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Integrated Fire Systems in Intensivecare Units- A Comparative Study

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ABSTRACT

Critical care units require special space and equipment considerations for safe and effective patient care, staff functions, and family participation. Families and visitors to critical care units often wait for long periods, including overnight, under highly stressful situations. They tend to congregate at unit entries to be readily accessible to staff interaction. Not every hospital will provide all types of critical care. Some hospitals may have a small combined unit; others may have separate, sophisticated units for highly specialized treatments. Critical care units shall comply in size, number, and type with these standards and with the functional program. Design shall address such issues as privacy, atmosphere, and aesthetics for all involved in the care, comfort of patients and fire protection in critical care units.

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Introduction

The level of Intensive Care available should support the delineated role of the particular hospital. The role of a particular ICU will vary, depending on staffing, facilities and support services as well as the type and number of patients it has to manage.

Dependent upon the size and intended use of the ICU, a dedicated electronic and pneumatic equipment maintenance service may have to be accommodated within the hospital or a 24 hour on-call emergency service made available.

All ICUs must have available 24-hr Clinical Laboratory services. When this service cannot be provided by the Central Hospital Laboratory, a satellite laboratory within or immediately adjacent to, the ICU must serve this function.

Depending upon the availability of nearby commercial Accommodation, consideration should be given to the provision of overnight accommodation for relatives and staff, preferably near the unit.

A Special Procedures Room shall be provided if required by the Operational Policy. If a special Procedures Room is desired, it should be located within, or immediately adjacent to, the ICU.

A Staff Lounge shall be provided within the unit for staff to relax and prepare beverages. Inclusion of a window to the outside is desirable. Where only an Intensive Nursing facility is provided, the Hospital Staff Dining Room will suffice.

The ICU should be a separate unit within the hospital with easy access to the Emergency Unit, Operating Unit, and Medical Imaging. The location shall be arranged to eliminate the need for through traffic.

All ICUs should have an intercommunication system that provides voice linkage between the Staff Station, Patient Modules, Staff-Overnight Stay Rooms, Conference Rooms, and Staff Lounge.

Every effort should be made to provide an environment that minimizes stress to patients and staff. Therefore, ICU design should consider natural light and view. Windows are an important aspect of sensory orientation, and as many rooms as possible should have windows to reinforce day/night orientation.

In all areas where patient observation is critical, colors shall be chosen that do not alter the observer's perception of skin color. Health buildings shall be planned to minimize the need for sprinkler systems. The need for fire sprinklers for a specific facility and the suitable solution shall be established during the design process by a Certified Fire Engineer.

The alarm system shall also be hard wired from the essential power supply if available with status indication panels sited strategically throughout the hospital on a master and slave arrangement. The master panel shall be in a permanently manned location such as the Emergency Unit with slave panels sited in critical areas such as Operating Unit and Intensive Care Unit. Alternatively, an independent alarm panel can be provided for Operating Unit and Intensive Care Unit.

Methodology

Burn Intensive Care Units (ICU) has among the most stringent design criteria for patient rooms in hospital design. Healthcare Sector.

Burn Intensive Care Units (ICU) has among the most stringent design criteria for patient rooms in hospital design.

When designing a space is the background of the patients that may be receiving treatment. In burn care units, nearly 70% of the patients admitted are male, and many of them are homeless and suffer from substance abuse. Because of this, some patients may not understand what is going on around them and may not have what we may consider "typical" circumstances. Many of the patients treated are also very young, under the age of five, and therefore will need a special type of treatment as well. Burns are much more common than most people may think. In the United States alone, approximately 2.4 million burn injuries are reported per year. Approximately 650,000 of the injuries are treated by medical professionals; 75,000 are hospitalized. Of those hospitalized, 20,000 have major burns involving at least 25% of their total body surface. Between 8,000 and 12,000 of patients with burns die, and approximately one million will sustain substantial or permanent disabilities resulting from their burn injury.

Health care facilities use a concept known as defend-in-place to protect their vulnerable population.

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A defend-in-place approach consists of egress systems ;passive fire-resistive containment and separations; and active fire protection systems such as fire detection and alarm, automatic sprinklers and other automatic suppression systems, stair pressurization, and smoke control. This package of passive and active systems provides the code-required level of life safety for the health care facility.

Defend-in-place is a key element of the criteria used to accredit facilities. Ongoing compliance requires steps to ensure that the active and passive systems remain functional and effective. That means, after initial construction and issuing of an occupancy permit, the focus of a facility manager shifts to inspection, maintenance and ongoing testing of the fire protection systems.

