current: less than 5 milliamps
- actuation time: 2 milliseconds

**Dangerous Goods Classification**

- 4.1 class, category C

**Service Life**

- 7 - 10 years
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 2:
SYSTEM DESIGN FOR MARINE APPLICATIONS
SECTION 2. SYSTEM DESIGN FOR MARINE APPLICATIONS

IMPORTANT! CARE SHOULD BE TAKEN TO PREVENT ANY POSSIBILITY OF PERSONNEL EXPOSURE TO THE HIGH INITIAL CONCENTRATIONS OF PYROGEN AEROSOL.

2.1 General

The Pyrogen system of aerosol generators distributed within the risk eliminates the complications associated with traditional gaseous agent systems. *Pyrogen does not require pressurised cylinders of liquefied gas, traditional pipe and nozzle networks, or engineered hydraulic calculations to determine nozzle orifices.*

The Installer only needs to determine the size and number of Pyrogen generators required as well as their location within the enclosure. A System Design Approval Certificate has been included in Appendix A (Form 1) which gives a step by step guide on how to carry out these simple design calculations.

2.2 Design Methodology

The outline for the design of a Pyrogen Marine fire suppression system generally involves the following at a minimum:

1. Identify all possible hazards within the protected enclosure. Please refer to Section 1.7 for the list of fire hazards/fuel types that are unsuitable for use with Pyrogen. For fire hazards/fuel types not covered in Section 1.7, please refer the query to an Authorised Pyrogen representative.

2. Identify possible points of agent loss within the protected enclosure

3. Determine volume of the protected enclosure. Identify if the required coverage extends to the ceiling void and/or raised floor and determine the protected volume for these.

4. Calculate the quantity of agent required for the hazard and fuel type within the enclosure. Factors such as non-closable openings, forced ventilation, low altitude, low temperature and other conditions may affect the quantity of agent required.

5. Select the model and quantity of generators required to achieve the minimum design quantity.
2.3 Design Factor

Pyrogen design calculations refer not to the design concentration of the actual extinguishing agent, aerosol, but to the design factor, which is the mass of solid aerosol-generating element per unit of enclosure volume required to extinguish a specific type of fire, including a safety factor.

- Pyrogen design factor is expressed in g/m$^3$.
- Pyrogen minimum design factor for Class B fires, involving flammable liquids such as petrol, diesel, hydraulic oil and automotive distillate is 100 g/m$^3$.
- Pyrogen minimum design factor for Class A surface fires, involving non-smouldering combustible solids such as wood, textile and ordinary plastic is 100 g/m$^3$.
- Pyrogen minimum design factor for Class A non-surface fires, involving dense cables is 200 g/m$^3$.
- Pyrogen design factor of 100 g/m$^3$ has been accepted for marine applications in machinery spaces.

Advice from Pyrogen Corporation or authorised Pyrogen Representative should be sought for any fire/fuel type not covered by the above minimum design factors.

2.4 Enclosure Volume

Please note that enclosure volume for marine applications refers to the gross volume of the machinery space.

If a compressed air vessel is fitted in the machinery space, the gross volume must always be included for the free air volume of the air vessel. The free air volume is the volume of air at atmospheric pressure (1 Bar). It is calculated by using the following formula:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

The $T_1$ and $T_2$ cancel out and $P_2$ is always 1 Bar absolute for this calculation.

The formula can now be re-arranged and reduced as:

$$V_2 = P_1 V_1$$

Where

- $V_2$ = volume of free air in m$^3$ at 1 Bar;
- $P_1$ = absolute pressure which is the gauge pressure on the compressed air vessel at 20 C plus 1 Bar;
- $V_1$ = volume of compressed air in the vessel at $P_1$.
Example: If the compressed air vessel stores 2m$^3$ of air at 8 Bar gauge at 20C, what is the volume of free air?

\[ V_2 = P_1 \cdot V_1 \]

\[ P_1 = 8 + 1 = 9 \text{ Bar}; \quad V_1 = 2m^3, \quad \text{therefore} \quad V_1 = 9 \times 2 = 18m^3 \text{ of free air.} \]

In determining the machinery space gross volume, the Naval architect responsible for the vessel's design should be consulted. However, if this information is not available, refer to the Maritime Authority System Design Approval Certificate (Form 1) in this manual, which gives a guide in determining gross volume and quantity of extinguishing agent.

2.5 Design Quantity

For normal total flooding applications based on a static volume enclosure with all openings sealed and all ventilation systems shut down prior to Pyrogen discharge, the total flooding quantity is determined as follows:

\[ \text{Total Flooding Quantity (g)} = \text{Design Factor (g/m}^3\text{)} \times \text{Enclosure Volume (m}^3\text{)}. \]

Total Flooding Quantity refers to the total mass of solid aerosol-forming composition required to suppress fire in a given volume, including safety factor.

2.6 Number of EXA generators

For normal total flooding applications based on a static volume enclosure with all openings sealed and all ventilation systems shut down prior to Pyrogen discharge, the number of EXA generators is determined as follows:

\[ \text{Number of EXA} = \frac{\text{Total Flooding Quantity (g) [as calculated in Section 2.5]}}{\text{The mass of the solid aerosol-forming composition in one EXA generator}} \]

The above calculation refers to the same size of EXA generators only. However, different sizes of EXA generators may be selected, in which case the total mass of aerosol-forming composition shall be not less than the Total Flooding Quantity.

Please refer to Section 2.7 for a complete list of Pyrogen EXA generators available.
The type of EXA generator selected is typically based on several considerations as follows:

1. **Height of Protected Enclosure:** EXA generators chosen must be appropriate for the height of the protected enclosure. Please refer to Section 2.10 for the height limitation list.

2. **Minimum Clearance:** minimum clearance is an essential criteria to ensure that the possibility of damage due to heat of the discharge is minimised. Please refer to Section 2.10.

