August 19, 2013

# *Considerations When Specifying Clean Agent Systems*

Oklahoma City Chapter

# *How Does Fire Suppression Affect the Consultant?*

- Responsibility and accountability as the Engineer of Record has increased exponentially.
- Most MEP firms have utilized existing personnel with differing qualifications to provide basic specification requirements.
- A growing minority of firms have hired FPE's, sprinkler design technicians, and many have utilized the interest of existing employees in "cross-training" into fire protection as their "go-to" people in the development of sprinkler specifications and establishing basic design criteria.
- Firm web sites now indicate that their responsibilities and services include fire protection and suppression.
- Most firms have relied upon third-party specification services (ie: MASTERSPEC) to provide their basic fire protection specification formats.
- It still remains a challenge-and an opportunity-to provide current, qualified, and applicable design criteria-tailored to a specific project.
- Specifications must be properly sectioned, current, and project/hazard-specific !
- **Despite the historical reliance upon the 'performance specification', there are many things that a consulting engineer must do to mitigate the exposure of the project design team and provide a quality set of construction documents. In many cases these items would also provide more qualified "apples-to-apples" bids and mitigate post-award RFI's, RFQ's, and the hated change orders.**
- **What does YOUR clean agent specification look like?**

# A Historical Perspective…

- The primary concern throughout most of history has been to extinguish fire, with little concern over the mess that water or other extinguishing agents made.
- Near the close of the 19th century man began to realize the advantage of "clean" agents which could be used to extinguish a fire but caused little or no damage themselves.
- From the late 1800's to the 1920's carbon tetrachloride was commonly employed in small thin-walled glass containers to fight small fires –in the event of a fire these "fire grenades" were simply thrown at the fire.
- Late 20's - methyl bromide was found to be more effective than carbon tetrachloride. It was widely employed as a fire suppressant agent by the British in the late 1930's in aircraft protection and by the German military during World War II for aircraft and marine applications.
- Late 30's - Suppression systems employing bromochloromethane were also developed and employed by the German Luftwaffe. This chemical was evaluated in the United States during the late 1930's to the late 1940's and was eventually employed by the US Air Force.
- Although effective as fire suppression agents, the toxicities of these chemicals prompted the US Army to initiate research in 1947 to develop an extinguishing agent which retained the high fire suppression effectiveness of these agents and was less toxic. US Army sponsored research at Purdue University evaluated over 60 possible agents, most of which were halogenated hydrocarbons.
- These evaluations ultimately led to the widespread use of Halon 1301 in total flooding applications.

# *A Historical Perspective…continued*

- The non-conducting nature of Halon 1301 enabled it to protect electrical and electronic equipment, of low toxicity, non-abrasive, non-corrosive and ideal for areas such as libraries and museums where the secondary damage caused by water was a huge concern.

- Due to these unique properties, Halon 1301 served as a near ideal fire suppression  agent for more than 30 years.

- One drawback was that of human tenability.

- Due to its implication in the destruction of stratospheric ozone, the Montreal Protocol of 1987 identified Halon 1301 as among a number of other halogenated agents requiring limitations of use and production.

- An amendment to the original Protocol resulted in the halting of production of Halon1301  January 1, 1994.

# *A Historical Perspective…continued*

- **The ideal Halon replacement would have the following properties:**
  - Clean (no residues)
  - High fire extinguishment efficiency
  - Low chemical reactivity
  - Long term storage stability
  - Noncorrosive to metals
  - High material compatibility (metals, plastics)
  - Electrically non-conducting
  - Low toxicity
  - Zero ozone depletion potential (ODP)
  - Zero global warming potential (GWP)
  - Reasonable manufacturing cost

- To date no replacement agent has been found which satisfies <u>all</u> of the above requirements Replacements <u>have</u> been found that match many of the above criteria. This presentation will discuss those alternatives within the frame of reference of the fire suppression specification.