Healthcare facilities require a unique approach to addressing Fire Safety needs of the building occupants who may not be capable of self-evacuation. The unique strategy relies on building systems and staff to safely care for the building occupants during a fire. However, it is not the intention for the Fire Strategy to prevent the care of patients during normal operations. This study will identify the unique Fire Safety approaches for Healthcare facilities and will identify fire safety features which may conflict with normal building operations. Sprinkler Protection Is Invaluable and Essential, but Not Infallible. As NFPA statistic show, they are not always effective. Balanced fire protection, that is, a combination of detection, compartmentation and suppression, is required to maintain the optimum level of fire protection and life safety, and has been demonstrated to work effectively. Fire prevention covering the years 2006-2010, Indicates that when sprinkler systems were present and the fire large enough, the sprinkler operated and was effective 86 percent of the time.

The same NFPA Report also identifies the top five reasons that sprinkler systems failed to operate or were ineffective during a fire:

- System shut off (38 percent)
- Inappropriate system for the type of fire (18 percent)
- Water discharged did not reach fire (12 percent)
- Lack of maintenance (12 percent)
- Problem with water supply or not enough water discharged (9 percent)

With statistics indicating that sprinklers operated and were effective in only 86 percent of incidents, this does not warrant elimination of other fire safety features.

AT conclusion the scope of this paper is to find new fire protection system for hospitals that can manage to cover the disadvantages of the sprinkler system.(1)

Objectives

The main objective of this Master degree is to find new fire protection system for hospitals that can manage to cover the disadvantages of the sprinkler system. (1)

- To adapt new Fire Precautions in New Hospitals.
- To provide fire protection in order to have Close invasive monitoring and support from specialist equipment and medication in intensive care units in order to ensure normal bodily functions.
- To control smoke and a roaring blaze—are a nightmare combination anywhere—especially in a hospital full of patients.
- To discuss the special fire risks pertaining to hospitals and other Care facilities. Company c continuity, Risk control, Damage reduction, Cost efficiency.

Material and Methods

The problem

The NFPA Report identifies the top five reasons that sprinkler systems failed to operate or were ineffective during a fire.

Intensive care units cater to patients with the most severe and life threatening illnesses and injuries, which require constant.

So new fire protection for patients should be uniquely safe, nontoxic, non-corrosive, non-conductive and environmentally friendly. DSPA systems do not deplete the oxygen content nor does it affect CO or CO2 levels in any harmful way for humans or animals (1).

Test Comparison between systems

Test Comparisons between different systems like Oxy reduce system, High pressure water mist system, Fire trace suppression system, Wet sprinkler system and the NOFIQ fire system.

The system

The NOFIQ fire system

NOFIQ focuses on situations where the effects of fire and/or smoke damage are high. For example:

- avoiding process interruption (production and logistics)
- protection of cultural heritage (museums, monuments)
- protection of knowledge and data (laboratories, research centers)
- protection of human life (hospitals, nursing homes)
- environmental Protection (shopping-malls, infrastructure)

The Experimental

The experiment is to prove that oxygen content in the intensive care unit at the time of fire does not affect the patients when we use DSPA NOFIQ fire system.

Experimental procedure and sampling

At the manufacturing company branch in Jeddah a lab size 4 x 4meter room will be used to test The NOFIQ fire system.

Methods of fire extinction

Condensed aerosol suppressants, like gaseous suppressants, use four methods to extinguish fires. This will be elaborated at the research.

The Effect of DSPA fire system

Noise. Discharge of a system Methods for Increasing Visibility and Ability to Exit Space Potential Toxicity.

The Comparison between the Integrated Fire Systems.

DSPA protection against wet fire sprinkler system

High concentration antifreeze solution Fire incident involving a sprinkler system that contained a high concentration antifreeze solution, research and standards development activities were begun to address concerns raised by the combustibility of antifreeze solutions in residential sprinkler systems.

In cold areas the use of antifreeze solutions in sprinkler systems cause problem where DSPA does not affect with freezing conditions. (2)

Structural Problems of the building.

Using up to 80% less water has safety benefits to firefighters as well. One gallon of water weighs 8.4lbs. With a flow of 400gpm, you can add 3,360lbs of weight to the floor of a structure in 1 minute. This weight when added to an already weakened support system is a game changer. The possibility of collapse increases almost 2 tons every minute the hose is utilized. Today's building materials burn quicker and hotter than those used even 10 years ago.(3)

DSPA protection against FIRETRACE

DSPA is an advanced effective & innovative system. It outlasts all other conventional systems i.e. CO₂ / FM200 / Halon / Water / Inertgas, etc which is used by fire trace. .(4)

In 2012 DSPA Aerosol was reviewed on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential which resulted in official SNAP listing by the U.S. Environmental Protection Agency.