3. **Distribution of Aerosol:** Although Pyrogen aerosol has the three-dimensional distribution of a gas, the even and rapid attainment of the minimum extinguishing concentration throughout the protected enclosure would obviously be desirable. E.g. In applications such as the protection of cable ducts and trenches, which are typically long and narrow, it would be appropriate to select several smaller units and spread them out evenly along the protected volume although one large unit may fulfil the agent quantity requirement.

4. **Mounting Locations:** Certain protected enclosures may have very specific permissible mounting locations. This may influence the quantity and orientation of the units selected.

5. **Cost Factors:** The price/m³ of the different EXA units may differ. The best cost option without sacrificing technical requirements are the elements of good design.
2.7 Pyrogen Range

Pyrogen comes in a series of small non-pressurised canisters with one or two end-plate delivery nozzles. The canisters are called EXA/EXA-M generators and vary in size depending on the mass of solid aerosol-generating chemical contained in the generator. EXA-M series have been specially developed for –M industries (Marine, Mining, Military and Machinery) and feature extended application temperature range (up to 95°C), resistance to high humidity and vibration levels and “heavy-duty” execution. Technical parameters of the current range of EXA/EXA-M generators are as follows:

### TABLE 2-1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>EXA</th>
<th>GENERAL SERIES</th>
<th>M-SERIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Z3</td>
<td>Z6</td>
<td>1</td>
</tr>
<tr>
<td>1. Mass of generator, g</td>
<td>325</td>
<td>650</td>
<td>750</td>
</tr>
<tr>
<td>2. Mass of aerosol-forming element, g</td>
<td>20</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>3. Max protected volume m³</td>
<td>0.2</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>4. Nozzle outlet</td>
<td>Bi</td>
<td>Mono</td>
<td>Mono</td>
</tr>
<tr>
<td>5. Length of generator, B (mm)</td>
<td>173</td>
<td>88</td>
<td>117</td>
</tr>
<tr>
<td>6. Diameter of generator, A (mm)</td>
<td>32</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>7. Discharge time, s</td>
<td>&lt;5.0</td>
<td>&lt;10.0</td>
<td>&lt;15.0</td>
</tr>
</tbody>
</table>

1 Based on Design Factor of 100g/m³
Diagram 2-1

Diagram 2-1: Typical Construction of Pyrogen Generators
EXA-20, EXA-30, EXA-50

FRONT VIEW

SIDE VIEW

A (see table page 25)

B (see table page 25)

50 mm
Diagram 2-2: Typical Construction of Pyrogen Generators
EXA-M-02, EXA-Z3, EXA-M-06, EXA-Z6, EXA-ML-1, EXA-MS-1, EXA-1,
EXA-M-2, EXA-2, EXA-M-5, EXA-5, EXA-M-10, EXA-MB-10 & EXA-10
2.8 Minimum Holding Time

Upon Pyrogen discharge a minimum holding time of 3 minutes should be allowed for fires involving flammable liquids (class B fires) and non-smouldering combustible solids (class A surface fires).

_For fires involving electrical cables and smouldering solids the minimum holding time should be extended to 10 minutes._

2.9 Enclosure Requirements

The area of non-closable openings shall be kept to a minimum. The presence of unclosable openings in the ceiling should be avoided. _The total area of unclosable openings should not exceed 1% of the total area of the protected enclosure._

_Air-handling systems serving the protected area should generally be shut down or isolated by dampers._

Any services within the enclosure, such as fuel valves and pumps, heating appliances and others which if left running would impair the efficiency of Pyrogen, shall be shut down prior to or simultaneously with the release of the extinguishant.

For tight enclosures, venting of an enclosure may be necessary to relieve pressure build-up due to the discharge of large quantities of extinguishant.

Venting requirements refer to large EXA units only and are as follows:

<table>
<thead>
<tr>
<th>EXA model</th>
<th>Minimum venting area, cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXA-20</td>
<td>70</td>
</tr>
<tr>
<td>EXA-30</td>
<td>100</td>
</tr>
<tr>
<td>EXA-50</td>
<td>150</td>
</tr>
</tbody>
</table>

Minimum venting area includes existing natural gaps, ventilation outlets and etc. Where additional pressure relief venting is required the installed vents should be of an appropriate type, such as closeable flaps, and suitably located to ensure maximum possible containment of Pyrogen aerosol within the enclosure during and after discharge.
2.10 Design Limitations

Height Limitations

The Pyrogen extinguishant, being a hot aerosol, has a tendency to rise upward on its release due to buoyancy forces. As such, the aspect of spatial distribution needs to be addressed.

This requires that a height limitation for the protected enclosure be set for each individual Pyrogen generators:

<table>
<thead>
<tr>
<th>Table 2-4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENERAL SERIES</strong></td>
</tr>
<tr>
<td>EXA-Z3</td>
</tr>
<tr>
<td>1 m</td>
</tr>
</tbody>
</table>

| **M-SERIES** |  |
| EXA-M-02 | EXA-M-06 | EXA-ML-1 | EXA-ML-2 | EXA-M-2 | EXA-M-5 | EXA-M-10 | EXA-MB-10 |
| 1 m | 1.25m | 2.0m | 2.5m | 2.5m | 3.0m | 3.5m | 3.5m |

For large enclosures where several generators are distributed evenly throughout the area, the total height shall not exceed the height limitations for a single generator, unless uniformity of the aerosol distribution within accepted time period has been proved for the greater height by a discharge test.

Minimum clearances

Due to a potential hazard of high temperatures (100-150°C) of Pyrogen aerosol at the end-plate nozzle, the minimum clearances from the discharge nozzle for each type of EXA generator should be observed during installation. The below minimum clearances refer to the locations where people may be present and where therefore temperature at the minimum clearance should not exceed 75°C.

