UPDATE IN THE EVALUATION OF SELECTED NFPA 2001 AGENTS FOR SUPPRESSING CLASS "C" ENERGIZED FIRES

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This paper describes the results from testing the effectiveness of 1st and 2nd generation halon alternatives in extinguishing fires and preventing reignition of such fires from a continuously energized heat source. This paper is an extension of the work previously performed by Bengtson et al[1], Bayless et al[2] and Craft et al[3]. The report includes updated data for HFC-227ea (FE-227) and new data for HFC-125 and the inert gas IG 541. These results are compared to other clean agents included in NFPA 2001: HFC 227ea, HFC 236fa, HFC-23, and FK-5-1-12.

INTRODUCTION

The National Fire Protection Association (NFPA) 2001, Standard for Clean Agents, 2004 Edition, provides for guidance in Chapter 5 System Design of Class "C" Hazards.

> 5.4.2.5 Minimum design concentration for Class "C" hazards shall be at least that for Class A surface fires.

In a mission critical data center and telecommunications environment, the highest probability will be that the source of the fire event is an electrically energized circuit or power supply.

The assumption is that the gaseous suppression system applied to suppress an electrical fire (Class "C") must have the capability to both extinguish the combustion of materials and inert the ignition source as described by Simms[4].

A Class C fire is defined in the 2004 NFPA 2001- 3.3.5 as follows:

> "Fires that involve energized electrical equipment where the electrical nonconductivity of the extinguishing media is of importance."

But, that definition seems lacking in treatment of the key element, that is, the effect of a continuous energy source. A more apt definition, based on the testing included in this paper might be the following:

> A fire that involves energized electrical equipment where an uninterrupted energy source will continue to reignite the surrounding Class A or B fuels. It is also a fire where the electrical nonconductivity of the extinguishing media is of importance. This report provides data for using selected clean agents to suppress a fire event by extinguishing and preventing reignition.

OBJECTIVE

The objective of this testing was to contrast the effectiveness of 1st and 2nd generation halon alternatives in extinguishing Class "A" fires as reported in the FDIS ISO 14520[5] with their ability in preventing reignition in Class "C" energized fires ignited by a heated metal surface energized by direct current (DC) power supply. The rationale here is that the latter more accurately reflects that which occurs in an end use application involving electrical and electronic components. Unfortunately, to date, the codes and standards give little guidance to the fire protection design professional on how to address such hazards.

The following data were obtained:
1) Minimum concentration required to extinguish and
2) Minimum concentration required to prevent re-flash / reignition are shown for the application where the energy source is not de-energized and the ignition is the cause of the fire event.

AGENT SELECTION CRITERIA

The criteria considered for clean agents tested were:
1) Must be accepted total flooding agents found in NFPA 2001, 2004 edition[6]
2) Currently being used in telecommunication and data center applications

TEST METHODOLOGY AND PROCEDURE

Tests were conducted in a 1.2 m^3 (45 ft^3) enclosure. The fuel was polymethacrylate (PMMA). The ignition source was nickel – chromium resistance wire energized by a DC power source. Power levels were 48 w and 192 w. A series of tests was conducted according to the protocol used by Craft[3] demonstrating an over-heated metal surface igniting the surrounding materials.
The following procedures were used to conduct the test:
- The cylinder is filled with appropriate amount of agent
- The test enclosure is ventilated and sealed
- DC power is applied to nichrome wire / PMMA sample
- Upon reignition and sustained flame a 60 second pre-burn is allowed
- Cylinder is discharged agent discharge time recorded
- Fire extinguishment is recorded. If fire extinguishment does not occur within ten minutes (or when fuel) is consumed, the test is discontinued
- The test is considered acceptable if extinguishment occurred within 30 seconds after agent discharge
- In the event the flame is extinguished, the test is continued to determine the time required for reignition or re-flash to occur. If reignition or re-flash does not occur within ten minutes, the test is discontinued.
- Tests are repeated using higher concentrations of each agent until TRUE suppression is reached, extinguishment without re-flash or reignition.

These criteria were the same as the previous testing provided.

TEST RESULTS

Using a system pressure of 25 bar (360 psig) for the two halocarbon agents and 150 bar (2175 psig) for the inert gas, the results attained are shown in Table 1. Table 2 contrasts the fire performance of the agents between Class A and Class C fire scenarios.

Table 1. Test Results.

Agent	Energy level (W)	Minimum Extinguish Conc %	Minimum Conc % to prevent reflash/ reignition	Tests conducted
HFC-125	48 192	11.5 11.9	12.0 12.4	20
HFC-227ea	48 192	6.5 8.0	8.0 9.3	3
IG-541	48 192	41.8 49.0	49.0 56.1	18

Table 2. Suppression Comparison Recap – Class A vs. Class C.

Agent	48 watt	192 watt	FDIS 14520 Class A extinguishing value %
Halon 1301	3.0	5.5	N/A
IG 541	49.0	56.1	30.6
FC-3-1-10	8.0	9.5	N/A
FK-5-1-12	4.5	5.1	4.1
HFC-23	16.0	20.0	11.7
HFC-125	12.0	12.4	8.6
HFC–227ea	8.0	9.3	6.1
HFC-236fa	8.7	9.0	6.8

CONCLUSIONS

- The current extinguishing design standards for Class "A" fires do not adequately provide for **suppression i.e. containment to prevent for re-flash and reignition.**
- Clean agent suppression concentration values for Class "C" energized fire should be based on material and the energy levels to be protected.

RECOMMENDATIONS

- This test protocol could be used to address electrical equipment by a 48 volt DC battery supply with distribution fusing at 1 amp and 4 amp.
- Higher energy application may require additional testing to validate performance and usage criteria.
- To prevent re-flash or reignition of Class "C" energized fires, clean agent system design should be based on the demonstrated performance level that prevents reignition plus a minimum safety factor of 10%.

REFERENCES

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