CLEAN AGENT FIRE SUPPRESSION SYSTEM TYPES AND ENVIRONMENTAL CONSIDERATIONS

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INTRODUCTION

Clean agent fire suppression systems designed for total flooding operate on principles comparable to carbon dioxide (CO_2) systems. They are suitable for use in areas that are normally occupied, subject to the specific agent selected. These systems are capable of suppressing fires efficiently while being electrically non-conductive and leaving no residue behind. In addition, the agent remains in a gaseous state, allowing it to disperse evenly and fully saturate the protected space.

A typical system setup includes storage cylinders for the clean agent, a network of steel piping, discharge nozzles, fire detection devices such as heat and smoke detectors, and a control panel that continuously supervises the protected area. Once a fire or smoke condition is detected, the system initiates both audible and visual warning signals and incorporates a preset discharge delay, ensuring occupants have adequate time to evacuate before the agent is released. These systems are widely used in environments like transformer rooms, electrical switch rooms, standby generator rooms, and other locations where water-sensitive equipment is present [1].

In accordance with Uniform Building By-Law 235 1984 (Amendment 2021), fixed fire suppression systems are required to be implemented either as total flooding systems or as localised (unit protection) systems, depending on the specific hazard, operational process, and type of occupancy. All such installations must receive approval from the Director General of the Fire and Rescue Department of Malaysia (FRDM). For clean agent systems, the relevant standards include NFPA 2001 – Standard for Clean Agent Fire Extinguishing Systems, and MS ISO 14520 – Gaseous Fire-Extinguishing Systems Using Clean Agents.

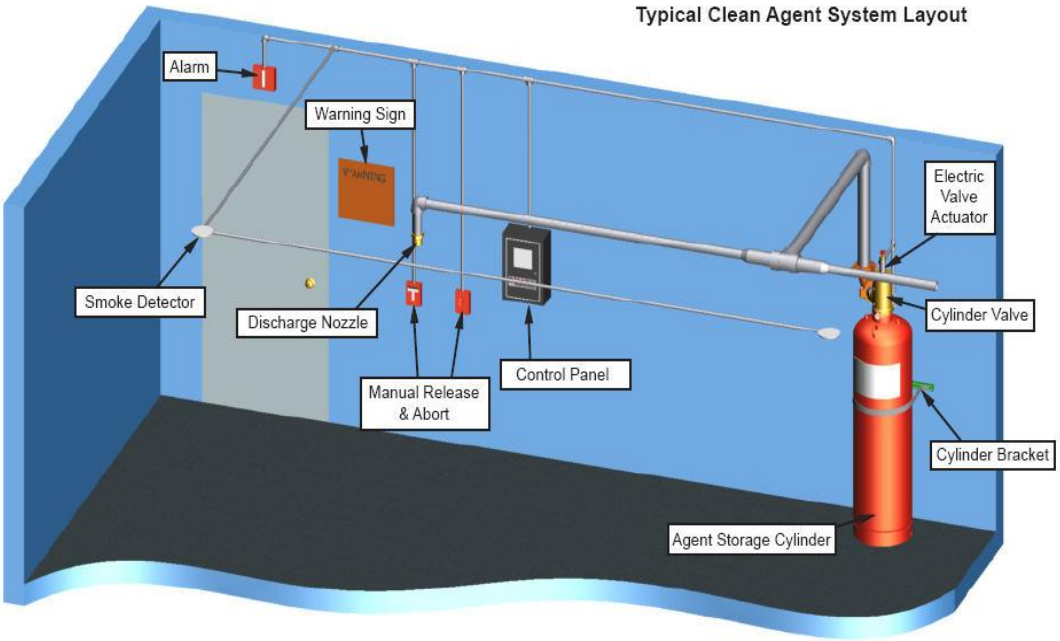

Figure 1: Typical Clean Agent System Layout [2]