<table>
<thead>
<tr>
<th>Table 2-5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENERAL SERIES</strong></td>
</tr>
<tr>
<td>EXA-Z3</td>
</tr>
<tr>
<td>EXA-Z6</td>
</tr>
<tr>
<td>EXA-1</td>
</tr>
<tr>
<td>EXA-2</td>
</tr>
<tr>
<td>EXA-5</td>
</tr>
<tr>
<td>EXA-10</td>
</tr>
<tr>
<td>EXA-20...EXA-50</td>
</tr>
</tbody>
</table>

| **M-SERIES** |  |
| EXA-M-02 | 150mm |
| EXA-M-06 | 300mm |
| EXA-ML-1 | 400mm |
| EXA-MS-1 | 400mm |
| EXA-M-2 | 700mm |
| EXA-M-5 | 700mm |
| EXA-M-10 | 1000mm |
| EXA-M-B10 (at each end) | 700 mm |
2.11 Pyrogen Discharge

Pyrogen aerosol extinguishes the fire chemically by reacting with the flame chain carriers and thereby interfering with the process of combustion. (Please refer to Section 1.5 for a full treatise on the process of flame extinguishment). As Pyrogen does not rely on halogen compounds to react with the flame, it does not produce corrosive halogen-acid by-products when in contact with flame.

In order to minimise damage due to the fire, however, the system should be designed to attain its design concentration within the shortest time possible upon actuation of the aerosol generators. An important factor to achieving a rapid and even distribution of the extinguishant depends upon the placement/distribution of the Pyrogen generators within the protected enclosure.
MARINE FIXED
AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 3:
SYSTEM OPERATION
SECTION 3. SYSTEM OPERATION

Operation of Pyrogen EXA generator is either electrical automatic, electrical manual or thermal automatic. Please note that normally marine fire suppression systems are operated manually only. Please refer to your local Marine Authority for other operation options you may have available for a specified vessel.

3.1 Electrical manual operation

Electrical manual operation is performed electrically by operating a manual release point located outside the protected enclosure.

3.2 System isolate switch

The discharge of Pyrogen generators in the electrical manual operation mode shall be capable of being prevented by means of a system isolate switch that shall be manually operated when personnel are present in the protected area or the adjacent area which could be rendered hazardous by the discharge of extinguishant.

The system isolate switch shall be situated outside the protected area or adjacent to the main exit from the area and protected from accidental operation.

While the system isolate switch is active and the discharge of the system is inhibited, the fire detection and alarm systems shall continue to function and the system shall return to full automatic control when the switch is reactivated.

The operation of the system isolate switch shall electrically isolate and earth each conductor of the wiring to the extinguishant discharge device and initiate a yellow or amber visual indicator at the Local Control Station and Control and Indicating Equipment. The purpose of this requirement is to provide a level of protection equivalent to a gas lock-off valve.

3.3 Manual Release Point

The manual release point must be fitted within an enclosure box. This enclosure box is to have a tamper switch fitted to the door, which raises an audible and visual evacuation alarm in the protected machinery space when the enclosure door is opened.

3.4 Operating devices

Operating devices such as system isolate switches and ancillary equipment, including shutdown equipment, dampers and door closures, required for successful system performance shall be considered integral parts of the system. All ancillaries shall incorporate manual reset facilities.

3.5 Detection, alarm and control systems, indicating equipment, warning devices

Automatic fire detection, alarm and control systems for Pyrogen as well as indicating equipment and warning devices shall comply with the standard requirements established for a specified risk.

3.6 Fire Alarm

The fire alarm is raised by a Fire Detection System and does not form part of this supply.

NOTE: Some Marine Authorities may not require a separate fire alarm from the audible and visual evacuation alarms provided in the machinery space. Other authorities may have different requirements, so each installing company should check with their local authorities.
3.7 Operation in Fire Situation.

In the event of fire and manual operation of the system, the sequence of events is as follows:

- Open the manual release point enclosure.
- The evacuation alarm will operate.
- Ensure all personnel have evacuated from the protected space.
- Shut down any ancillary machinery in the risk.
- Shut down the engine. This action may not be necessary if the air intake is taken from outside the protected space and the exhaust terminal is outside of the protected space.
- Close all vents and doors.
- Actuate the Pyrogen generators by operating the manual release system.
- After activating period, the aerosol will be generated and discharged within 3 to 10 seconds, depending on the size of EXA generator. The holding time for the design concentration shall be a minimum of 3 minutes.
- Report the incident.

3.8 Post-fire procedure

After the fire:

- Ensure first aid portable fire extinguishers are at hand.
- Ventilate the area / space by operating ventilation system or opening doors and vents to disperse the agent and fire combustion products. Avoid exposure to the fire by-products and extinguishant mixture.

NOTE: Wearing a respirator or other available means of protection should be required should it be necessary to enter the area before it is fully ventilated.

- Enter the area / space when it is clear of agent and fire by-products, to inspect and ensure that the fire is fully extinguished and there is no danger of re-flash from hot spots or damaged equipment.
- Inspect the area, machinery and equipment for any damage. Investigate the cause of the fire and repair if possible.
- Should any residue be left, blow, brush or, if appropriate, wash it away.

NOTE: Any residue that is allowed to absorb moisture may become electrically conductive.

- Start up the engine and check that all is correct.
- Start up ancillary equipment and machinery and check that all is correct.
- Report status.

Contact your Pyrogen Distributor for a replacement of EXA generators.
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 4:

SYSTEM COMPONENTS
SECTION 4. SYSTEM COMPONENTS

The Pyrogen Marine Fire Suppression System comes complete with EXA generators of a specified size/s, an electrical connector, mounting brackets, bracket supports, bolts and nuts.

Pyrogen EXA/EXA-M generators are made of marine grade aluminium-alloy or stainless steel and powder coated red. Generator’s mounting brackets are manufactured from mild steel and powder coated red. The EXA-Z3, EXA-Z6, EXA-1, EXA-2 and EXA-5 generators are supplied with one bracket for normal use, while the larger EXA-10 generators are supplied with two brackets.

