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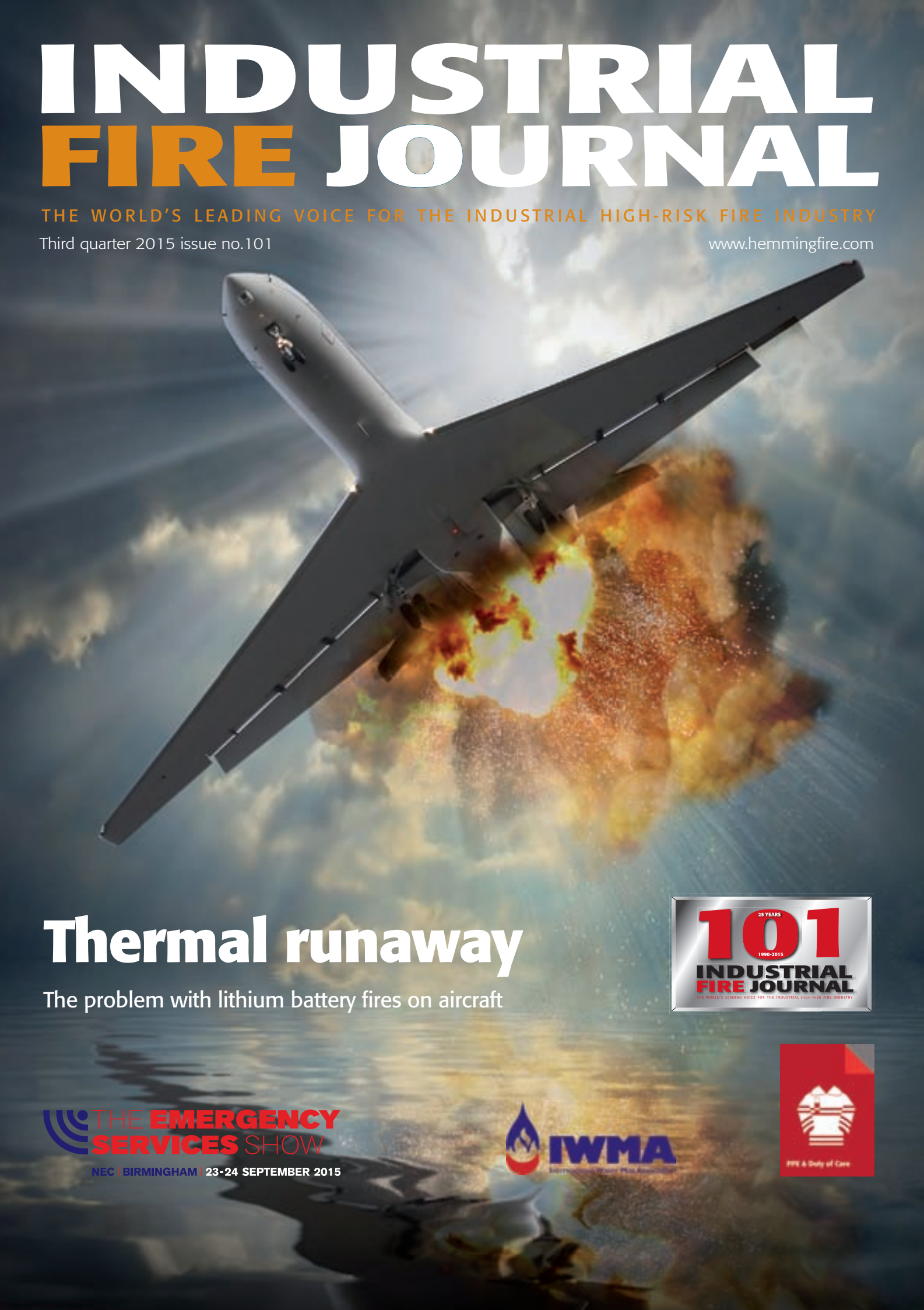

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The FARe approach

Storage tank fires are every operator's nightmare but what are the main threats and how can escalation into full surface fires be avoided? Valeriano Barrilà, Branch Manager, SA Fire Protection, introduces the FARe design method for rim seal fire protection.

