

Large-Scale LNG Fire Tests

Engineers from Angus Fire have conducted a series of large-scale tests of the efficacy of high expansion foam and application equipment on Liquefied Natural Gas (LNG) fires

The tests were carried out at the new world-class LNG testing and training facility developed and sponsored by BP in collaboration with Texas A&M University Emergency Services Training Institute.

The test programme was organised in response to the strong global increase in demand for natural gas, the cleanest burning of all fossil fuels. When natural gas is chilled to -164°C , it turns into a liquid, takes up to 600 times less space, and can be economically shipped around the world aboard super tankers, just like oil.

The trouble with LNG is that if it catches fire it gives off three times the amount of heat of an equivalent sized oil fire. Heat emissions are the principal cause of damage from LNG fires.

Initial small-scale tests were carried out to assess the effectiveness of different types of



Medium expansion Tridol ATF foam controls LNG spill fire

Fire Tests



LNG Turbex delivers high expansion foam in searing heat of LNG fire

foam concentrate and application technique on a range of LNG fires.

Foam concentrates are known to vary enormously in their effectiveness on LNG. Low quality brands exhibit poor stability as indicated by their faster drainage rates. In contrast, high quality brands like Expandol and Tridol ATF from Angus Fire are known to produce a more stable foam layer for optimal performance and minimal topping-up.

A variety of application techniques were used including low, medium and high expansion as well as compressed air foam systems. The tests were carried out in a 10 m^2 square pit to simulate a small spill, and a 19 m^2 L-shaped trench to simulate an LNG pipeline.

In all tests a white cloud was observed where the vapourising liquid came into contact with moisture in the air. LNG is flammable when its vapour mixes with air in concentrations of between 5 and 15%. Such levels are normally expected on the fringes of the visible cloud, but portable gas monitoring equipment detected pockets of flammable vapours up to 150 metres from the cloud.

The vapour cloud was ignited at the edges and allowed to burn back through the cloud to the liquid pool in the pit. In one test, Tridol ATF foam applied gently through a hand-held medium expansion foam branchpipe was observed to control the fire and achieve a reduction in heat radiation of over 90% in only one minute.

LARGE-SCALE TESTS

Large-scale tests were carried out to simulate a major spill fire in the bunded or diked region surrounding an LNG storage tank. LNG was placed in a huge 65 m² test pit, the largest of its kind in the world. When the vapour cloud was ignited, flames shot over 30 metres into the air and gave off so much heat that personnel were forced to retreat to a safe distance.



Flames shoot over 30 metres into the air

Such intense heat emissions from a major LNG fire mean that ordinary high expansion foam equipment is totally unsuitable. It quickly distorts, buckles and ceases to generate any foam. That's why the specialist LNG Turbex from Angus Fire was used throughout the test programme. The exceptional heat resistance of the LNG Turbex ensures reliable operation even after prolonged exposure to searing heat. It has previously passed the demanding NFPA 11A fire exposure test with flying colours, withstanding temperatures as high as 1000°C.

Additional features of the LNG Turbex that proved crucial during the tests included a unique water-driven turbine motor and special aerofoil fan. These provided a

consistent air flow through the foam generator that produced foam with uniform expansion ratio at all times. Its cocoon-shaped design generated a stable slow-draining foam blanket with uniform bubble size for optimal performance, while stainless steel ducting ensured reliable foam delivery even in high winds.

Expandol high expansion foam of 300 to 500:1 expansion ratio was found to achieve rapid fire control and subsequently a controlled burn-off, achieving 90% reduction in heat radiation in just one minute. Once control was achieved, the foam application rate was varied while maintaining full control.

VAPOUR DISPERSION

The 65 m² pit was also used to simulate an unignited spill in the bunded region around a storage tank. The LNG Turbex was observed to reduce ground-level vapour concentrations within seconds to well below the Lower Flammable Limit of 5% by covering the spill with a blanket of top quality Expandol high expansion foam. A layer of frozen foam formed at the LNG/foam interface that supported several feet of additional foam. Ice tubes also formed where the vapours boiled through the foam blanket. As the vapours ascended through the foam, they were warmed, became lighter than air, rose upwards, and dissipated safely in the air above potential sources of ignition.

SYSTEM DESIGN

The importance of applying the findings of this latest test work to the design of LNG fire protection systems cannot be overstated. NFPA 11A, for example, suggests that application rates and discharge times should be established by test work.

Designing a successful system is not limited to using foam generating equipment and concentrates that have been thoroughly tested on LNG. A detailed risk analysis should be carried out early on, and critical variables such as induction rate, expansion ratio, drainage time and foam depth, as well as application rate and discharge time, should be carefully defined to suit each individual risk.

Combining all these factors into a properly engineered system is the hallmark of Angus Fire Engineering. The company is recognised world wide as the leading provider of engineered systems for the protection of LNG facilities. Staffed by a dedicated team of design engineers with extensive experience of LNG contracts, it has a proven track record of designing systems that have no equal in the industry.

The research and test programme will continue in 2005 with the construction of additional LNG fire testing facilities, maintaining Angus Fire Engineering's leading position at the forefront of LNG fire suppression technology.



Angus Fire Engineering has designed numerous LNG fire protection systems around the world