Generators EXA-20-EXA-50 come without brackets as they have mounting clamps welded to their casings.

The Pyrogen generators have been designed to operate in a wide range of temperature and humidity conditions.
Operating temperature range for EXA generators is from -50 °C to + 65 °C.
Operating temperature range for EXA-M generators is from -50 °C to + 85 °C.
Operating humidity range is up to 98 % humidity.

Generators shall not be subjected, however, to severe weather conditions or to mechanical, chemical or other damage. Where excessive climatic or mechanical exposures are expected, suitable protection or enclosures shall be provided.

The following Pyrogen accessories are optional and designed to complete Pyrogen System Supply for specific installations, where other components besides those supplied by manufacturer may be required:

- **T-start device** - Designed for an automatic thermal detection of fire and subsequent automatic operation of Pyrogen generators. T-start does no require any external power supply;
- **Directional Nozzles** - Designed to constrict and direct the original aerosol flow in a specified application;
- **Fire Rated Cable** - Shall be used in Pyrogen electrical wiring to prevent shorting of circuitry in an event of fire as well as accidental discharge due to an induction or electromagnetic interference;
- **System Isolate Switch** - Designed for normally unoccupied areas. Is a guarded switch, which prevents a discharge of electrically operated Pyrogen generators. Operated manually. Located outside the protected area;
- **Pyrogen Signs** - Designed for normally unoccupied areas.

The following signs are available:
- Label displayed at the entrance to the enclosure;
- Instruction Label displayed inside the enclosure;
- System Isolate Switch Label;
- Instruction Label displayed at manual release point.

For more information on Warning and Instruction signs, please refer to Section 6.3.
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 5:
SYSTEM INSTALLATION
SECTION 5. SYSTEM INSTALLATION

5.1 Prior to installation

- **Integrity and resistance of the electric actuation circuit**

It is important that prior to the installation of EXA generators the integrity and resistance of the electric circuit for each EXA generator be checked with the use of a digital multi-meter. The maximum test current shall not exceed 50 milliamps for a period of 5 minutes. The monitoring current shall not exceed 5 milliamps.

Resistance of the electric activation circuit shall be within 0.6-5.0 Ohms.

It is also important to check earth fault of every EXA generator. Earth fault resistance must not be less than 0.1 MOhm.

5.2 Spacing and Location

Once the size and number of Pyrogen EXA generators have been determined, they should be securely mounted on to a bulk head or similar location, observing the following:

- **Even distribution**

*Generators should be evenly distributed within the risk area,* to achieve an unhindered distribution of the agent discharge.

- **Orientation of aerosol discharge**

Aerosol discharge should not be orientated across any route of exit.

Generators should be so oriented to reduce any potential thermal damage caused by hot generators and extinguishant discharge. There should be no flammable or highly combustible materials or equipment within a specified minimum clearance from the generator’s nozzle.

If there are any un-closable openings that cannot be avoided such as exits, doors and apertures, aerosol discharge should be directed across the likely fire zone and towards those openings, but not away from them.

- **Clear obstructions**

While Pyrogen aerosol is an extremely penetrating extinguishing agent, severe obstruction of the aerosol discharge pattern should be avoided. Several small generators may be preferable to one large generator, should design limitations for smaller units allow such a replacement. If it is not possible, the distance from the nozzle to the obstacle shall be not less than the specified minimum clearance.

In case of multiple obstacles the design factor shall be increased, such increase to be determined by preliminary tests conducted in the areas and spaces concerned.
**Environment**

Temperature range of application for EXA generators is from -50 \(^\circ\)C to +65 \(^\circ\)C.

Temperature range of application for EXA-M generators is from -50 \(^\circ\)C to +95 \(^\circ\)C.

Humidity range of application is up to 98 % humidity, non-condensing.

Generators shall not be subjected to severe weather conditions or to mechanical, chemical or other damage. Where excessive climatic or mechanical exposures are expected, suitable guards or enclosures shall be provided.

**5.3 Mounting Methods**

Pyrogen generators could be mounted in any orientation without affecting its aerosol-forming capability. It is important to bear in mind that the resultant aerosol being warm would tend to rise at the onset. Pyrogen has been tested successfully, however, in the lateral mounting position on the ceiling i.e. under a most unfavourable orientation. Please refer to Diagram 5-1 and 5-2.

![Diagram 5-1](image)

*Typical Mounting Layout - Horizontal Mount*
Diagram 5-2

Typical Mounting Layout - Within A Ceiling Void, Vertically Mounted
5.4 Electric Wiring

Up to ten Pyrogen generators may be connected on a single discharge circuit with one power source. Should more than ten generators be required for one enclosure, two circuits with two separate power sources should be used.

*Wiring between generators shall be by parallel configuration only.*

- **Cable**

  **Cables should be fire-resistant.** Conductors should be of copper, each having a cross-sectional area of not less than 1 mm², or if stranded, not less than 0.5 mm² should be used.

  The cable shall be screened and the care taken when the cable runs through a high frequency energy zone, such as a two-way radio, a sonar, etc.

  Should the cabling run alongside electric magnetic fields of high intensity, such as high voltage transformers in power substations or cable tunnels, the cables shall be enclosed into a steel conduit.

  Cable screen and steel conduit shall be grounded in accordance with standard requirements.

  Should there be any possibility of the mechanical damage, the cables shall be enclosed into a plastic or metal conduit.

- **Power Sources**

  A standard power source that provides at least 2 Amp current and 6 to 24 Volts voltage shall be used.

  The power source shall have a backup power supply of the same voltage. Where the backup power is shared with other devices, sufficient capacity for a minimum of 24 hour's standby condition, 1-hour alarm condition and thereafter, sufficient capacity remaining to discharge the generators shall be provided for.