TYPES OF CLEAN AGENT

1. Inert Gas

Inert gas (e.g. IG-55, IG-100 and IG-541) is a colourless, odourless, and flavourless clean agent that leaves no residue after discharge, eliminating the need for clean-up. Inert gas consists of these gases as components, which are helium, neon, argon, or nitrogen [3]. It has zero Ozone Depletion Potential (ODP), no greenhouse effect, and no global warming impact, making it an environmentally safe extinguishing medium. The agent produces no decomposition products, ensuring clear post-discharge visibility with no fog. Inert gas is non-corrosive, non-toxic, and safe for occupied areas. Stored as a compressed gas in cylinders, it is discharged through a network of pipes and nozzles to rapidly flood the protected enclosure when activated. It suppresses fire by reducing oxygen concentration to a level that prevents combustion while remaining safe for occupants. Inert gas is effective against Class A (solid combustibles), Class B (flammable liquids and gases), and Class E (electrical) fires, making it ideal for data centres, archives, control rooms, and other critical environments that require both safety and equipment protection.

2. Halocarbon

Halocarbon (e.g. FK-5-1-12) is a colourless, odourless, and electrically non-conductive clean agent that leaves no residue after discharge, eliminating the need for clean-up and preventing damage to sensitive equipment. Halocarbon agents are substances primarily composed of one or more organic compounds that include elements such as fluorine, chlorine, bromine, or iodine, which includes hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), perfluorocarbons (PFCs or FCs), fluoroiodocarbons (FICs), and fluoroketones (FKs) [3]. Stored as a liquid in pressurised cylinders and discharged as a gas, it extinguishes fire primarily by heat absorption and chemical interference with the combustion process. Halocarbon is effective against Class A (solid combustibles), Class B (flammable liquids and gases), and Class E (electrical) fires. It is also considered one of the safest agents for use in human-occupied spaces. Common applications include data centres, server rooms, hospitals, manufacturing facilities, the oil and gas industry, power plants, and substations.

ENVIRONMENTAL CONSIDERATIONS

1. Global Warming Potential (GWP)

- Inert Gas Systems: Have zero GWP since they are composed of naturally occurring gases that do not contribute to global warming.
- Halocarbon Systems: Generally have low to moderate GWP depending on the specific agent. Modern agents such as FK-5-1-12 have an extremely low GWP of less than 1, making it one of the most environmentally friendly synthetic clean agents currently available [4].

2. Ozone Depletion Potential (ODP)

- Inert Gas Systems: Zero ODP, as it contains no halogenated compounds that could harm the ozone layer.
- Halocarbon Systems: Zero ODP, fully compliant with environmental protection standards and safe for the ozone layer.

3. Atmospheric Lifetime

- Inert Gas Systems: Permanent atmospheric presence as it is a naturally occuring gases, does not react, accumulate, or pose environmental risk.
- Halocarbon Systems: Can vary depending on the agent. Newer, more advanced agents such as FK-5-1-12 have very short atmospheric lifetimes (around 3–5 days),

which means that it decomposes quickly and does not persist in the environment, ensuring long-term sustainability [4]. Meanwhile older agents may persist longer in the atmosphere and slower to decompose.

4. Regulatory Status

- Inert Gas Systems: Considered future-proof and not subject to any phase-out regulations, as it has no environmental restrictions under global or local standards.
- Halocarbon Systems: Subject to evolving environmental regulations depending on the specific chemical composition of the agent. Certain halocarbon agents may face production controls, phase-down initiatives, or increased regulatory scrutiny due to their global warming potential or environmental persistence. However, many modern halocarbon agents such as FK-5-1-12 remain approved for use, are listed and certified by recognized bodies (e.g., UL, FM), and comply with standards such as NFPA 2001 and MS ISO 14520.

CONCLUSION

In conclusion, clean agent extinguishing systems that utilise inert gases and halocarbons provide effective, residue-free, and environmentally responsible fire protection solutions for sensitive and occupied spaces. Both categories meet international standards for safety and performance, offering rapid fire suppression without harming people, equipment, or the environment. With zero ODP, low to no GWP, and compliance with NFPA 2001 and MS ISO 14520, these systems represent a sustainable and reliable choice for modern fire protection applications.

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