# *Primary Questions That Must be Answered When Clean Agent Systems are Contemplated*

- What is the hazard being protected?
- For what specific use(s) is the space planned?
- Is there a fire sprinkler system in the space and if not is one planned or required? What type of sprinkler system?
- How critical is the occupancy and protected hazard to the owner's business?
- Does the owner have a suppression preference?
- What are the requirements – if any – of the owner's insurer? AHJ?
- Budget/costs…

## *Primary Questions That Must be Answered to Assist Clean Agent Selection, Project-specific Specification, System Design, and Installation*

- Volume of enclosure(s) to be protected?  3-D protection!
- Hazard being protected?
- How many rooms/areas to be protected and where are they located in the building?
- Hardware (bottles, associated hardware, detection, controls) locations? Make sure the architect has allowed enough room!
- How many entrances/exits?
- What kind of detection & control systems are desired or required? (Ensure your electrical counterparts are involved!)
- Type of construction in the protected area(s)?  Example: are the walls full height? Ceiling type and construction?
- Enclosure atmospherics (temp, altitude)
- Under floor spaces?
- What kind of specification do you have available? (needs to be project & system specific!)

# *Common Elements of Clean Agent Systems*

- Usually not compliance-driven. Normally not required by building or fire codes.
- Focused on asset/process protection – sprinklers protect the building, clean agents protect the contents!
- Non-corrosive, non-conductive, safe for humans and the environment, no residue, no clean-up.
- Custom engineered for the application
- Business protection is primary objective. Down time not an option.
- Insurance or loss prevention can influence choices.
- Knowledgeable service providers required!
- The operative NFPA standard is NFPA 2001.

# *Clean Agent Vertical Markets*

## **Data Processing**

- Computer Rooms and Under-floor Areas
- Data Vaults and Tape Storage
- Cabinets (i.e. “Storage Tek”)

# *Clean Agent Vertical Markets*

## Hospital & Medical Centers

- CT Scan Rooms
- MRI Rooms
- Mobile MRI and CT Scan Trailers
- Datacenters
- File storage areas

# *Clean Agent Vertical Markets*

## Telecommunications

- Switch rooms and under-floor areas
- UPS power supplies (batteries and generators)

# *Clean Agent Vertical Markets*

## Power Plants

- Control Rooms and I/O (“Rack”) Rooms
- Cable Spread Vaults
- Power Turbines

# *Clean Agent Vertical Markets*

- **Air Traffic Control Towers**
- **9-1-1 call centers**
- **Banks, Record Storage**

# *Clean Agent Vertical Markets*

## Marine / Off-Shore Applications

- $CO_2$ Issues with these applications.
- EPA Intervention is imminent
- Portability
- Water supplies limited

# *Clean Agent Vertical Markets*

## Museums, Libraries, Archives

Harvard University: 15 Million Books

New York Public Library: 20 Million Books

Stanford University: 8 Million Books

Abraham Lincoln Library

The Alamo

Yale University

National WWII Museum

# *Available Chemical Agents*

- Novec 1230™ Fire Protection Fluid flouroketone (FK)
- HFC 227ea (FM-200) hydroflourocarbon (HFC)
- HFC 125 (FE-25) hydroflourocarbon (HFC)

# *Inert Gas Alternatives*

- INERGEN *( Argon-Nitrogen-CO2 mix)*
- NITROGEN/ARGON/ARGONITE (IG-55)

# What type of fire is expected based upon the hazard being protected?

- **Class 'A'**
  - Ordinary Combustibles
  - Plastics, Paper, Wood
- **Class 'B'**
  - Flammable Liquids
  - Polar Solvents
  - Alcohol, Acetone
  - Hydrocarbon Fuels
    - Gas, Oil
- **Class 'C'**
  - Live Electrical Equipment
    - Computers, Switchgear
- **Class 'D'**
  - Burning Metals
  - Reactive Metals generate $O_2$ when burning
    - Sodium, Magnesium, Uranium

# *Methods of Fire Suppression*

- Halon 1301

  80% interruption of the chain reaction (O2 depletion)

  20% cooling

- Halocarbon alternatives (ie: Novec/Sapphire)

  20% interruption of the fire chemical chain reaction

  *80% cooling (heat extraction)*

- Inert gases (ie: Inergen)

  Reduces oxygen from 21% to slightly below 15%

# *Halocarbon Systems*

- Stored as a liquid. Discharged as a gas.
- Typical installation = Two tanks (one for above floor & one for the sub-floor).
- Tanks usually close or located within the protected area.
- Very large applications can have several tanks.
- Piping: Schedule 40.
- Nozzles both 360 and 180º spray patterns.

