



# Selecting the right fire extinguisher for operating rooms

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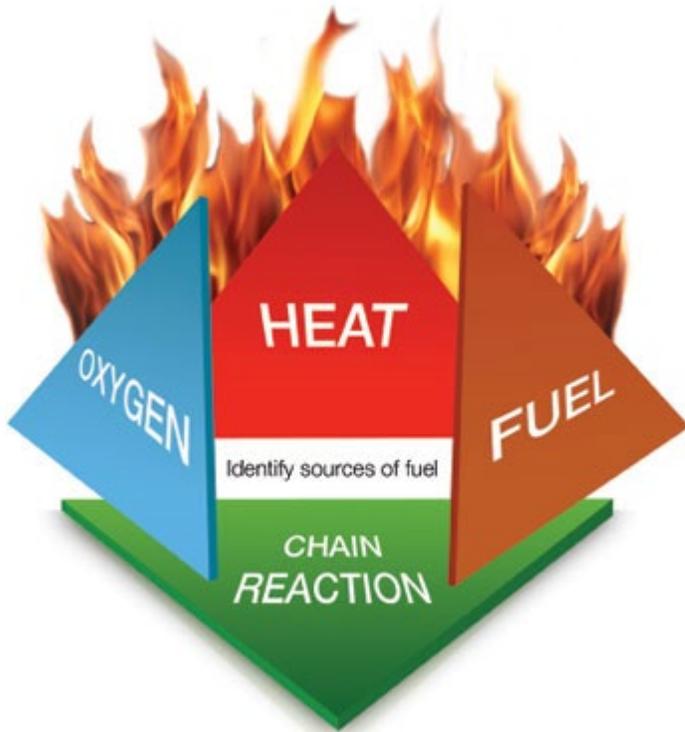


# The Concern

- According to the Association of periOperative Registered Nurses (AORN), it is estimated that there are between **200 and 240 operating room (OR) fires per year** in the United States.
- According to ECRI Institute it is estimated that surgical fires occur between **550 and 650 times in the United States annually**.
- There needs to be a greater focus on fire prevention and extinguishment in the OR setting.
- There has been a significant amount of debate on the best use and selection of fire extinguishers in the OR environment.
- This presentation provides background on fire extinguisher types, their applications, and other factors to help settle this question.

# Understanding the Combustion Process

## Basic Fire Tetrahedron



- Replaced the old Fire Triangle – due to the Chemical Chain Reaction (Pyrolysis)
- Object heated to combustion temperature through friction, focused light, or other heat source.
- Material decomposes into its elemental components releasing volatile hydrogen, carbon, carbon monoxide, carbon dioxide, and oxygen. (Chemical decomposition)
- The off-gases on the surface of the decomposing materials burn.
- As those gases burn they release heat back to the fuel, thereby creating self-sustained heat to the continue the combustion cycle.

***To adequately extinguish a fire, it is necessary to interrupt at least one of the four elements that make up the fire tetrahedron***

# Sources of Ignition in an OR

## According to ECRI

70 % - surgical fires are ignited by electrocautery devices

20 % - started because of light sources, wires, and defibrillators

10 % - sparked by lasers



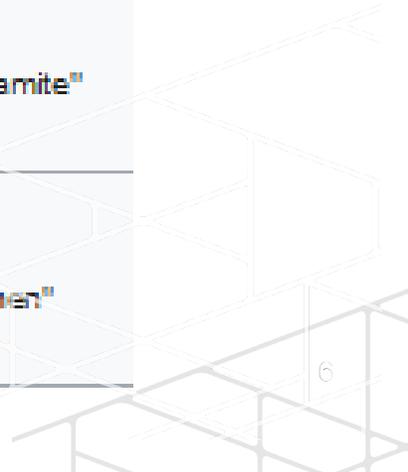
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- Overhead surgical lights
- Defibrillators
- Electrosurgical or electrocautery units (ESUs, ECUs)
- Heated probes
- Drills and burs
- Argon beam coagulators
- Fiber-optic light sources and cables
- Lasers used with the free-beam method or with contact tips or fibers
- Magnets
- MRI machines

