NFPA Formal Interpretation Request Form

(This information is requested in Section 6 of the Regulations Governing Committee Projects)

Name: John N. Hannon, Chief, Plant Systems Branch

Company: United States Nuclear Regulatory Commission

Address:

City: Washington State: D.C. Zip: 20555-0001

Telephone: 301 415-2873 Fax: 301 415-2300

NFPA Document No.: 12A Edition: 1980 Paragraph Reference: A-2-4

Did this question arise from an actual field situation? Yes X No ☐

Please state your business interest in the matter and identify other parties involved:

On June 20, 2002, the NRC held an open regulatory conference with Florida Power & Light Company (FPL) to discuss FPL's position in response to NRC's Draft Apparent Violation concerning the adequacy of their Total Flooding Halon 1301 Fire Extinguishing system installed in St. Lucie Unit 1 Cable Spreading Room. This Formal Interpretation request is a result of information presented by a member of the 12A Technical Committee (consulting to FP&L) that differs from the NRC Staff Fire Protection Engineers understanding of the 12A Standard.

Question: (Should be worded so that it can be answered with a yes or a no.)

Is it the intent of the Technical Committee that the purpose of Section A-2-4 of Appendix A to NFPA 12A is to inform the user of the standard of the need to provide a higher concentration and longer hold time than those published in the Standard for the extinguishment of deep seated fires?

Signature: Date:

NFPA Fax (617) 770-3500

Mail to Secretary, Standards Council • National Fire Protection Association
1 Batterymarch Park • PO Box 9101 • Quincy, MA 02269-9101

Table A-2-3.2.3
Halon 1301 Design Concentrations for Inerting

Fuel	Minimum Conc.* % by Volume
Acetone	7.6
Benzene	5
Ethanol	11.1
Ethylene	13.2
Hydrogen	31.4
Methane	7.7
n-Heptane	6.9
Propane	6.7

*For references see Ref. (4) Appendix B-1-6.
NOTE: Includes a safety factor of 10 percent added to experimental values

A-2-4 Fires in Solid Materials. Two types of fires can occur in solid fuels: one, in which volatile gases resulting from heating or decomposition of the fuel surface are the source of combustion: and another, in which oxidation occurs at the surface of, or within, the mass of fuel. The former is commonly referred to as "flaming" combustion, while the latter is often called "smoldering" or "glowing" combustion. The two types of fires frequently occur concurrently, although one type of burning may precede the other. For example, a wood fire may start as flaming combustion, and become smoldering as burning progresses. Conversely, spontaneous ignition in a pile of oily rags may begin as a smoldering fire, and break into flames at some later point. Flaming combustion, because it occurs in the vapor phase, is promptly extinguished with low levels of Halon 1301. In the absence of smoldering combustion, it will stay out.

Smoldering combustion is not subject to immediate extinguishment as is flaming combustion. Characteristic of this type of combustion is the slow rate of heat losses from the reaction zone. Thus, the fuel remains hot enough to react with oxygen, even though the rate of reaction, which is controlled by diffusion processes, is extremely slow. Smoldering fires can continue to burn for many weeks, for example in bales of cotton and jute, and within heaps of sawdust. A smoldering fire ceases to burn only when either all of the available oxygen or fuel has been consumed, or when the fuel surface is at too low a temperature to react. These fires are usually extinguished by reducing the fuel temperature, either directly by application of a heat absorbing medium, such as water, or by blanketing with an inert gas. The inert gas slows the reaction rate to the point where heat generated by oxidation is less than heat losses to surroundings. This causes the temperature to fall below the level necessary for spontaneous ignition after removal of the inert atmosphere.

For the purposes of this standard, smoldering fires are divided into two classes: (1) where the smoldering is not "deep seated," and (2) deep-seated fires. The difference is only a matter of degree, and the distinction is a functional one: if a 5 percent concentration of Halon 1301 will not extinguish it within 10 minutes of application, it is considered to be deep seated. In practice, experiments have shown a rather sharp dividing line between the two. Deep-seated fires usually require much higher concentrations than 10 percent and much longer soaking times than 10 min.