- **Commissioning**

  1) Install electrical wiring;

  2) Install and connect such devices as audible and visual alarm devices, manual release points or automatic activation fire panel, heat or flame detectors, timer, etc;

  3) Connect miniature filament lamps with 12-24 Volts voltage and current up to 50mA *in place of EXA generators*;

  4) Ensure the manual release point or the automatic activation fire panel has been protected from the accidental discharge. Placing of a sign “Do not press. Device is under service” is recommended.

  5) Connect the circuit to a power supply;

  6) Activate the system. All devices shall operate and all lamps shall glow. Should the system fail to operate properly, disconnect the power supply, check connections between devices, reconnect the power supply and repeat.

  7) Reset the system. All lamps shall be switched off.
WARNING! Prior to connecting EXA generators ensure the wires leading to the generators are not carrying voltage. Connection of EXA generators should always be the last function in electrical wiring procedure.

8) Disconnect all of the lamps and connect the EXA generators in its place. Install EXA generators in accordance with installation recommendations.

9) Remove the sign on the manual release point or the automatic activation fire panel.
2RMDT Connector Assembly and Wiring for Pyrogen Connector

Diagram 5-4

From control panel
Rubber holder
Tightened with screws
Soldered
Note: Only pins 1 & 2 are utilized for connection
To Pyrogen generator
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 6:
SYSTEM MARKINGS
SECTION 6. SYSTEM MARKINGS

6.1 Pyrogen Product Label

Each Pyrogen EXA generators is complete with its product label stating vital information regarding the product. The general format is as follows:

![Pyrogen EXA/EXA-M-x Label](image)

- Mass of aerosol element: xx kg.
- Single use only – Non-refillable
- Classification: Class 4.1
- UN 3178: Hazchem 2[T]
- Do not disassemble or incinerate canister
- Contact your nearest distributor, or Pyrogen Technologies SDN. BHD. +(603) 5621 2211
- In case of emergency

**IN CASE OF EMERGENCY**

CONTACT YOUR NEAREST DISTRIBUTOR, OR PYROGEN TECHNOLOGIES SDN. BHD. +(603) 5621 2211
6.2 Pyrogen Warning & Instruction Signs

The following Warning and Instruction Signs shall be firmly attached to specified locations by the installer on completion of Pyrogen installation in normally unoccupied areas, where people may enter the enclosure for brief periods:

a) Label to be displayed at entrance to enclosure:

```
THIS AREA IS FITTED WITH A PYROGEN FIRE EXTINGUISHING AEROSOL SYSTEM

DO NOT ENTER
UNLESS THE FIRE SUPRESSION SYSTEM IS ISOLATED

AFTER AEROSOL DISCHARGE DO NOT ENTER
UNTIL AREA HAS BEEN THOROUGHLY VENTILATED
```

b) Label to be displayed inside enclosure

```
THIS AREA IS FITTED WITH A PYROGEN FIRE EXTINGUISHING AEROSOL SYSTEM

EVACUATE AREA ON SOUND OF ALARM

AFTER AEROSOL DISCHARGE DO NOT ENTER
UNTIL AREA HAS BEEN THOROUGHLY VENTILATED
```

c) Label to be displayed at System Isolate Switch

```
PYROGEN SYSTEM ISOLATE SWITCH

WARNING
CHECK THAT THE AREA IS CLEAR OF PERSONNEL BEFORE RE-ACTIVATING THE SYSTEM
```

d) Label to be displayed at Manual Release Point

```
PYROGEN FIRE EXTINGUISHING AEROSOL SYSTEM

MANUAL RELEASE POINT

ENSURE AREA IS EVACUATED BEFORE RELEASE OF PYROGEN AEROSOL
```
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 7:
SYSTEM COMMISSIONING
SECTION 7. SYSTEM COMMISSIONING

The completed Pyrogen installation shall be commissioned in accordance with Commissioning Checklist attached in Appendix A (Form 2).

On completion and acceptance of the commissioning procedure, the installation contractor shall issue a Notice of Completion in Appendix A (Form 3).

Commissioning should be carried out by trained and authorised personnel only.

- Commissioning

1) Install electrical wiring;

2) Install and connect such devices as audible and visual alarm devices, manual release points or automatic activation fire panel, heat or flame detectors, timer, etc;

3) Connect miniature filament lamps with 12-24 Volts voltage and current up to 50mA in place of EXA generators;

4) Ensure the manual release point or the automatic activation fire panel has been protected from the accidental discharge. Placing of a sign “Do not press. Device is under service” is recommended.

5) Connect the circuit to a power supply;

6) Activate the system. All devices shall operate and all lamps shall glow. Should the system fail to operate properly, disconnect the power supply, check connections between devices, reconnect the power supply and repeat.

7) Reset the system. All lamps shall be switched off;

WARNING! Prior to connecting EXA generators ensure the wires leading to the generators are not carrying voltage. Connection of EXA generators should always be the last function in electrical wiring procedure.

8) Disconnect all of the lamps and connect the EXA generators in its place. Install EXA generators in accordance with installation recommendations.

9) Remove the sign on the manual release point or the automatic activation fire panel.
MARINE FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 8:

SYSTEM MAINTENANCE
SECTION 8. SYSTEM MAINTENANCE

The user of the installation should ensure that the system is in good working order at all times. The user should carry out monthly inspections of the fire suppression equipment. This should include looking out for obstruction of the discharge nozzle, extension/alteration of the protected enclosure, openings left unclosed that were not catered for during design, and that the position and orientation of the Pyrogen generators remain in the designed position.

The installation should be inspected at least once a year by an authorised inspector. The inspection plan should include all components of the system and parts of the area / space necessary for the effective operation of the system.

The EXA/EXA-M expiry date should be checked on once a year by an authorised inspector and shall not occur within the next 12 months from the inspection. The owner shall be notified by the inspector if the expiry date occurs within the next 12 months from the inspection.

A system maintenance log should be kept and status of every maintenance visit is recorded. Please refer to the attached Maintenance Checklist in Appendix A (Form 4) for a typical maintenance record.