# Fire Extinguisher Classifications

- **Class A extinguishers will put out fires in ordinary combustibles such as wood and paper.**
- **Class B extinguishers are for use on flammable liquids such as machine and lubricating greases, gasoline, and oil.**
- **Class C extinguishers are suitable for use only on electrically energized fires.**
- **Class D extinguishers are designed for use of fires in metals.**
- **Class K extinguishers are for fires in cooking oils and greases, such as animal fats and vegetable fats.**

Fire class	Geometric symbol	Pictogram	<u>Intended use</u>	Mnemonic
A			Ordinary solid combustibles	A for "Ash"
B			Flammable liquids and gases	B for "Barrel"
C			Energized electrical equipment	C for "Current"
D			Combustible metals	D for "Dynamite"
K			Oils and fats	K for "Kitchen"



# Class A Extinguishers

- **Class A Extinguishers are for ordinary combustible materials such as paper, wood, cardboard, and most plastics.**
- **The numerical rating on these types of extinguishers indicates the amount of water the extinguisher holds and the amount of fire it can extinguish.**
- **The numeral indicates the approximate relative fire-extinguishing capacity of the extinguisher for that class of fire.**
- **Generally, the larger the extinguisher the larger the numbers. For example, a 4-A extinguisher can put out approximately twice as much fire as a 2-A extinguisher.**



# Class B Extinguishers



- Class B fires involve flammable or combustible liquids
- The numerical rating for Class B extinguishers indicates the approximate number of square feet of fire it can extinguish.
- For Class B extinguishers the numeric rating also indicates the fire suppression capacity of the extinguisher when used by an inexperienced operator. **That is, a novice can put out a fire encompassing 10 sq. ft. with a 10-B extinguisher and a 20 sq. ft. fire with a 20-B extinguisher.**
- The fire suppression capacity is related to the experience of the operator. For example, an experienced operator can put out a fire encompassing 25 sq. ft. with a 10-B extinguisher and 50 sq. ft. with a 20-B extinguisher.
- So this implies the importance of proper training for those staff expected to use a Class B fire extinguisher.
- Due to the characteristics of the fuel involved in Class B fires, it is important not to use water to extinguish the flames. In most cases a spray of water would not reduce the heat but would spread the fuel farther, causing more damage.
- Smothering the flames and reducing the oxygen supply is the best method of combatting this type of fire; so foam, CO<sub>2</sub>, Sodium Bicarbonate, and Potassium Carbonate are commonly used as weapons against Class B fires.

# Class C Extinguishers

- **Class C fires involve electrical equipment, such as appliances, wiring, circuit breakers, and outlets. Never use water to extinguish Class C fires-the risk of electrical shock is far too great!**
- **Class C extinguishers carry only an alphabet “C” symbol and have no numerical rating because such fires are essentially Class A or Class B fires involving energized electrical equipment.**
- **A “C” classification means the extinguishing agent is non-conductive.**



# Class D Extinguishers



- **Class D fires involve metals that burn.**
- **Commonly lithium, magnesium, potassium, sodium, titanium, and zirconium**
- **May be extinguished by eliminating the oxygen supply and smothering the fire**
- **Never water because it may react with these metals or their compounds.**
- **They are available with two different types of extinguishing agents, a copper powder or a sodium chloride.**
- **The copper powder Class D fire extinguishers are mainly for combustible metal fires that contain lithium, or lithium alloys. (lithium batteries).**
- **Sodium Chloride (less expensive) can be used for magnesium, sodium, potassium and sodium-potassium alloy fires.**
- **These Class D fire extinguishers are yellow and weigh almost 60 pounds with the chemical weighing in at 30 pounds. It has a soft-flow nozzle extension applicator that shoots out the side instead of a direct shot.**

