



FOAM SYSTEMS APPLICATION CASE STUDY

Protection of Jet Fuel Tank Farm

Overview

Handling, storing, and transporting large volumes of flammable liquids can be difficult. Precautions for safety and fire protection must be taken into account. This was the case for a recent Ansul foam system installation for a newly constructed Jet Fuel Tank Farm expansion at Washington Dulles International Airport. The six storage tanks hold over 14 million gallons (52 million liters) of Jet-A Fuel. The use and availability of the fuel is critical to the operation of a major airport such as Dulles in a major city such as Washington DC. Downtime is not an option.

Protection of stored flammable liquids and hydrocarbons such as Jet-A Fuel is covered in NFPA 11: *Standard for Low-Expansion Foam*. For fixed-roof storage tanks containing hydrocarbons such as Jet Fuel, NFPA 11 recommends the use of a fixed foam system using

one of the following methods of protection: a) foam monitors and handlines, b) surface application with fixed foam discharge outlets, c) subsurface application, and d) semi-subsurface injection methods.

It should be noted that monitor nozzles shall not be considered for primary protection of fixed-roof tanks over 60 ft. (18.3 m) in diameter. Foam handline nozzles shall not be considered as the primary means of protection for fixed-roof tanks over 30 ft. (9.1 m) in diameter or those over 20 ft. (6.1 m) in height. In this case, each tank was 100 ft. (30 m) in diameter; therefore, "option b" was chosen using fixed-foam discharge outlets for the protection of the tank and the dike containment areas. NFPA 11 also gives design parameters for the number of fixed foam discharge outlets, minimum application rates, and minimum discharge time.

Application/ Design Criteria

The Metropolitan Washington Airports Authority was responsible for the Fuel Farm Expansion along with Burns and McDonnell of Kansas City (Engineer/Design), Bell BCI of New York (General Contractor), National Fire Protection, Inc. (Fire Protection Contractor) and Ansul Incorporated (Foam Agent and System Manufacturer).

Each of the six Jet-A Storage Tanks has a capacity of 55,950 barrels or 2,349,000 gal. (8,891,905 L), with a height of 40 ft. (12.2 m), diameter of 100 ft. (30 m), area of 7,854 sq. ft. (729.6 m²), and a shell area of 12,566 sq. ft. (1167.4 m²). The Containment Dike for each pair of tanks is 215 ft. x 343 ft. (65.5 m x 104.5 m), with a total area of 73,745 sq. ft. (6851 m²) and a net area (less tanks) of 58,042 sq. ft. (5392 m²). The design called for a manual foam deluge system with primary foam storage capacity to protect two Jet-A storage tanks and three dike containment areas. In addition, the reserve foam storage was required to be equal to the primary foam storage. The required foam-water flow rate was based on protecting two Jet-A storage tanks and one dike containment area simultaneously.

Foam-Water Application

Jet-A Tank (Each):	0.10 gpm/sq.ft. (4.07 Lpm/m ²) full surface area
Min. Discharge Time:	30 minutes
Dike Area (Each)	0.10 gpm/sq. ft. (4.07 Lpm/m ²)
Min. Discharge Time:	20 minutes

Total Flow Rate

Jet-A Tank (Each):	0.10 gpm/sq.ft. x 7,854 sq.ft. = 785 gpm (4.07 Lpm/m ² x 730 m ² = 2,973 Lpm)
Dike Area (Each):	0.10 gpm/sq.ft x 58,042 sq.ft. = 5,804 gpm (4.07 Lpm/m ² x 5,392 m ² = 21,968 Lpm)

Foam Concentrate

Jet-A Tanks (2):	785 gpm x 3% x 2 = 47 gpm (2,973 Lpm x 3% x 2 = 178 Lpm)
Dike Area (3):	5,804 gpm x 3% x 3 = 522 gpm (21,968 Lpm x 3% x 3 = 1,977 Lpm)

Foam Storage

Jet-A Tanks:	47 gpm (178 Lpm) x 30 min.	= 1,410 gal. (5,340 L)
Dike Areas:	522 gpm (1,977 Lpm) x 20 min.	= 10,440 gal. (39,540 L)
Foam Piping:	13,350 gpm (50,535 Lpm) x 3%	= 400 gal. (1,516 L)
Total Primary Foam Concentrate Required:		12,250 gal. (46,396 L)
Total Foam Agent Required (Primary & Reserve):		24,500 gal. (92,792 L)