Periodic check-up is required for electrical circuitry of Pyrogen system. The following steps shall be undertaken:

If the control system is designed to transmit alarm signals to a remote manned centre or bridge, always ensure that the link is disabled, or in the event that disabling the link is not an option, it would be essential to notify the centre before undertaking the test. Occupants of the area or space should also be notified that the system test might result in the sounders being activated.

WARNING! Prior to the start of ANY maintenance work, always ensure as the first step, that wiring to all Pyrogen generator loops have been electrically isolated. Failure to do so may result in unwanted spurious discharge.

1) Disconnect the wiring at EVERY single EXA generator. It is extremely important to ensure that there are no generators inadvertently left connected.

2) Connect miniature filament lamps with 12-24 Volts voltage and current up to 50 mA in place of EXA generators.

3) Connect the circuit to a power supply.

4) Activate the system. All devices shall operate and all lamps shall glow. Should the system fail to operate properly, disconnect the power supply, check connections between devices, reconnect the power supply and repeat.

5) Reset the system. All lamps shall be switched off.

WARNING! Prior to connecting EXA generators, ensure the wires leading to the generators are not carrying voltage. Connection of EXA generators should always be the last function in electrical wiring procedure.

6) Disconnect all of the lamps and connect the EXA generators in its place. Install EXA generators in accordance with installation recommendations.

7) Remove the sign on the manual release point or the automatic activation fire panel.
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 9:
SAFETY MEASURES
SECTION 9. SAFETY MEASURES

9.1 Personnel safety

The uses of Pyrogen automatic total flooding systems are limited to **unoccupiable and normally unoccupied areas only**. In any proposed use of Pyrogen where there is a possibility that people may enter the protected enclosure or be close to the protected risk, the following safety aspects shall apply:

- a thermal automatic operation shall not be used.
- a system isolate switch shall be installed at the entrance to the protected area to prevent actuation during abnormal periods of occupation such as maintenance and repair.
- a location drawing should be attached to or next to any manual actuation points.
- exit routes should be kept clear at all times with emergency lighting and adequate direction signs being installed to minimise travel distances.
- consideration should be given to canister location in the event of spurious activation. Unless absolutely unavoidable, canisters should not be placed at head height or in close proximity to egress doors nor emergency exits.
- outward-swinging doors shall be self-latching and incorporate a self-closing mechanism to prevent possibility of doors opening inadvertently due to increase of pressure within the protected enclosure during discharge. Doors should be able to be opened from the inside including when locked from the outside.
- continuous visual and audible alarms installed at entrances and designated exits should operate until the protected area has been made safe.
- warning and instruction signs shall be installed in accordance with Section 6.2.
- pre-discharge alarms shall operate immediately upon detection of the fire.
- a time delay shall be incorporated within the manual release point and shall commence upon Pyrogen system operation.
- means for ventilation after discharge should be available; forced draft ventilation will often be necessary. Care should be taken to completely dissipate hazardous atmospheres and not just to be moved to other locations.
- written instructions appropriate to the risk, instructions and drills shall be given to all personnel within or in the vicinity of protected area, including maintenance or construction personnel who may be brought into the area, to ensure their correct actions when the system operates.
- A hold off switch should be provided within any protected area if there is a risk of personnel taking longer to egress than any pre-discharge alarm may allow. This may apply to persons who are involved in maintenance or are unfamiliar or untrained in the company fire procedures.
9.2 Potential hazards

The discharge of Pyrogen in fire extinguishing concentrations represents potential hazards to personnel in protected area. The hazards include the following:

- **high obscuration caused by the aerosol during and after discharge.**
- **potential toxicity due to some by-products of the aerosol-generating combustion reaction.**
- **thermal hazard due to an elevated temperature at the end plate nozzle. See Section 2.10 Design Limitations for minimum clearances.**

Please refer to Section 1.8 for the detailed information on the above hazards.

9.3 Re-entry

Following the use of Pyrogen, personnel should not enter the protected area until it has been thoroughly ventilated. The minimum holding times should be observed prior to ventilation of the protected area (please refer to Section 2.8 for minimum holding times). Unless stated otherwise the minimum holding time permitted before re-entry is 3 minutes.

*Avoid exposure to the fire by-products and extinguishant mixture.*

The wearing of suitable RPE & other available means of protection may be required should it be necessary to enter the area before it is fully ventilated.

9.4 Clean-up

Following a system discharge the aerosol particles that have settled should be vacuumed, using HEPA filter fitted equipment, brushed or, if appropriate, washed away.

Protective gloves and goggles should be worn. A suitable RPE or mask may be required.

*Be aware, that any residue that is allowed to build up in large quantities and to absorb moisture may become electrically conductive.*

*When replacing Pyrogen generators, be aware that immediately after discharge the canisters outer surface may exceed 200°C. Therefore, protective gloves should be worn before handling generators until at least 15 minutes after discharge.*
9.5 Hot Work

As naked flame or prolonged exposure to temperatures above 300°C may cause activation of the generators, *hot work must not be carried out within the vicinity of any generator*. If hot works are absolutely necessary the Pyrogen generators should be removed to a safe area prior to any work being carried out.

9.6 Storage and Transportation

Storage and transportation shall be in accordance with Class 4.1 Dangerous Goods Classification.
MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

SECTION 10:
SYSTEM SERVICE LIFE
SECTION 10. SYSTEM SERVICE LIFE

10.1 Definitions of shelf and service life

Shelf (warehouse) life: a period from the date of manufacture to the date of installation – “dispatch from warehouse before” date – used by Pyrogen Distributors only;

Service (installation) life: a period from the date of installation to expiry date;

Expire date: a date after which the Pyrogen generators shall be replaced

10.2 System service life

- System service life in total flooding applications under normal conditions is 10 years. System service life in local applications or under conditions of aggressive environment is 7 years.

