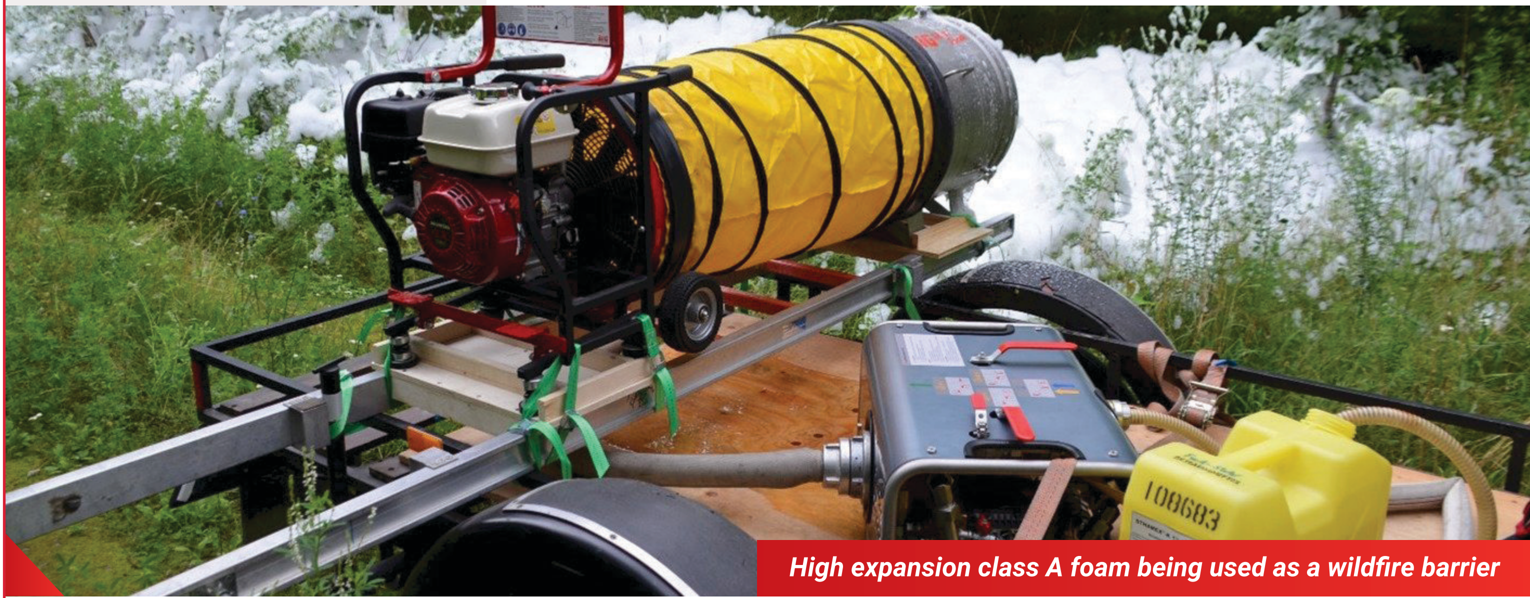
Fire fighting with foam and the importance of accurate proportioning



High expansion class A foam being used as a wildfire barrier

Fire fighting foam is seen as a complicated fire fighting method. Even though flammable liquid fires make up approximately one in five fires when they occur, they are particularly hazardous, so using foam correctly for extinguishing is critical. Mike Feldon, managing director of DoseTech Fire, shares current foam proportioning technology.

The fire fighting foam is the most critical component of a fire fighter's tool for class B fires. FireDos motto is 'Proportioning in excellence'. This fact binds everything we do in manufacturing precise foam proportioners and monitors designed to dispense foam accurately, regardless of the flow or pressure. This article helps to understand how it works, the equipment needed to proportion accurately and the latest developments in foam fire fighting equipment.

High Viscosity foam

Using foam to fight class B fires has led to it being used for class A fires as a wetting agent, where water droplets' natural surface tension is reduced, making the same quantity of water more effective at extinguishing. As a class A foam, it is also used as a barrier to prevent the spread of wildfires. As foam becomes more common in usage, fire fighters need to understand and use foam for a wider field of applications.

Using fire fighting foam means proportioning, admixing or dispensing it at the manufacturers and regulatory bodies (NFPA 11, BS EN13565, FM global, ICAO, UL162, IMO, MIL-F-24385) recommended proportioning rates. A common misconception is to increase the proportioning rate because a thicker mixture extinguishes the fire more rapidly.