Water Supply

Jet-A Tanks:	785 gpm (2,973 Lpm) x 97% x 2 x 30 min.	= 45,687 gal. (173,029 L)
Dike Areas:	5,804 gpm (21,968 Lpm) x 97% x 3 x 20 min.	= 337,793 gal. (1,278,538 L)
Foam Piping:	13,350 gpm (50,535 Lpm) x 97%	= 12,950 gal. (49,019 L)
Total Water Required for Foam System		396,430 gal. (1,500,586 L)

Project Scope

Once again referencing NFPA 11 and Table 3-2.3.2.1, with a tank diameter of 100 ft. (30 m), a minimum of two discharge outlets are required per storage tank. Thus, two foam chambers were supplied per tank. Foam Chambers are air-aspirating discharge devices (Type II) used for the protection of flammable liquid storage tanks. These devices are designed to generate foam and apply the expanded foam to the fuel surface in a manner that lessens submergence and agitation as the foam contacts the fuel. The foam chamber contains an orifice plate (sized for the required flow and inlet pressure), air inlets, an expansion area, and a discharge deflector to direct the gentle application of the expanded foam. This device also contains a vapor seal that prevents the entrance of vapors into the foam chamber and supply pipe.

Section 3.7 of NFPA 11 offers guidelines for the selection and number of foam outlets for the dike areas. For outlets or foam makers with discharge rates higher than 60 gpm (227 L/min), the recommended maximum distance between discharge outlets shall be 60 ft. (18.3 m). Based on this, 48 foam makers were supplied for each of the tank containment areas. A Foam Maker is an air-aspirated discharge device used primarily for the protection of open top, floating roof tanks and dike areas. The foam maker contains an orifice plate (sized for the required flow and inlet pressure), air inlets, and an expansion area. The device is connected in-line to pipe or hose.

A Balance Pressure Pump Proportioning System (Pump Skid) was the chosen design for delivering the foam solution to the tank farm. With this system, an automatic pressure-balancing valve regulates the foam concentrate pressure to match the water pressure. A duplex pressure gauge provides continuous monitoring of both water and concentrate pressures. Positive displacement pumps are used with these systems to allow maximum efficiency for liquids of varying viscosity. The size of pumps and drivers will vary depending on the application and the type of foam used.

The key items of the Ansul Foam System Scope of Supply for the Tank Farm were as follows:

- 6 - Polyethylene Foam Tank, 5,500 Gallons (20,820 L)
- 1 - Electric Foam Pump rated for a minimum of 265 gpm @ 190 psi (1,003 Lpm @ 13.1 bar), complete with Pump Controller and Remote Alarm Panel
- 1 - Diesel Foam Pump rated for a minimum of 265 gpm @ 190 psi (1,003 Lpm @ 13.1 bar), complete with Pump Controller and Remote Alarm Panel
- 1 - Jockey Pump & Controller
- 1 - Pressure Control Valve, 3"
- 1 - Foam Pump Flow Meter, 3"
- 2 - IBP-8M In-Line Balanced Pressure Proportioner Assembly with 8" Proportioner and Orifice
- 1 - IBP-6M In-Line Balanced Pressure Proportioner Assembly with 6" Proportioner and Orifice
- 2 - Hydraulically Actuated Foam Concentrate Ball Valve, 3" with Stainless Steel Actuator
- 12 - AFC-330 Foam Chamber with orifice plate sized for 393 gpm (1,488 Lpm) at specified inlet pressure over a K-factor range of 28.9 to 61.0, including Split Deflector and Mounting Pad
- 144 - FLR-90 Foam Maker with orifice sized for approximately 121 gpm (458 Lpm) over a K-factor range of 5.6 to 15.0
- 1 - Bulk Tanker Supply, 24,500 gal. (92,742 L) of ANSULITE® 3% AFFF (AFC-5A) qualified to MIL-F-24395 latest revision

Conclusion

For a special hazard project of this magnitude, it is critical to have all design details defined prior to the start of the project. This includes the hazard to be protected, the size of the area to be protected, the system sequence of operation, the water requirements, and of course, the foam concentrate requirements. Also, following the proper guideline (NFPA 11: *Standard for Low-Expansion Foam*) is a major requirement for foam system design as is using foam equipment and foam concentrates that are UL-listed and FM-approved. Finally, using a foam manufacturer such as Ansul that offers a full line of quality equipment and foam concentrates, design assistance, and field start-up support services is most important for a large long-term project such as the Dulles Tank Farm Expansion.

If you have questions concerning the design of foam systems for the protection of flammable liquid storage tanks, please call Ansul Technical Services at 800-862-6785 or 715-735-7415. See our Web Site at www.ansul.com.



ISO 9001 Registered