



دبلوم تطبيقات التحكم الأوتوماتيكي في نظم القوى الميكانيكية

MEP 599 Diploma Design Project-Summer Term 2015/2016

A Case Study for: Aircraft Hanger Fire Fighting Foam Suppression System

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Abstract: This project includes detailed design and calculations of a fire foam suppression system for the EAG650 Aircraft Hangar which is a closed building structure to hold aircraft or its equipments in protective storage. Hangars are used to protect Aircrafts from weather, direct sunlight and used for maintenance, repair, manufacture, assembly & also for storage of aircraft on airfields, aircraft carriers & ships. Installing firefighting equipment in an aircraft hangar is as much about protecting the aircraft as it is the hangar itself, such is the cost differentiation between the hangar and its contents.

The EAG650 Hangar is designed to contain 2 "Gulfstream G650" aircrafts at same time to perform scheduled maintenance & troubleshooting procedures for malfunctioned aircrafts. It is constructed of steel frame & translucent panels in walls & roof , (74mx 38m), with a clear height of 10m complete with insulated roof and wall cladding including doors. The hangar has one entrance at one span) consists of 8 doors slabs on 4 tracks, providing an entrance 72m x9m high to allow the entry of 2 Gulfstream G650 Aircrafts. The main hangar doors are of steel frame construction and are electrically operated. The hangar is provided by two control rooms(1st is electrical control room & the 2nd is for controlling the fire fighting system of the hangar). The hangar has 4 emergency exits for personal safety.

System Description: As per NFPA409"Standard on Aircraft Hangars", the EAG650 Hangar complies to Group I Hangars & must contain an over head Total Flooding, High-Expansion Foam-Water Deluge system as a primary fire protection system. It consists of fixed foam-generating apparatus complete with piped supply of foam concentrate & water, arranged to discharge into an enclosed space or enclosure around the hazard. For adequate protection, the foam shall be discharged at a rate sufficient to fill the enclosure to an effective depth above the hazard before an unacceptable degree of damage occurs.



The EAG650 Aircraft Hangar



Gulfstream G650 aircraft & maintenance tasks in EAG650 Hangar



Testing an Aircraft Hanger Fire Fighting Foam Suppression System

Description of Work Done: This project deals with 4 codes of NFPA standard: NFPA 11A (Standard for Medium & High-Expansion Foam Systems), NFPA 20 (Standard for Fire Water Pump Installation), NFPA 30 (Standard for Flammable & Combustible Liquids), NFPA 409 (Standard for minimum requirement for proper construction of the aircraft hangars & their fire protection tasks). EAG650 hangar equipments include the Fire foam suppression system & electrical control room. As per NFPA409, EAG650 hangar complies to Group I Hangars & it must contain over head Foam-Water Deluge system as a primary fire protection system. Fire protection for Group I & II are: Foam-water deluge system with supplementary fire protection system under single aircraft wing area over 279m². The systems will be low - level low-expansion foam system using oscillating monitors or low-level high-expansion foam system. A combination of automatic sprinkler protection & an automatic low-level or high low-expansion foam system. Fire fighting system consists of 3 basic parts: large fire storage tanks, specialized water pumping system, large network of pipes ending in either hydrant or sprinklers.

Total Flooding High Expansion Foam-Water Deluge System Calculations Requirements:

- 1-Description:** it consists of fixed foam-generating apparatus complete with piped supply of foam concentrate & water, arranged to discharge into enclosed space or enclosure around the hazard.
- 2-Foam Requirements:** medium- or high- expansion foam shall be discharged at rate sufficient to fill the enclosure to effective depth above hazard before unacceptable degree of damage occurs.
- A-Foam Depth:** min. depth shall be not less than 1.1 times height of highest hazard but in no case less than 0.6m over hazard. For flammable/combustible liquids, required depth over hazard shall be permitted to be considerably greater & shall be determined by tests.
- B-Submergence Volume:** defined as foam depth multiplied by floor area of space to be protected.
- C-Submergence Time:** Recommended times to achieve submergence volume are as NFPA 11A.
- D-Rate of Discharge:** is for extinguishment or sufficient control to permit overhaul depends on strength of sprinkler protection, nature & configuration of hazard, vulnerability of structure & contents to fire, and loss potential to life, property, and production. Rate also depends on foam properties, such as expansion ratio, water retention, effect of water contaminants, & temperature effects on water retention. Discharge rate shall be sufficient to satisfy foam depth requirements & submergence time as per NFPA11A, with compensation for normal foam shrinkage, foam leakage, and break- down effects of sprinkler discharge.

The High Expansion Foam System Calculations:

- 1-Discharge rate, R:** as per NFPA 11A, discharge rate, R, from formula;
- V= hangar volume, discharge time, T= 3min. (R_S= 0 no sprinkler installed), C_N= 1.15, C_L=1.1 for moderate leakage. We get R=142170.2 ft³/min.
- 2-No. of Foam Generators:** select generator JET-X 2% (can produce 23965 cfm @ 50 psi inlet pressure with expansion ratio 883:1 & inlet foam solution flow of 203gpm. So; No. of generators ≈ 6
- 3-Foam concentrate supply:** each generator requires 203gpm of foam solution. So for minimum of 15 min operation; Total Stored Foam Concentrate= 365.4 US gallon.
- 4-Water Supply for 15min operation** = Total solution flow-foam concentrate flow = 17904.6USGal.

$$R = \left(\frac{V}{T} + R_S\right) \times C_N \times C_L$$



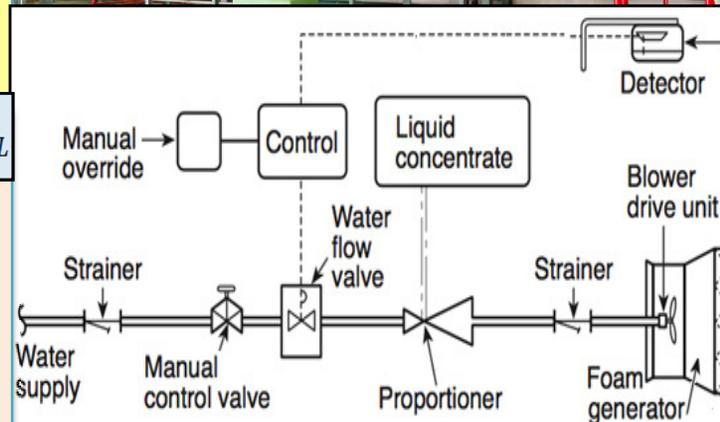
EAG650 Hangar
Fire Fighting Water Storage Tanks



Fire Fighting Pumping System



EAG650 Hangar
Fire Fighting Water Piping System



Block Diagram of Automatic High Expansion Foam system