Fire fighting with foam and the associated extinguishing or suppression devices have developed substantially over the past few years. The advantages of foam-based fire fighting are the ability to quickly smother a potential hazard and effectively knock down an oil/chemical-based fire.

Foam successfully operates by:
1. Forming a blanket, smothering and preventing oxygen from fuelling the fire,
2. Eliminating the flammable vapours released from the fuel surface
3. Separating the flames from the fuel
4. Cooling the fuel surface and surrounding area, such as adjacent tanks.

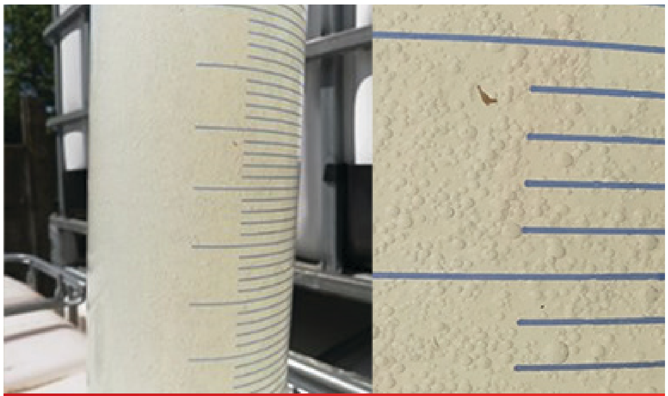
Equipment manufacturers have successfully automated foam proportioning systems to reduce the stress on fire fighters having to make mental calculations for eduction rates, application rates and required foam concentrate volumes. However, this has disadvantages in that the systems can be inadvertently abused, thus sometimes making the foam solution ineffective, for example, cycling handline hoses on/off with electronically controlled proportioning systems, as the foam quality is difficult to reach.

Many new and existing foam concentrates exhibit varying characteristics, such as high-viscosity, pseudoplastic and non-Newtonian, with differing viscosities at different temperatures and shear-thinning, as the foam viscosity reduces the more it is agitated. Other considerations are air entrainment and sedimentation and the introduction of environmentally friendly, fluorine-free foams, technically known as Synthetic Fluorine Free Foams (SFFF). Foam type and selection should naturally affect the selection of foam proportioning equipment, as the flow range, system pressure and mechanical mixing method all impact the foam quality.

Foam proportioning rates and their importance

Typical foam proportioning rates for class B fires are in the 1% to 6% range. However, recent years have seen a steady migration to move from 6% (using Fluoro-Protein foams (FP)) to 3% (Alcohol Resistant and Aqueous Film Forming Foams (AR-AFFF/AFFF) with some 1% in use.

However, as many existing fire fighting foams in use are known to be hazardous to health and the environment, the newer replacement Synthetic Fluorine Free Foams (SFFF) are generally proportioned at 3% until the foam concentrate technologists develop them further to reduce the proportioning rate. The PFAS (per- and poly-fluoroalky substances family) debate and development of suitable tested biodegradable fire ighting foams is ongoing but has an important impact on the use of fire fighting foams in legacy and new equipment.



High Viscosity foam

Accuracy

The purpose of a specific proportioning rate and why regulatory bodies insist on strict nominal proportioning rates of 3% or a minimum of 3,0%, maximum of 3,9%, a tolerance of -0% to +30% or 1% above the rated concentration (whichever is less) to maintain the effectiveness of the foam.

With lower proportioning rates, there may not be enough active foam ingredients for extinguishment and the discharged foam solution cannot form an effective blanket to both extinguish a fire and prevent re-ignition. If the proportioning rate is too high, the foam blanket is too thick and cannot travel fast enough across the surface of a liquid to extinguish. With some foam concentrates, the foam may also be too thick to dissolve effectively.

Extinguishing time

For an end-user or fire brigade, the obvious advantage of a lower proportioning rate is the ability to make the available stored foam last longer.

A foam proportioning rate at 1% lasts three times longer than a 3% proportioning rate and six times that of a 6% rate at a given flow rate. For example, a typical fire truck in the UAE with 8 000 litres of water

Too rich proportioning, meaning the foam solution cannot flow effectively to seal on a tank rim seal test (image courtesy of LaStFire)

and 2 000 litres of foam equates to 16 minutes of 3% foam solution at a flow of 4 000lpm, assuming a backup supply/hydrant is available for water (otherwise, it is two minutes). For a proportioning rate of 1% foam solution, 48 minutes is available.