- **Class K fires burn a specific type of fuel, namely cooking fat and oils, and can spread quickly, causing damage and potential injury. Class K flames are technically a subclass of class B flames, since it involves flammable liquid.**
- **Used on fires involving cooking media (fats, grease, and oils) in commercial cooking sites such as restaurants.**
- **Wet chemical Class K fire extinguishers spray a fine mist of potassium citrate, potassium acetate, or potassium carbonate to create a foamy, soapy layer on the cooking fuel.**
- **This process, called saponification, retains steam and vapors, absorbing heat from the fire and extinguishing it.**

## **Class K Extinguishers**

**K**



# Hazards Found in the OR

- Hazards found in the OR are most frequently Class A, B, or C hazards.
- In the OR, Class A hazards can involve fuels such as surgical drapes, the patient's hair, and other combustible materials.
- Flammable liquids (e.g., alcohol, flammable prep solutions) are considered Class B.
- Class C hazards are either a Class A or a Class B hazard combined with an electrical current (e.g., laser, electrosurgical unit).
- If a Class C fire occurs, unplugging the electrical device from its power supply or interrupting the electrical supply by shutting off a circuit breaker would most likely revert the fire classification to a Class A or B.

# Extinguishing Mediums

## Water and Foam

- Take away the heat component of a fire, while also wetting the combustible material, providing an evaporative cooling effect.
- Foam extinguishers help to cut off oxygen from the surface of the fire by creating a foaming film on the burning surface.
- A water extinguisher should only be used on Class A fires (combustibles such as wood, paper, cloth, trash, and plastics).
- If water is used on Class B fires (flammable liquid), the discharge could help spread the flammable liquid.
- Foam, depending on the type and application, may be beneficial to extinguish a flammable liquid fire.
- If water or foam is used on a Class C fire (electrical equipment), it could create a shock hazard.



# Extinguishing Mediums

## Carbon Dioxide (CO<sub>2</sub>)



- This type of fire extinguisher takes away the oxygen from a fire and removes the heat with a cold discharge.
- Carbon dioxide fire extinguishers should be used only on Class B and Class C fires.
- It is not effective on Class A fires. The force of discharge can disperse burning materials.
- Should only be used by persons trained to use a CO<sub>2</sub> extinguisher.

# Extinguishing Mediums

## Dry Chemical

- Remove the chemical reaction of a fire.
- Is the most used fire extinguisher of all extinguishers because it is effective on Class A, Class B, and Class C fires.
- Creates a barrier between the oxygen and fuel elements on Class A fires (attacks the chain reaction of fires).
- If you are using an ordinary dry chemical extinguisher (sodium bicarbonate or potassium bicarbonate) and not a multipurpose dry chemical extinguisher (mono-ammonium phosphate), only use it on Class B and Class C fires.



# Extinguishing Mediums

## Wet Chemical



- Removes heat and creating barriers between oxygen and fuel so a fire cannot be re-ignited.
- Wet chemicals are for Class K fires such as fires involving vegetable cooking oils.
- These extinguishers are a must-have if you are in the commercial cooking industry.
- Some wet chemical extinguishers can be used on Class A fires as well because they are more like foaming extinguishers.

# Extinguishing Mediums

## Clean Agent

- Clean agent extinguishers use halogenated hydrocarbon that interrupt the chemical reaction component of a fire.
- They are considered “clean” because they leave no residue.
- This type of extinguisher is most effective on Class B and Class C fires.
- However, larger clean agent extinguishers are listed for Class A, B, and C fires.



# Extinguishing Mediums

## Clean Agent

- Older first-generation clean agents (halogenated hydrocarbons like Halon 1301) were cardiac sensitizers, meaning they could cause fatal arrhythmias when inhaled in large concentrations, which could put a patient at risk.
- However, the newer generation HFC (halogenated hydrofluorocarbon) suppressants like HFC-236fa are better suited for use as a fire suppressant in hand-held fire extinguishers since they have a much lower toxicity than Halon and can be safely used in small spaces and around susceptible (high-risk) populations.



