



Frank Rizzuto, AMEC Americas Limited, Canada, discusses the importance of making 'beyond zero' safety a benchmark in design, construction and operations.

Caribbean Petroleum
Fire in Puerto Rico.

GETTING IT RIGHT

During these challenging economic times, companies are driven to maintain performance while at the same time minimising cost, a formula that can lead to shortcutting.

It is tempting to recycle old designs. Worse, there is a tendency to rely on minimal code compliance and project budgets for fire protection based on 'factoring', a formula that may or may not align with commercial reality. This formula can lead to capital loss, human tragedy and environmental disaster.

Minimal code compliance is an arena in which best practice and a higher level of technical safety may be sacrificed in the interest of cost reduction. Although fire codes are periodically updated, these minimal measures necessary to secure approval by



Figure 1. A large vapour cloud ignited at the Caribbean Petroleum tank farm storing gasoline, diesel fuel, jet fuel and heavy fuel oil.

governmental authorities may nonetheless leave a facility potentially unsafe to operate. The International Fire Code, for example, leaves it to the discretion of the local fire official (there may not be one, depending on location) as to whether or not a fire suppression system should be installed on a liquid hydrocarbon storage tank.¹

Fire codes in general are moving from a prescriptive to a more risk and performance based approach as industry dictates solutions to the authority having jurisdiction, often a person who does not understand the issues involved in historical prescriptive requirements. At the end of the day, the engineering solution that receives approval (usually the lowest cost producer) is the outcome of an exercise in commercial evaluation supported by arguments for consequence versus probability. It is, in practice, the antithesis of inherently safer design (ISD) and 'beyond zero' safety engineering where zero probability is the benchmark.

Superficial risk assessments

During the engineering and construction of downstream petroleum products storage facilities owned by refineries, terminal operators and product end users, the authority with the most to lose but the least say on what is permissible is often the insurance underwriter. Unlike legislated national building and fire codes, industry codes and standards such as API, NFPA and the FM Global system, which on the whole reflect best practice, are not law but merely recommendations. Nonetheless, engineers rely on them as a standard for good practice with which they generally strive to comply.

Insurance underwriters and fire marshals routinely accept less comfortable protection levels offered by the industry they endeavour to safeguard. Pipeline terminal operators, for example, have typically not installed fire detection and fire suppression systems on large diameter storage tanks unless the tanks are over 45 m in diameter, a dimension beyond which some fire codes require it.² Facilities owners are inclined to argue that compliance with the minimal separation distances outlined in the fire codes is sufficient, ignoring the nature of tank and containment area fires, which can be multidimensional in character and, in the case of a vapour cloud, do not respect fire breaks and other passive fire protection measures. They 'risk assess' their way out of needing to adequately protect the tank farm, with risk decisions being made on faulty data.

If the tanks are fire code separated and therefore compliant, underwriters have not become excited enough to deny insurance, although they constantly recommend that active fire detection and suppression systems be installed, especially on large diameter tanks. Insurance is a commodity and relies on commodity type pricing, therefore it is rare that a facility is denied insurance based on protection levels. In rebuttal, operators will point out that the contents of one burning tank in a grouping can always be pumped back into a pipeline or a holding tank, thereby removing most of the fuel from the fire area and reducing exposure to adjacent tanks, an example of risk assessing one's way out of needing to provide protection. The fallback is on minimal fire code protection levels.

Examples of getting it wrong

Two recent tank farm fires on opposite ends of the dollar loss spectrum illustrate this trend toward lesser protection resulting in capital loss and environmental damage.

Case study one

A fire at Chevron Texaco's key Escravos oil terminal in Southern Nigeria in July 2002 forced the shut in of approximately 300 000 bpd of oil production when lightning struck one of the terminal's storage tanks, incinerating 100 000 bbls (4.2 million gal.) of crude and distributing fire effluent (volatile organic compounds, carbon monoxide, oxides of nitrogen, sulfur dioxide, hydrogen sulfide, and soot) over the local area. The fire, which burned for several days, caused shutdown of production from offshore lines accounting for approximately 300 000 bpd.

Despite the loss of the major portion of the tank's contents and severe damage to equipment, another 80 000 bbls were successfully pumped out of the burning tank into a pipeline. Mobile firefighting equipment was brought into place to try to prevent the flames from spreading to other tanks and additional support was asked from other oil firms. The company announced that there were no casualties. Without extinguishment of the fire by a fixed foam fire suppression system, the inevitable loss of the tank and resulting environmental damage was typical of the 'let it burn' philosophy supported by a consequence versus probability approach that justifies the absence of fixed fire detection and automatic fire suppression systems. It was not revealed whether or not the involved tank was equipped with lightning protection or adequately bonded and grounded.

Case study two

A more recent Caribbean Petroleum fire in Puerto Rico sits at the other end of the loss spectrum. On 23rd October 2009, a large vapour cloud ignited at a tank farm storing gasoline, diesel fuel, jet fuel and heavy fuel oil in approximately 40 aboveground storage tanks. The associated refinery had been shut down in 2000. At the time of the incident, gasoline was being offloaded to a storage tank from a ship docked in San Juan Harbour.

Of course, moving a large quantity of fuel, typically in the order of millions of gallons, from a burning tank to an empty holding tank or back into a pipeline can only be accomplished if the associated pumps are of sufficient capacity and piping is configured to do this before the fire spreads to other tanks. In practice, a fully involved tank fire must be extinguished within the first five minutes of ignition if distortion of the tank shell and loss of the tank itself, as well as its contents, is to be avoided.

Pipeline pumps, such as those of Chevron Nigeria's Escravos facility but unlike those of a typical refinery, are usually