Air entrainment can also be a problem when mixed with foam concentrate as the air volume at a system pressure of 10 bar is ten times less than at atmospheric pressure. What does this mean in practice: A foam concentrate containing 5% air due to being trapped in a high viscosity fluid. When the foam concentrate is mixed under a system pressure of 10 bar, the foam solution has 0,15% of air under pressure. When this expands upon reaching atmospheric pressure, the air expands by the same factor of the pressure it was under, ie 10 bar, therefore 10 times. This 5% air of the foam concentrate, made up 0,15% of the foam solution, expands ten-fold to 1,5% of the foam solution. We now have a proportioning rate of less than the optimum as 1,5% of the solution is air, not foam. The pumping of foam trapped with air is more complex than the example due to several factors such aspump speed, vacuum filling, thermal conductivity and vapour pressures. Air trapped in the foam means the system is under-dosed with a corresponding reduction in proportioning rate. Typically, we see lower than acceptable proportioning rates with higher air volume in the foam concentrate, meaning a failed foam test.

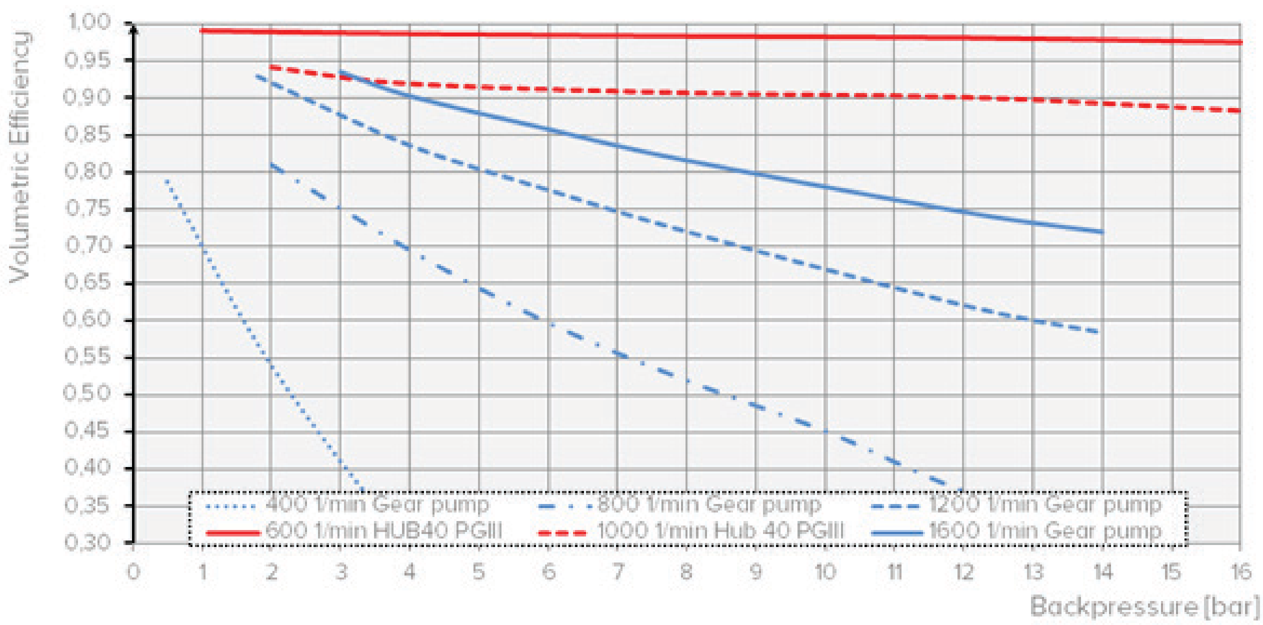
Many of these issues are stated as new problems. History tells us these are the same problems foam concentrate manufacturers, equipment manufacturers and end-users were faced with, when many new formulations were released dating back to the widespread introduction of AFFF in the 1970s and 1980s.