# Extinguishing Mediums

## Dry Powder



- **Similar to dry chemical extinguishers, dry powder separates fuel from oxygen or removes the heat element of a fire by smothering.**
- **Dry powder extinguishers are primarily used on Class D (combustible metal fires) only.**
- **They will not be effective on any other type of fire class.**

# Extinguishing Mediums

## Water Mist

- **Work by taking away the heat element of a fire.**
- **Mainly use this extinguisher for Class A fires, however, if listed it is safe to use the water mist extinguisher for Class C fires as well.**
- **Tested to ANSI/UL 8 and ANSI/UL 711 are safe to be used on fires with electrically charged equipment involved because it will not deliver a shock to the operator back through the discharge stream.**
- **Disperse very fine water sprays (i.e. water mist). The supersonic nozzle disperses microscopic water mist particles .**
- **The small water droplets allow the water mist to control, suppress, or extinguish fires by cooling both the flame and surrounding gases by evaporation, creating the immediate evaporation of the water droplet that creates steam that displaces oxygen, attenuating radiant heat by the small droplets themselves.**



# What to Use (and NOT to use) in Operating Rooms

## Multi-purpose Dry Chemical – DO NOT USE

- Without a doubt it can be said that a multipurpose dry chemical fire extinguisher rated for Class A, B, or C fires should not be used in an OR.
- The dry chemical used (mono-ammonium phosphate) is highly corrosive, and any electronics in the immediate area would eventually need to be replaced.
- In a dry chemical fire extinguisher discharge, microscopic powder disperses widely.
- With average particle sizes of 20 microns, it can be suspended in the air and will eventually settle on all surfaces. Long clean up time!

# What to Use (and NOT to use) in Operating Rooms

## Water Mist - Maybe

- **Currently listed for Classes A and C\*, although under the right conditions and use, could be used to put out small Class B (flammable liquid) fires.**
- **The effectiveness of a water mist depends on its spray characteristics, which include the droplet-size distribution, flux density, and spray dynamics, with respect to the fire scenario, such as the shielding of the fuel, fire size, and ventilation conditions as well as operator experience.**
- **Water mist is most effective fire extinguishing agent in small compartmentalized fires that would benefit from the smothering effect and oxygen displacement of evaporation.**
- **Because of the small droplet size, a water mist is not as effective for "wetting" of combustible materials, although you will get some minimal wetting.**
- **You might as well use a Class A pressurized water extinguisher with sterile deionized water or even a saline squeeze bottle for a "wetting" effect to prevent fire propagation with drape materials.**



# What to Use (and NOT to use) in Operating Rooms

**CO<sub>2</sub>- Maybe, If staff properly trained specifically to CO<sub>2</sub>**

- **CO<sub>2</sub> extinguishers are listed for Class B and C fires. Although might work on Class A fires.**
- **They may not suppress efficiently due to inability to displace oxygen.**
- **Improper CO<sub>2</sub> use can result in hypothermic injury if used in extremely dose proximity or in direct contact with skin for an extended period. Thermal damage to tissue, resulting in much longer healing times and or deadening of tissue that will need to be removed.**
- **Users not properly trained in the use specifically to CO<sub>2</sub> could be ineffective with extinguishment and risk patient injury if discharged on or too close to the patient.**
- **Although a CO<sub>2</sub> could be effective in dousing flammable skin preps and oxygen-driven fires, staff should be trained on the proper use and application of a CO<sub>2</sub> extinguisher.**
- **In addition, consideration should be given to using only extinguishers that have been properly cleaned, sterilized, and filled with non-reclaimed, higher-purity, lower-moisture CO<sub>2</sub>**
- **A “cleaned” CO<sub>2</sub> extinguisher will obviously increase the cost.**

# What to Use (and NOT to use) in Operating Rooms

## Clean Agent- Yes

- Clean agent extinguishers are rated for Class A, B, and C.
- Clean agents are actually refrigerant-type liquids that evaporate quickly when discharged- these liquids are sometimes called streaming agents.
- Extinguish a fire by providing a break in the chemical reaction of fuel and oxygen.
- They do not extinguish fires by oxygen displacement, and they have minimal cooling or wetting effect.
- They are very effective at being “clean”, since they are non-conductive, non-corrosive, and do not leave any residue.
- The biggest issue with older first-generation clean agents (halogenated hydrocarbons like Halon). They were cardiac sensitizers, meaning they could cause fatal arrhythmias when inhaled in large concentrations, which could put a patient at risk.
- However, the newer generation HFC (halogenated hydrofluorocarbon) suppressants like HFC-236fa are better suited for use as a fire suppressant.
- In hand-held fire extinguishers since they have a much lower toxicity than halon and can be safely used in small spaces and around susceptible (high-risk) populations.