# *Halocarbon Systems*

- Concentrations from 4.2% to 7% for class A hazards. FM-200 = 7%; Novec 1230 = 4.2%; Halon = 5%
- Tanks are charged with Nitrogen to 360 *psi.*
- 10 seconds to discharge. Selector valves not yet available.
- Room must be well sealed.
- Can breakdown upon high heat forming hydroflouric acid (HF). (Novec = 900F)
- Some jurisdictions used to require a purge system to exhaust HF gases. This was more common w/ Halon as it generated HF quickly.

# *HFC 227ea (FM-200)*

- Hydrofluorocarbon (HFC)
- First replacement for Halon that had no Ozone Depletion Potential (ODP).
- Still the most recognized name in alternative agents.
- Made by Great Lakes Chemical Corp as FM200
- Equipment Suppliers : Pyro-Chem (Ansul), Kidde, Fenwal, Chemetron, Siemens, Fenwal, Fike
- NOT made by or marketed by FM Global!

# *FE-125 Ecaro*

- Made by DuPont
- Hydrofluorocarbon (HFC)
- First attempt for approval failed to pass toxicity (Cardiac Sensitization) tests – 1992
- Second attempt passed under new liberalized testing parameters (PBPK Modeling) 2000
- Fike Inc. is the only Supplier

# *NOVEC 1230 Fluid*

- First ODP (ozone depletion potential = 0) and GWP (global warming potential = 1) alternative
- Fluoroketone, not HFC
- Fluid made by 3M Corporation
- Used heavily in Europe
- Equipment Suppliers:  Ansul, Kidde-Fenwal, Chemetron, Minimax, Firetrace
- Long-term replacement for all types of systems

# *Environmental Properties*

| Properties | Novec 1230 (Sapphire) | Halon 1301 | HFC-227ea (FM200) | HFC-125 (Ecaro) |
|---|---|---|---|---|
| Ozone Depletion Potential (ODP) | 0.0 | 12 | 0.0 | 0 |
| Global Warming Potential (GWP)* <br> * A unitless measurement based on GWP of CO2 (=1) | 1 | 6900 | 3500 | 3400 |
| Atmospheric Lifetime (years) | 0.014 | 65 | 33 | 29.0 |

# Safety Margins

| Agent | Concentration | NOAEL* | Safety Margin |
|---|---|---|---|
| Novec 1230 (Sapphire) | 4% - 6% | 10% | 67% -150% |
| Halon 1301 | 5% | 5% | NIL |
| HFC-227ea (FM200) | 7.5%-8.7% | 9% | 3% - 20% |
| HFC-125 (Ecaro) | 8%-11.5% | 7.5% | 0% |

* No Observable Adverse Effect Level

# *Inert Gas Systems*
## *(Inergen Example)*

- Stored as a gas
- 34.2% concentration for Class A hazards
- Possibly multiple tanks required
- Manifold pressure @ 2100 psi, then pressure reducer, System pressure @ 1200 psi, Nozzle pressure @ 325 psi
- Room pressure venting required.

# *INERT GAS SYSTEMS*

- 60 Seconds to discharge
- Can be piped long distances up to 400 ft
- Similar density to the atmosphere therefore the systems minimize leakage and maximize hold times.
- Big plus: “Selector Valve” Systems. Same manifolds can serve multiple areas. Benefits include less cylinders, less space, less cost.