Whether a fire will become deep-seated depends in part upon the length of time it has been burning before application of extinguishing agent. This time is usually called the "preburn" time. Underwriters Laboratories wood crib fires (1A) and stacks of wood pallets have been readily extinguished with less than 5 percent Halon 1301 maintained for less than 10/min following discharge. In these tests, a 10 min preburn was allowed. Charcoal, the ultimate product of a wood fire, required over 30 min for complete extinguishment in a 5 percent Halon 1301 concentration. In charcoal fires, higher agent concentrations were found to reduce the soaking times. At a 10 percent concentration, a 20 min soaking time was required, and at 20 percent, the soaking time was reduced below 15 minutes.

Another important variable is the fuel configuration. While wood cribs and pallets are easily extinguished with 5 percent Halon 1301, vertical wood panels closely spaced and parallel require about 25 percent concentrations for 30 to 40 min for extinguishment. Fires in boxes of excelsior and in piles of shredded paper also required about 20 percent Halon 1301 for extinguishment. In these situations, heat tends to be retained in the fuel array, rather than being dissipated to the surroundings. Radiation is an important mechanism for heat removal from smoldering fires.

Experiments with a similar agent, Halon 1211, have shown that the ratio of the burning surface area to the enclosure volume can affect the concentration-soaking time requirements for some deep-seated fires. Low area/volume ratios required higher agent concentrations and longer soaking times than higher ratios. In other words, small fires in large enclosures were more difficult to extinguish than the contrary situation. This suggested that oxygen depletion is important in the extinguishment of deep-seated fires.

To date, no firm basis has been developed to predict the agent requirements for a deep-seated fire. In a practical sense, however, the use of a Halon 1301 system for control or extinguishment of a deep-seated fire is usually unattractive. Long soaking times are usually difficult to maintain without an extended agent discharge, and at high

agent concentrations these systems become rather expensive. The use of Halon 1301 systems will generally be limited to solid combustibles which do not become deep-seated.

The deep-seated potential of a solid material in a given situation can be established positively only by experiment. The information given in this standard may assist the authority having jurisdiction to decide whether such experimentation is necessary.

A-2-5.2 Total Flooding Quantity. The volume of Halon 1301 required to develop a given concentration will be greater than the final volume remaining in the enclosure. In most cases, Halon 1301 must be applied in a manner that promotes progressive mixing of the atmosphere. The displaced atmosphere is exhausted freely from the enclosure through small openings or through special vents, as Halon 1301 is injected. Some Halon 1301 is therefore lost with the vented atmosphere. This loss is greater at high concentrations.

For the purposes of this standard, it is assumed that the Halon 1301/air mixture lost in this manner contains the final design concentration of Halon 1301. This represents the worst case from a theoretical standpoint, and provides a built-in safety factor to compensate for non-ideal discharge arrangements.

A-2-5.3 Special Conditions.

Effects of Ventilation. Halon 1301 discharged into a ventilated enclosure for total flooding is subject to loss of agent in the effluent ventilating air. A greater amount of agent may be required to develop a given concentration, and continuous agent discharge is required to maintain the concentration at a given constant level.

Beginning with an enclosure containing pure air, the Halon 1301 discharge rate required to develop a given concentration of agent at any given time after start of discharge is as follows:

$$R = \frac{C\ E}{S(100\text{-}C)\ 1 - e - \frac{E}{V} T}$$

Where:

R = Halon 1301 discharge rate, lbs per sec (kg/s)
C = Halon 1301 concentration, percent by volume
E = Ventilation rate, cu ft per sec (m^3/s)
V = Enclosure volume, cu ft per sec (m^3)
T = Time, sec
e = Natural logarithm base, 2.71828
S = Specific volume of Halon 1301 vapor at the design temperature (ft^3/lb) (m^3/kg)