# Industry/Code Recommendations

- The AORN advises following the ECRI recommendation.
- ECRI was recommending Class A, B, C extinguishers.
- NFPA 10 recommends extinguishers rated as Class A, B, C, or AC in the OR. But it also cautions to check with the authority having jurisdiction (e.g., local fire marshal).
- NFPA 99-2012: Health Care Facilities Code (Section 15.9) – *“Portable fire extinguishers shall be selected, installed, inspected, and maintained”*.
- NFPA 10-2010, Standard for Portable Fire Extinguishers. A 15.9.1 states *“The selection of portable fire extinguishers for health care facilities is a vital step in preparing the facility to effectively deal with a fire in its incipient stage.”*
- NFPA 10 - Annex D specifically mentions ORs. Per DA.8 -Water Mist Extinguisher. Fire extinguishers of this type are available in 2.5 gal and 1.75 gal. They have ratings of 2-A-C. The agent is limited to distilled water, which is discharged as a fine spray. In addition to being used as a regular water extinguisher, water mist extinguishers are used where contaminants in unregulated water sources can cause excessive damage to personnel or equipment . Typical application include operating rooms, museums, and book collections.

# NFPA 99

- **NFPA 99 – 2018 Edition – 16.9.1.3 – *Clean Agent or Water Mist type fire extinguishers shall be provided in operating rooms.***
- **ECRI submitted a 2<sup>nd</sup> draft revision comment to change to the standard to the 2021 Edition - ~~Clean agent or water mist type~~ Five lb. carbon dioxide-type fire extinguishers shall be provided in operating rooms. Conductivity testing of the extinguisher fire hose assembly shall be performed annually per NFPA 10.**
- **Basis – not enough agent comes out and may not be sterile.**
- **The committee rejected the 2<sup>nd</sup> draft revision comment. ECRI could still submit an NITMAM at the 2020 Technical Session.**

# Summary

**Recommend “Clean Agent” halogenated hydrofluorocarbon fire extinguishers for OR’s**

**The benefits of the Clean Agent hand-held fire extinguishers are:**

- **A-, B-, C-rated**
- **Better user operability for marginally trained staff, controllable discharge**
- **Low toxicity, Non-conductive, Non-corrosive, Leave no residue**
- **Reduce the likelihood of thermal shock and infection to open incisions**
- **They are environmentally friendly in that they do not contain chlorine or bromine and have zero ozone depletion potential (ODP).**
- **Best option for the protection of the facility and equipment, patient protection, and rapid clean-up for OR business continuity.**

**From a cost perspective:**

- **A similar-sized CO<sub>2</sub> extinguisher would be about a 50% greater cost than a multipurpose A-B-C extinguisher, and the Clean Agent extinguisher would be about a 20% increase in cost as compared to a CO<sub>2</sub> extinguisher.**
- **A water mist extinguisher would be similar in cost to a multipurpose dry chemical extinguisher.**

# Closing

- **Extinguishers can't replace saline as a first defense.**
- **If you choose to use CO<sub>2</sub>, you must have hands on training for staff.**
- **Regardless of the type of fire extinguisher that you select for your OR, keep in mind that the Joint Commission has begun to ask OR staff during surveys whether they perform fire time-outs, perform OR fire drills and whether staff members have been trained on the use and type of fire extinguishers present in the OR.**
- **A common qualifying question by a Joint Commission surveyor is "Can staff articulate the types of extinguishers you chose and how and where to use that specific extinguisher?" i.e.- Staff Training!!**

# Questions