Valeriano Barrila, Branch Manager, SA Fire Protection, Pisa, Italy.

A rim seal fire on a floating roof tank is one of the most dangerous threats for chemical and petrochemical storage farms and over the years the world has experienced several instances that have developed into large-scale disasters

These sorts of fires are normally caused either by lighting strike or by human error related to maintenance work or operational activities. Less common are fires caused by sparks occurring as a result of electrostatic charge, natural disaster or an uncontrolled exothermic chemicals reaction.

Lightning as the result of a thunderstorm or sandstorm is nevertheless the most probable cause of a fire outbreak on floating roof tanks. During such phenomena the ignition of the rim seal zone occurs either through a direct strike or through a secondary effect related to a nearby lightning strike, such as electric charge build up.

Maintenance or operational errors are recorded as the second most probable cause of rim seal fires and are generally related to mechanical friction, overfilling or unsafe engineering practice such as hot works on the tanks. Although very rare, exothermic chemical reactions have also been observed, especially in the case of storage of crude oil with a high concentration of hydrogen sulphide. In the latter case, the combination of the movement of the floating roof with the degradation over time of the seal allows ingress of traces of crude oil into the internal wall of the rusty tank shell. When the hydrogen sulphide comes into contact with air and metal rust, the perfect conditions are created for the development of powdered iron sulphide, which is pyrophoric and therefore ignites spontaneously in air.

This reaction is highly exothermic and can create hot spots capable of igniting the flammable vapours.

Once the rim seal zone has ignited it is imperative that the fire be immediately extinguished to avoid escalation into the worst-case scenario of a full surface fire. It is worth bearing in mind that as long as the floating roof remains stable and buoyant the fire will be limited to the rim seal zone at a scale that can be extinguished by an automatic fire extinguishing system.

In order to suppress a rim seal fire quickly and successfully on a floating roof tank we recommend the use of an automatic fire extinguishing system that has been designed in accordance with the 'FARe' principles ie that it be fast, available and reliable.

Under these principles, the fire is detected instantaneously and the fire extinguishing agent released on the fire from the very earliest of stages. In addition, no foam system unavailability is allowed at any time during regular storage tank operations.

Fast detection and attack

Rim seal fire extinguishing systems are widely recognised as providing very fast fire detection and a quick attack on rim seal fires. These systems are self-contained units that store a certain amount of fire extinguishing agent (gas or foam) that is normally propelled by nitrogen. Nitrogen is also part of the pneumatic fire detection and activation system which not only detects the fire but also triggers the alarm and activates the discharge of the fire extinguishing agent.

The rim seal unit is installed directly on top of the floating roof (see image above), and it is set to constantly monitor and protect a portion of the rim seal zone.

From an operational point of view, once the fire breaks out it is instantaneously detected by the pneumatic detection system, which at the same time provides an alarm to the main control system and activates the discharge of the fire suppression agent. While the unit is suppressing the fire, the signal sent to the main control system triggers the activation of the NFPA 11 traditional foam system. Although these foam systems typically require some time – approximately 20-60 seconds depending on the system design – before delivering foam towards the rim seal, the rim seal unit covers this delay with its own discharge which lasts approximately 40 seconds.

When confirmation to activate the NFPA 11 foam system is provided, the main control system usually operates deluge valves for releasing the water to the water/foam systems. The role played by the deluge valve is critical to the protection of the storage tank. A failure or even just a temporary unavailability of the deluge system will jeopardise the fire protection of the whole storage farm. As deluge valves with a high level of reliability and availability are so important, they are often specified with an increased functional safety performance level that is commonly measured using Safety Integrity Level (SIL2 or SIL 3). The higher the SIL level of the deluge system the lower the probability of failure on demand (PFD), and therefore the higher the probability that the storage tank will be constantly protected against fires.

Summarising, the most common causes of fires on floating roof tank are localised in the seal area and are mainly related to lightning strikes. The key to minimising the damage to rim seal fires is to extinguish the fire quickly and to react at the very earliest stage possible.