<table>
<thead>
<tr>
<th>Service life</th>
<th>10 years</th>
<th>7 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions</td>
<td>Total flooding applications under normal conditions</td>
<td>Local applications or aggressive environments</td>
</tr>
<tr>
<td>Temperature range</td>
<td>From 0 °C to +40 °C</td>
<td>from -50 °C to 0 °C; from +40 °C to +85 °C</td>
</tr>
<tr>
<td>Humidity range</td>
<td>0 – 90 %</td>
<td>Above 90 %</td>
</tr>
<tr>
<td>Environments</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>which subject the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>system to continuous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or intense vibrations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior situations</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>exposed to the sun,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ultraviolet radiation,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wind, rain, or salt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>spray</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrosive atmospheres</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Abnormally dusty or</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>moisture-laden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>atmospheres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples of applications</td>
<td>General Industrial</td>
<td>Marine</td>
</tr>
<tr>
<td></td>
<td>Power Industry</td>
<td>Automotive</td>
</tr>
<tr>
<td></td>
<td>Electrical</td>
<td>Aviation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mining</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gas &amp; Oil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defence</td>
</tr>
</tbody>
</table>


MARINE
FIXED AEROSOL FIRE SUPPRESSION SYSTEM

APPENDIX A:

APPROVAL DOCUMENTATION
PYROGEN MARINE FIRE SUPPRESSION SYSTEM

FORM 1 – MARINE SYSTEM DESIGN APPROVAL CERTIFICATE

To be completed by the contractor/installer to seek the approval of the appropriate authority prior to installation (where required for a specified risk area)

Forms an integral part of Pyrogen Warranty Card to be completed upon Pyrogen installation and sent to a local Pyrogen Key Representative/Distributor.

1. CLIENT INFORMATION:

Address: ...........................................................................................................................................

Telephone: ............................................. Fax: ...........................................................................

Contact: ...........................................................................................................................................

Name: ..............................................................................................................................................

2. CONTRACTOR / INSTALLER:

Name: ..............................................................................................................................................

Address: ...........................................................................................................................................

Telephone: ............................................. Fax: ...........................................................................

Contact: ...........................................................................................................................................

3. VESSEL CLASSIFICATION:

Class of vessel: 1A, 1B, 1C, 1D, 1E, 2A, 2B, 2C, 3A, 3B, 3C (Circle Class)…………..

Vessel name and registration number: .........................................................................................

4. FIRE HAZARD CLASSIFICATION (Type of Fire: Class A, B, C or E)
(Please refer to Section 2.3 of the Design, Operation and Maintenance Manual):

..........................................................................................................................................................
5. **PROTECTED SPACE IDENTIFICATION:**

Protected space: (Typ. engine compartment) ..........................................................

Occupancy: unoccupiable ...............................................................normally unoccupied..................................

6. **ELECTRIC POWER SUPPLY AVAILABLE:**

Main ..........................................................................................................................

Emergency ..................................................................................................................

7. **NUMBER AND ELECTRICAL CHARACTERISTICS OF EQUIPMENT TO BE SHUTDOWN** .................................................................

8. **DESIGN CALCULATIONS:**

**Protected space dimensions:**

Height .......................................................................................................................... m
Length .......................................................................................................................... m
Width ........................................................................................................................... m
Area ............................................................................................................................. m²
Total area of unclosable openings to the total area of the enclosure .................... %

**Protected space volume:**

Maximum Gross volume ............................................................................................ m³
Add for exhaust and inlet ducts ................................................................................ m³
Deduct non-removable equipment, e.g. tanks, etc ...................................................... m³
Design Net volume .................................................................................................... m³

**Quantity of agent required:**

Design Factor: (Typ. 100 g/m³) ..................................................................................g/m³
Minimum Design Quantity: Minimum Design Factor x Design Net vol. ............... g
**Pyrogen generators selected:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
<th>Serial Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXA-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXA-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXA-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXA-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Installed quantity of agent as determined by sizes of Pyrogen generators available:................g

*This quantity shall never be less than the minimum design quantity.*

### 8. METHOD OF ACTUATION

a) Manual Electrical ..............................................

b) Automatic Electrical ...........................................................
   *(i.e. Control Panel & detection system required – please provide further data)*

d) Automatic Electrical/Thermal .................................
PYROGEN MARINE FIRE PROTECTION SYSTEM

FORM 2 – MARINE COMMISSIONING AND ACCEPTANCE TESTING

Criteria for Acceptance

The completed Pyrogen system shall be commissioned in accordance with this Commissioning Checklist. On completion and acceptance of the commissioning, the installation contractor shall issue a commissioning report.

COMMISSIONING CHECK LIST

<table>
<thead>
<tr>
<th>No</th>
<th>Inspection</th>
<th>Compliance verified</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Obtain a copy of the System Design approval Certificate (Form 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Isolate Pyrogen generators by disconnecting generators power supply or system power supply.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Risk area classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Is it the same as the System Design Approval Certificate (Item 3 Form 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Is the occupation the same as the System Design Approval Certificate (Item 4 Form 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Are air handling shutdown relays and fire dampers provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Are there any unclosable openings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Design Calculations

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td><strong>Design Calculations</strong></td>
</tr>
<tr>
<td>(a)</td>
<td>Are volumes the same as System Design Approval Certificate (Item 7 Form 1)</td>
</tr>
<tr>
<td>(b)</td>
<td>Are the dimensions of the enclosure the same as System Design Approval Certificate (Item 7 Form 1)</td>
</tr>
<tr>
<td>(c)</td>
<td>What is minimum Design application density? Does this correspond to the type of hazardous materials involved? (Item 8 Form 1)</td>
</tr>
<tr>
<td>(d)</td>
<td>Check minimum design quantity. Is it correct?</td>
</tr>
<tr>
<td>(e)</td>
<td>If unclosable openings are present, have calculations of maximum design quantity been effected as required? Are they correct?</td>
</tr>
<tr>
<td>(f)</td>
<td>Are design limitations in terms of enclosure height, length and width not exceeded for the type of EXA generators selected?</td>
</tr>
<tr>
<td>(g)</td>
<td>Check number of EXA generators can supply the design quantity required</td>
</tr>
<tr>
<td>(h)</td>
<td>Is pressure relief venting required? If yes, is min vent area the same as System Design Approval Certificate Item 7 Form1)? Check type, number and location of vents</td>
</tr>
</tbody>
</table>

