



A UTC Fire & Security Company

Badger Fire Protection
www.badgerfire.com

TECHNICAL BULLETIN

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Subject: Foam Applications for Flammable Liquid Fires of Appreciable Depth (Fuel-in-Depth)

The class "B" (Fuel-In-Depth) hazard coverage recommendations contained within NFPA-10 do not specifically address the effects various types of flammable liquid fuels may have on foam extinguishing agents. While there is a broad base of flammable liquids which fall under the class "B" fire hazard category, the fire test criteria used to obtain fire ratings on foam extinguishers is based on only one type of fuel. The ANSI/UL-711 class "B" extinguisher pan fire test protocol specifies a 2-inch depth of "Heptane" fuel, which does not possess the same flammability, vapor pressure and solubility characteristics that other types of flammable liquids may have.

Foam extinguishing agents work by floating on the surface of flammable liquids to create a barrier between combustible vapors and oxygen in the air, therefore it is essential to understand that fuel properties can affect foam agents and their necessary application rates. It is also important to realize that the specific properties of a foam agent are only relevant, if the foam solution is being delivered at or above the minimum application rate necessary to successfully extinguish that fire.

Unfortunately, much of the data available for various foam solutions is established on agent application testing rates which are much higher than those delivered from portable fire extinguishers. This potential discrepancy between various foam agent solution recommendations and the specific hardware being used can result in improper foam fire protection coverage on certain types of flammable liquid fuels.

To address various fuel foam application concerns, Badger conducted live fire tests on other hydrocarbon and polar solvent types of fuels commonly found within industry to verify and establish some specific hand portable recommendations for their model F-250 foam fire extinguisher. Establishing a realistic fire test criteria to evaluate foam agent suitability upon various types of "fuel-in-depth" flammable liquid fires, took some considerable thought and consideration. The following rationale was utilized in establishing our foam test procedure.

1. To establish a consistent test fire hazard configuration, the same heavy square steel fire test pans containing a minimum 2 inch fuel depth and the 1 minute pre-burn specified within the ANSI/UL-711 class "B" pan fire test protocol was utilized.
2. It was felt that a reasonable safety factor could be obtained by using larger test pans having greater surface areas that those identified in NFPA-10 (reference paragraphs 6.3.2.1 and 6.3.2.2) and by requiring total fire extinguishment to be accomplished prior to the two-thirds point of the fire extinguishers total discharge time.
3. As required within the ANSI/UL-711 class B fire test criteria, outdoor wind conditions were limited to under 8 mph and the extinguisher operator was only allowed to only approach the fire from one side of the test pan. Intermittent discharge of the foam fire extinguisher was not permitted.

For specific Badger model F-250 AR-AFFF foam fire extinguisher application recommendations regarding various types of fuel-in-depth flammable liquid fire hazards, refer to the following page:

Badger Universal Ultra Foam Fire Extinguisher Application Chart for Fuel-In-Depth “Flammable Liquid Fires of Appreciable Depth”

Flammable liquids of appreciable depth are defined as fire situations involving liquid fuel depths greater than ¼ inch. These liquid hazards are sometimes also referred to as fuel-in-depth hazards. Under NFPA-10 the maximum allowable open flammable liquid surface area for extinguisher protection of such hazards not protected with a fire suppression system, is limited to either 10 or 20 square feet of maximum surface area, depending on whether or not trained extinguisher personnel are available on the premise. (Reference 2010 NFPA-10 paragraphs 3.3.17, C.2.6.2, 6.3.2.1 and 6.3.2.2)

Paragraph 6.3.2.4 allows AFFF foam extinguishers to be provided and permitted on the basis of 1B of fire rating per square foot of liquid surface hazard area protected.

Paragraph 5.5.3 requires the use of special alcohol resistant types of (AR) foam solution fire extinguishers for use on water-soluble (Polar Solvent) flammable liquids.

IMPORTANT BADGER TECHNICAL APPLICATION DATA NOTICE:

All of the following test fires were conducted with a 2.5 gallon Badger model F-250 “Universal Ultra” AR-AFFF fire extinguisher having an ANSI/UL-711 fire rating of 1A:30B and total discharge time of 100 to 110 seconds. This test information is provided for assistance and guidance with the proper selection and placement of Badger F-250 foam fire extinguisher models protecting various types of flammable liquid (fuel-in-depth) fire hazards of appreciable depth. Badger assumes no liability or responsibility for any use or misuse of the test information provided.

Hydrocarbon Fuels Tested

Fuel Name	Flash Point	Ignition Temperature	Test Pan Utilized	Fire Extinguished	Maximum Coverage Area Recommended
Mineral Spirits (odor less)	104F/40C	473F/245C	25 sq. ft.	29.0 seconds	20 sq. ft.
#2 Diesel Fuel	125F/52C	494F/257C	25 sq. ft.	31.2 seconds	20 sq. ft.
K-1 Kerosene	100F/43C	410F/210C	25 sq. ft.	32.3 seconds	20 sq. ft.
Heptane (ANSI/UL-711 Test Fuel)	25F/-4C	399F/204C	25 sq. ft.	38.9 seconds	20 sq. ft.
87 Octane-Unleaded Gasoline	-45F/-42C	536F/280C	25 sq. ft.	54.0 seconds	20 sq. ft.
89 Octane-Unleaded Gasoline	-45F/-42C	536F/280C	25 sq. ft.	50.9 seconds	20 sq. ft.
92 Octane-Unleaded Gasoline	45F/-42C	536F/280C	25 sq. ft.	53.6 seconds	20 sq. ft.
110 Octane-Leaded Gasoline	-45F/-42C	536F/280C	25 sq. ft.	58.5 seconds	20 sq. ft.

Polar Solvent (Water-Soluble/Miscible) Fuels Tested

Fuel Name	Flash Point	Ignition Temperature	Test Pan Utilized	Fire Extinguished	Maximum Coverage Area Recommended
Ethyl Acetate (99%)	24F/-4C	800F/426C	25 sq. ft.	40.0 seconds	20 sq. ft.
Methanol Alcohol	52F/11C	867F/463C	25 sq. ft.	65.0 seconds	20 sq. ft.
Acetone	-4F/-20C	869F/465C	25 sq. ft.	66.0 seconds	20 sq. ft.
* Methyl Ethyl Ketone (MEK)	16F/-9C	759F/404C	12.5 sq. ft.	33.6 seconds	10 sq. ft.
*Ethyl Alcohol	55F/13C	685F/363C	12.5 sq. ft.	37.5 seconds	10 sq. ft.
* Isopropyl Alcohol	53F/12C	750F/399C	12.5 sq. ft.	43.8 seconds	10 sq. ft.

* **Note:** The reduced test pan utilized and the reduced maximum coverage areas recommended for these fuels.