	Halon 1301	Other gas systems	CO ₂	DSPA
Ozone Depletion Potential (O.D.P.)	High	Low	Zero	Zero
Global Warming Potential (G.W.P.)	Moderate	Low	Zero	Zero
Atmospheric Life-time (A.L.T.)	High	Very High / Medium	Very High	Low
Toxicity	Low	Low	High	None
Corrosion	Moderate	Moderate/ Low	Moderate / Low	None
Volumetric efficiency	Good	Low	Low	Good
Extinguishing density (gr/m ³)	200 – 350 gr/m ³	350 – 950 gr/m ³	700 – 1500 gr/m ³	From 30- 100gr/m ³

DSPA is uniquely safe, non-toxic, non-corrosive, non-conductive and environmentally friendly. DSPA systems do not deplete the oxygen content nor does it affect CO or CO₂ levels in any harmful way for humans or animals. .(5)

Clean Agent Suppression vs DSPA

- A fire must first occur before system is activated. Damage is unavoidable
- Does the system work? There is no way to test a gas system.
- Before FM-200 is activated everyone must leave the room immediately.
- A Fire is burning for at least two minutes before the system activates (depending on your level of detection).
- You cannot re-enter room until firefighters arrive.
- If someone opens a door too soon, any fire can re-ignite with the introduction of newly oxygenated ambient air.
- Clean Agent Suppression discharges within 10 seconds, after which, there is no fire protection. The system is empty.
- If the fire re-ignites you have no way of extinguishing it.
- If the fire goes out you need to send empty cylinders back to factory for re-fill or have on-site service.
- The System is limited to small tightly sealed enclosed spaces.
- FM 200 has been identified as a global warming product.
- At the contact with fire, FM 200 decomposes into deadly chemicals, Halogenic acids.

Clean Agent Suppression vs Inhalation

Misuse or intentional inhalation abuse may cause death without warning symptoms, due to cardiac effects. Other symptoms potentially related to misuse or inhalation abuse are: Anesthetic effects, Light-headedness, dizziness, confusion, in coordination, drowsiness, or unconsciousness irregular heartbeat with a strange sensation in the chest, heart thumping, apprehension, feeling of fainting, dizziness or weakness. Vapors are heavier than air and can cause suffocation by reducing oxygen available for breathing.(6).

DSPA protection against High pressure water mist fire protection system (HI-FOG)

Water mist, high pressure water system, needs a lot of storage and maintenance.

They are unproven for residential and domestic applications;

There are no British, European or International systems design or components standards for residential/domestic applications; their performance can be detrimentally affected by, e.g. ventilation, small fires, some fire types. There is a danger of inappropriate application where appropriate performance test data are not available; there is no uniformity of design principles; they operate at comparatively higher pressures; they may depend on additives and may be susceptible to blocking of small orifices.

The systems have proved to have some major shortcomings:

- They are more expensive than conventional systems
- They do not perform as well in open plan areas or large areas generally where 'drift' has proved to be a major disadvantage.
- Water mist suppression systems do not perform as well in areas with high ceilings.
- A mist head is more visually intrusive since no mist heads have been developed with a flat cover plate unlike conventional sprinkler systems.
- More outlets are generally required for a given floor area making them even more intrusive a particular consideration in domestic situations.
- Individual components cannot be used on an ad-hoc basis as conventional domestic sprinkler systems can be and this increases costs still further. (7).

DSPA protection against Oxygen Reduction Systems

There is no oxygen depletion or reduction. The DSPA stops the fire by interfering with the chemistry of the fire, not by changing the atmosphere. .(8).

Fire-prevention systems which result in the oxygen content being less than 19.5% are not permitted for occupied spaces by federal regulation (OSHA) in the United States.

However, hypoxic air is considered by some to be safe to breathe for most people. Medical studies have been undertaken on this topic. Angerer and Novak's conclusion is that "working environments with low oxygen concentrations to a minimum of 13% and normal barometric pressure do not impose a health hazard, provided that precautions are observed, comprising medical examinations and limitation of exposure time.(9).

Can be expensive to setup as the system requires pumps, tubing, and tanks/beds. This is certainly true though it doesn't necessarily need to be.

Health risks need to be managed considering exposure times, medical exams, strenuous work, and increased risk for human error, technical provisions, and information among others.

A DSPA extinguishing system is also uniquely safe: It is not pressurized and does not affect oxygen levels. It is officially tested as non-toxic, making a DSPA system perfect for many applications in healthcare facilities. (10).