### Power Source

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><strong>Power source</strong></td>
</tr>
<tr>
<td></td>
<td>Check there are not less than two (2) separate sources of power, one being emergency source remote from the protected area</td>
</tr>
</tbody>
</table>

### Manual Release System (where appropriate)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td><strong>Manual release system</strong></td>
</tr>
<tr>
<td>(a)</td>
<td>Is manual release system installed outside the protected space?</td>
</tr>
<tr>
<td>(b)</td>
<td>Check the connection of manual release system to Pyrogen generators</td>
</tr>
<tr>
<td>(c)</td>
<td>Is 30 seconds time delay incorporated within the release mechanism?</td>
</tr>
<tr>
<td></td>
<td><strong>Electrical circuitry</strong></td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>7</td>
<td>(a) Disconnect the wiring circuit(s) to the generators at the manual release point</td>
</tr>
<tr>
<td></td>
<td>(b) Check integrity of the electrical circuit of the whole system. Use digital multi-meter only (supervisory current not to exceed 0.05 A for the period of 5 min)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Instruction and warning signs</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>(a) Is the warning sign fitted inside the space?</td>
</tr>
<tr>
<td></td>
<td>(b) Is the warning sign fitted next to the entrance outside the space?</td>
</tr>
<tr>
<td></td>
<td>(c) Is operation sign for the manual release point fitted?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Alarm test</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Perform a functional alarm system check. Ensure evacuation/visible/audible alarms operate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Timer &amp; Release test</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Check the operation of the 30s time delay by operating the manual release mechanism at the manual release point. Alarms should sound and after 30 s sufficient power should be available to the disconnected generator circuit(s).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Post fire ventilation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>(a) Do the ventilation systems work satisfactory?</td>
</tr>
<tr>
<td></td>
<td>(b) Check operational conditions of air handling shutdown relays and fire dampers if provided. Do they open and close satisfactorily?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Reconnection of the system</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Reconnect generators by reconnecting the power supply and ensure the system is left in operable condition. This should always be the last commissioning function.</td>
</tr>
</tbody>
</table>
FORM 3 -- NOTICE OF COMPLETION

TO BE COMPLETED BY INSTALLER FOLLOWING THE COMMISSIONING CHECK

I (name of installer)........................................................................................................

of (company)..................................................................................................................

hereby certify that

we have completed on (date)........................................ to the
(name/address/identification of protected vessel
area)..................................................................................................................................

a PYROGEN Marine Fixed Fire Suppression System installation in accordance with
the Marine Authority requirements detailed in the System Design Approval Certificate.

Commissioning test(s) were conducted by..............................................................

..........................................................................................................................Date...

Commissioning test(s) were witnessed by............................................................

..........................................................................................................................Date...

This notice of completion shall have the following attached:

a) Marine System Design Approval Certificate
b) Commissioning Check List

Signature of installer..............................

Date......................................................
### FORM 4 -- MAINTENANCE CHECK LIST

**Maintenance**

**Organisation**: .................................................................................................................................

**Premises**: ...........................................................................................................................................

**Address**: ................................................................................................................................................

<table>
<thead>
<tr>
<th>No</th>
<th>ITEM</th>
<th>MONTHLY, BY OWNER</th>
<th>ANNUALLY, BY AUTHORISED INSPECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrically isolate Pyrogen generators.</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>2</td>
<td>Confirm the generators are secure, undamaged and free from corrosion</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>3</td>
<td>Check that generators’ nozzles are unobstructed within the specified in Sec. 2.10 minimum clearances</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>4</td>
<td>Confirm all electrical wiring and connections are intact</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>5</td>
<td>Open the manual release point enclosure</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>6</td>
<td>Confirm that 30 sec time delay, evacuation and/or audible, visual and fire alarms operate</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7</td>
<td>Check that instruction and warning signs are legible</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>8</td>
<td>Inspect power source condition</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>9</td>
<td>Inspect emergency power source (back-up battery) condition</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>10</td>
<td>Confirm that all previously requested rectification’s or modifications have been completed</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>11</td>
<td>Inspect the area to confirm there are no unclosable openings</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>12</td>
<td>Inspect controls for closing pressure relief vents where applicable. Inspect for damage, corrosion, accessibility and test correct operation.</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>13</td>
<td>Check the post fire ventilation facilities are functional.</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>14</td>
<td>Check that the expiry date of all generators will not occur within the next 12 months and report to the owner.</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>15</td>
<td>Check the generator’s electric activation circuit. Follow steps 1-8 of Section 9.</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>16</td>
<td>Check that all system controls are returned to normal and system is “on line”</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>17</td>
<td>Reconnect Pyrogen generators.</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>18</td>
<td>Record all inspections and necessary rectification’s</td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>19</td>
<td>Inform owner</td>
<td>-</td>
<td>✔</td>
</tr>
</tbody>
</table>

Signed:............................................... Date:..................................................
PYROGEN INDUSTRIAL FIRE SUPPRESSION SYSTEM

FORM 5 -- ANNUAL MAINTENANCE CERTIFICATE

TO BE COMPLETED BY THE MAINTENANCE CONTRACTOR AFTER EACH ANNUAL MAINTENANCE SERVICE

I ..............................................................................
(name of Service Person)

of..............................................................
(company)

hereby certify that we have completed the Annual Maintenance on

...............................................................................................
(protected area)

on...........................
(date)

at....................................................................................................
(location)

in accordance with the attached Maintenance Checklist.

Signature of Service Person..............................................

Date......................................