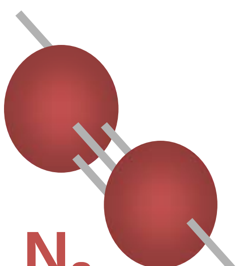
# *Inergen Chemical Composition*

## Composition

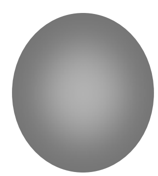
**Nitrogen .................. 52%**

**Argon ...................... 40%**

**Carbon Dioxide ....... 8%**



$N_2$



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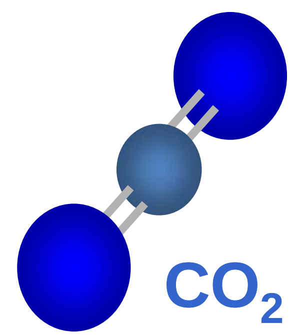
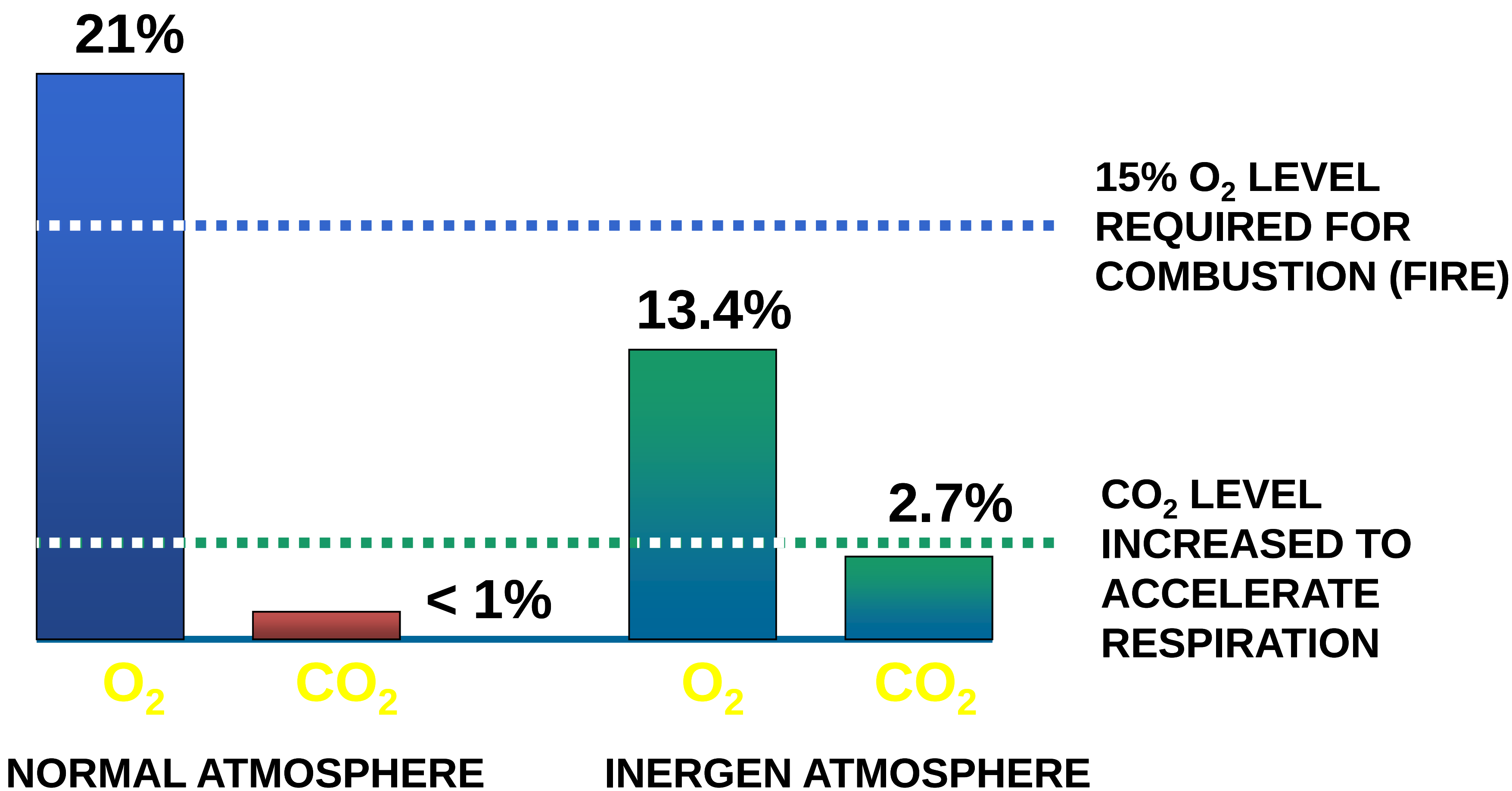
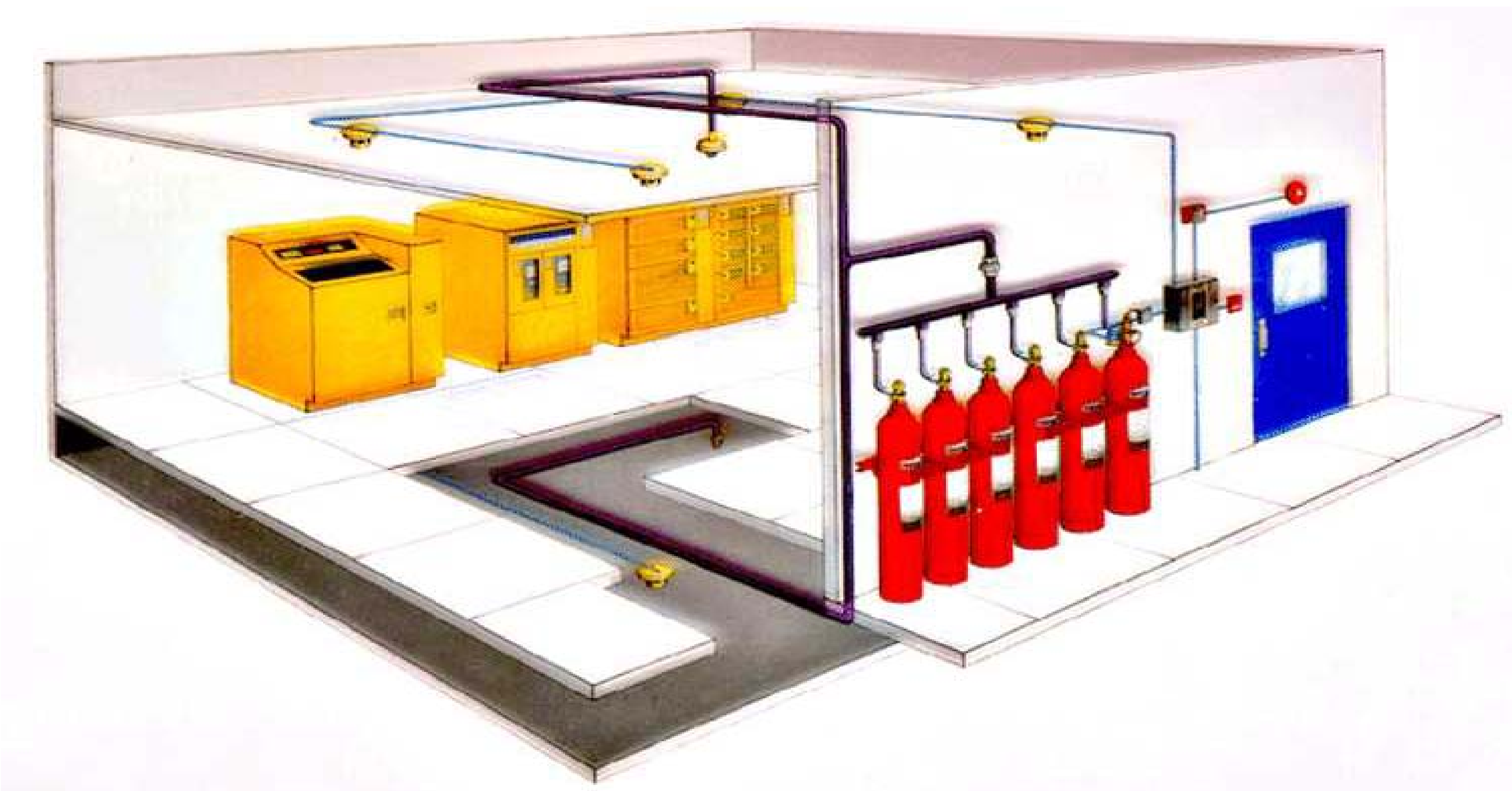


$CO_2$

# *Method of Suppression*



# *Typical System Layout*



# *Inert Gas or Halocarbon?*

**Inert Gas**

- Inexpensive to refill
- Safe for occupants
- Have to install a pressure vent
- Typically cost more to install
- More tanks, more room required
- Environmentally friendly
- More effective in 'leaky' rooms

**Halocarbon**

- Costly to refill
- Can decompose upon very high heat, otherwise safe for occupants.
- Environmental concerns depending on the agent.
- Less expensive to install
- Less Space
- Bottles and controls to be located close to the hazard area
- Room has to be sealed

# *Clean Agent Testing*

- Designed to be total flood based on room/enclosure volume.
- Area has to be sealed. Sealing method is dependent upon agent utilized.
- Discharge test restricted for all HFC compounds for environmental reasons and discharge tests are cost-prohibitive.
- Room integrity determined primarily by “Door Fan Test”.
- “Room Integrity Test” will determine what has to be sealed based on the agent being used.
- Testing requires maintaining 85% of initial design concentration for 10mins.
- Guideline: NFPA 2001 - Standard For Clean Agents 2001. Also describes door fan test.

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# *Thank You!*
# *Questions?*

Oklahoma City Chapter