The Results

The Effect of Powdered aerosols

Powdered aerosols are typically composed of multiple soluble and insoluble compounds. As such, acute inhalation exposure to very high concentrations of these compounds can induce a variety of adverse effects in humans. Therefore ,a limited battery of toxicity tests is required to determine the appropriateness of the powdered aerosol system for use in occupied spaces. These tests are the following:

(1) Draize Eye Irritation Test. This assay, using a rabbit model, is currently recommended for assaying the potential for eye irritation (reversible eye effects) and corrosion

(irreversible damage to eye tissue) after exposure to a variety of toxicants.

(2)Static Acute Inhalation Toxicity Test. This assay is designed to determine the acute toxicity of an actual exposure to the powdered aerosol agent at its design concentration. The test assays the potential for suffocation and immediate pulmonary responses in the test animal induced by both insoluble and soluble particles in the powdered aerosol. Because exposure in this test is limited to a very short period (e.g.,15 minutes),it is necessary to model exposure to the powdered aerosol at its design concentration Doing so ensures that the design concentration has been adequately tested with regard to immediate adverse effects(e.g., suffocation).

(3)Additional Toxicity Tests as Needed. In the event that a powdered aerosol comprises components with unknown toxicity, it can be appropriate to conduct a more extensive inhalation toxicity test to determine potential effects, particularly if the design concentration cannot be achieved or closely approximated in the static toxicity test. An example of an additional test is the acute inhalation limit test, which uses a 4-hour exposure duration.

Some components of powdered aerosols can have the potential for inducing extra respiratory systemic toxicity. This means that they do not cause toxicity to the respiratory system but instead result in an adverse effect to another organ (e.g.,liver, kidneys, and central nervous system) following uptake into the body's circulatory system .Examples of extra respiratory toxicants are potassium carbonate, potassium bromide, and sodium bicarbonate. Exposure concentrations should be compared to known occupational limits set by appropriate governing bodies .For example, short-term exposure limits (STEL) can be available for these chemicals and should be used to determine whether individual components of the aerosol can pose a risk to human health following acute accidental exposure. Further, any available toxicity information on the aerosol components, combustion products (for condensed aerosols),or trace gases should be used to determine the potential for toxic effects following such an acute exposure. When reviewing the toxicity data, the focus should be on the target organ(s) and most sensitive effects.

DSPA has been included into the “SNAP Listing” by EPA.

The U.S. Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) program implements section 612 of the amended Clean Air Act of 1990, which requires EPA to evaluate substitutes for the ozone depleting substances to reduce overall risk to human health and the environment. Through these evaluations, SNAP generates lists of acceptable and unacceptable substitutes for each of the major industrial use sectors. The intended effect of the SNAP program is to promote a safe, smooth transition away from ozone depleting compounds to the available substitutes.

Once more this proves DSPA to be environmentally friendly and safe for humans and animals. We advise all our distributors to use this listing for their benefit while offering our products to end users and installers.(12)

Helps maintain structural integrity of the building.

DSPA® Aerosol fire suppression is recognized as one of the most effective and simple solutions in protecting enclosed areas such as electrical substations, transformers, switchboards, generator rooms, stores, machinery and equipment, engine compartments of vessels and automotive

vehicles as well as many other risks from fires and associated damages. Unlike clean agent, inert gas or water systems, fire suppression systems, DSPA aerosol systems can be characterized as requiring no piping, zero storage pressure, solid-state technology, environmentally friendly, nonconductive, non-corrosive and offer significant cost, space and weight advantages in comparison with clean agent and inert gas systems. Correct use of DSPA will help maintain the integrity of the structure and keep you safe.

Conclusion

Why the customer did choose DSPA?

- All high risk facilities with regards to fire and all spaces must be equipped with a fire extinguishing system. A few examples are transformer stations, electrical cabinets, hydraulically power units, vehicles, tunnel boring machines hospitals etc.

- If we used water mist in the intensive care units, the effect of water will put the space in danger because of electrical equipment's and damaging to the equipment's which cost expensive is.

- The installed systems must operate under an ambient temperature up to 35 ° C humidity up to 95% and in some cases endure very large vibrations caused by blasting and tunnel drilling machines. Not many extinguishing systems were suitable under these conditions. DSPA provided a solution here.

- Due to the easy installation of DSPA, there were virtually no limits with regards to application in all construction. The price & quality combination was very good and the systems require hardly any maintenance.

On conclusion DSPA is uniquely safe ,non-toxic, non-corrosive, on-conductive, and environmentally friendly. DSPA systems do not deplete the oxygen content nor does it affect CO or CO2 levels in any harmful way for humans or animals.

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