Equipment considerations

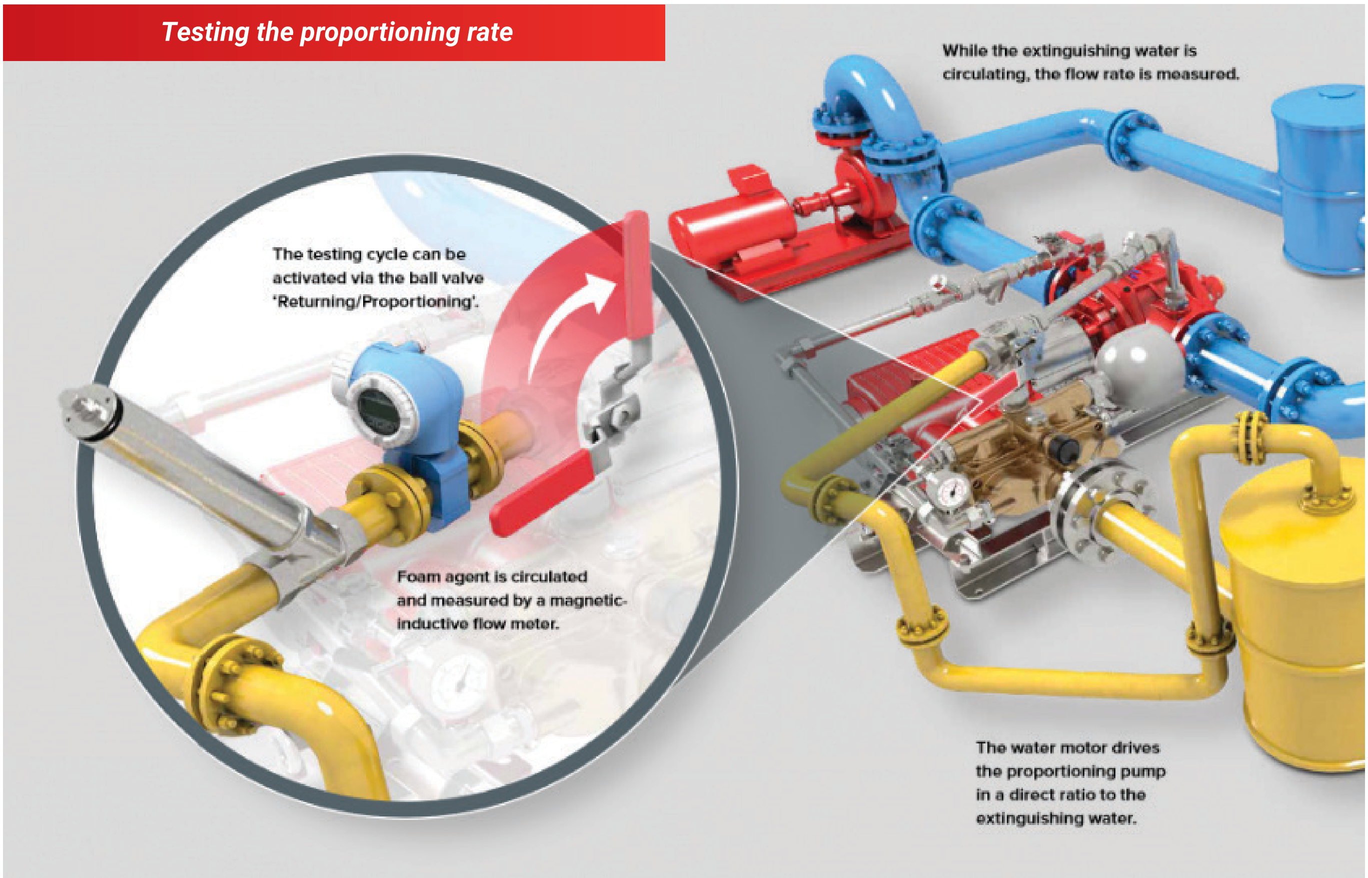
Different proportioning methods have different characteristics regarding the proportioning rate. In addition, sometimes their operation is affected by the foam type.

Bladder and Eductor proportioning

A bladder tank is pumped via the firewater pressure on a bladder and squeezed into the pipework and eventually to the Eductor before the discharge device (pourer, monitor, sprinklers). A system is designed to suit a constant viscosity, flow ranges are reduced when the fluid being pumped has a higher viscosity. The pressure loss also increases due to the effort required to educt or suck the foam concentrate into the water stream. This fact applies to any system using an eductor method of proportioning, such as a jet ratio controller, balanced pressure proportioner or wide range proportioner.



Curves show the difference between the FM-approved plunger pump technology used by FireDos in comparison to gear pumps



Gear pumps for foam pumping

Balanced pressure proportioners rely on the eductor principle with a pressurised flow of foam concentrate by a gear pump requiring an external drive (electric, diesel-driven or water-driven motor). However, with varying flow rates for differing fire scenarios and low viscosities, gear pumps have poor efficiencies, which translates into varying proportioning rates.

Water-driven variable flow proportioning pumps

FireDos, with their latest Gen III model, was designed after many years of real-life experience and using CFD techniques to optimise the pump head for high viscosity foam concentrates. Traditional thinking that piston pumps are for low viscosity and gear pumps are for high viscosity has been turned on its head. For accurate proportioning, high-efficiency pumps are required, which gear pumps cannot meet due to their susceptibility to different system pressures, flow ranges and varying viscosities. FireDos flow rate range has a ratio of 1:15 times (an FD8000 at 3% proportioning rate has an FM-approved flow rate range of 520 to 8 000lpm). An equivalent gear pump might have a flow rate range of two or three times, as shown in image 5.

The testament to this is the approval by the leading global fire protection authority, FM approvals. These approvals have been designed with water motor-driven foam pump proportioners specifically for variable viscosity foam proportioners with standardised conditions for approval.

The new pump design offers many advantages, not least:

- Low-pressure loss at specific system pressures. For a fire protection system designer, this offers the advantage of minimising the effect of the proportioning system on final discharge flows.
- A minimum flow threshold to achieve the proportioning rate
- A low NPSH requirement (in comparison to traditional off-the-shelf piston pumps).

The FM testing also includes many worst-case scenarios to simulate real-life applications, such as:

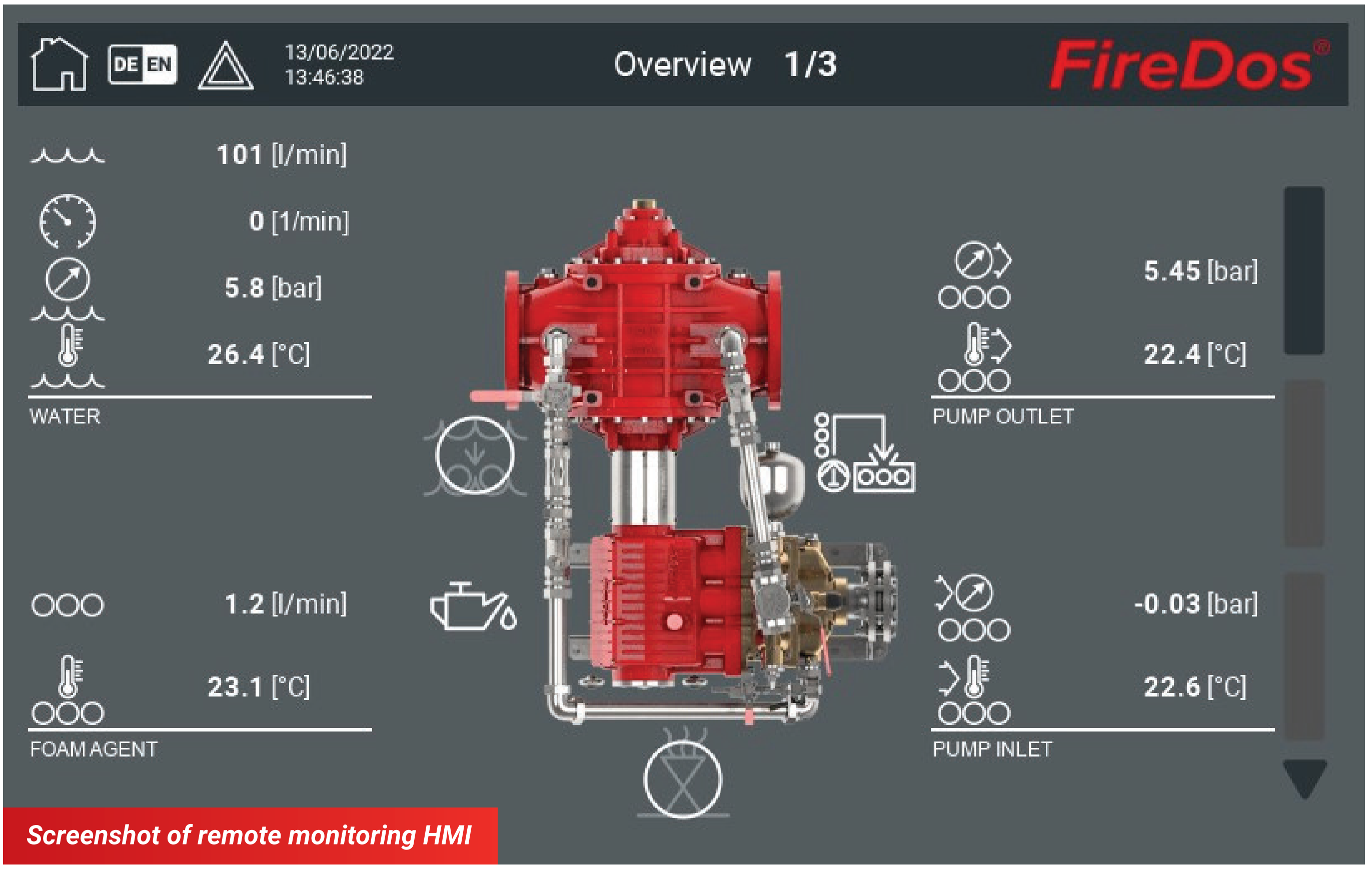
- Test points through the entire working range for testing viscous fluids, not only one point on a dynamic viscosity curve.
- Overload tests for pressure, flow and dry running
- Material compatibility tests, especially in saline environments

Testing the proportioning rate

An advantage of the FireDos proportion system is the ability to test the foam proportioning rate. As fire fighting foam concentrate becomes more complex, especially with SFFF, the cost rises. The NFPA and FM recommend annual foam proportioning rate testing. FireDos achieves this by measuring the flow rate of a foam concentrate return line to the foam storage tank and the water motor flow to calculate the precise proportioning rate.

The future is now: remote monitoring

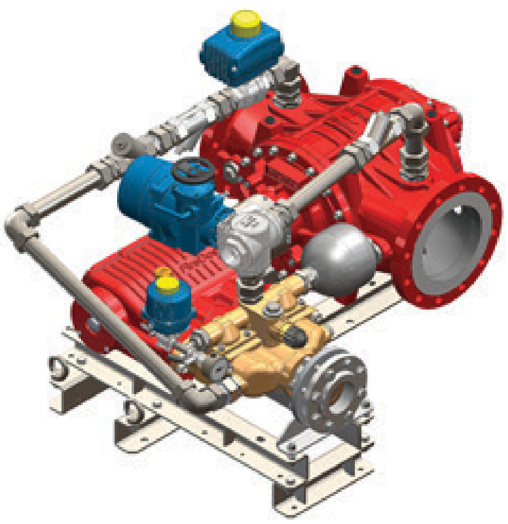
Monitoring fire protection systems in testing and readiness mode provides instant feedback without needing many remote and semi-skilled or qualified fire protection engineers. The system can be operated on-site with instructions provided remotely, providing



Screenshot of remote monitoring HMI

instant feedback and the creation of electronically created schedule maintenance logs. In addition, various data points are captured, such as flow rate, proportioning rate, oil fill level and temperature, ensuring at any time during service the FireDos proportioning system is always in a state of readiness.

A natural development of remote measurement, which relies on an operator to be present to turn the valves for testing and return to operational readiness, is the ability to perform an unmanned test. As the FireDos proportioner needs no external energy, adding actuators to the water



FireDos fitted with remotely operated valve actuators for operation and testing

motor doesn't require the start-up of any additional equipment, such as the fire pumps. Additional actuators are added to the two-way ball valve for proportioning/return.

All this information can be managed and viewed from a remote terminal or signals embedded into the end-users computerised maintenance management system.

A low-cost system

Considering fire protection systems are often legally required, the cost is considered an expense. However, the simplicity of a FireDos system, with very few system components, means the capital expenditure cost within an overall fire protection system is less expensive than many systems where redundancy must be designed in (electric motor-driven foam pumps, plus additional backup diesel engines).

The operational cost is also low, considering ongoing annual foam testing costs are one of the highest ongoing expenses. The FireDos' proportioning system's ability to test the foam and recirculate the concentrate back to the foam tank without discharging means the payback versus a lower-cost system which must discharge foam is regularly within two years.

What does this mean in practice: For the avoidance of doubt when specifying a precise foam proportioning system combined with almost any foam concentrate, the future of foam fire fighting systems, independently type-tested and approved, are available now from FireDos.

For more information please contact DoseTech Fire's Mike Feldon at email: mgf@dosetech.co.za or visit their website www.dosetech.co.za