Eric Lavergne, Williams Fire & Hazard Control

Guatemala Teaser

Fire within the vapor space of an enclosed tank can result in challenging and unseen dangers that require superior foam performance and tactical wisdom.

The Incident

On Saturday July 26, 2003 a hydrocarbon storage terminal in Guatemala suffered a lightning strike to one of their 95' diameter storage tanks, igniting gasoline that was temporarily stored within.

Two days earlier on Thursday, July 24, the facility transferred gasoline into the cone roof tank as a temporary storage option as the facility was at maximum capacity. The facility used a pump driven balanced pressure system with separate water/foam solution lines installed at each tank, which met all applicable design criteria for NFPA 11 regarding fuel storage tank protection.

These fixed systems were used for initial attacks on the internal fire resulting from the lightning strike. The system's 1,500-gallon atmospheric foam concentrate tank (3% F.P.) was depleted during the attack with failure to extinguish via the fixed foam chambers.

Williams Fire & Hazard Control was contacted at 5:00 A.M. on Sunday, July 27, 2003 for support services. Williams immediately deployed a team of 5 firefighters to the facility to aid in ongoing response operations and to develop response tactics for the equipment and foam resources that were en route.

Upon sizing up the incident, several pumps located at the site were directed to replenish the firewater tank, and were then utilized as "make-up" water during an attack. Facility personnel were able to fill the foam concentrate tank with additional 3% F.P. from stores onsite in preparation of a second foam attack — once again via systems application. By this time the tank seams had been compromised by extreme heat, and "fishmouth" gaps were occurring along the areas where the roof meets the shell. With the facility at full capacity, there was not a tank available with proper outage to allow product transfer from the burning tank.

Foam was applied until it was expelled out of the vents and the gaps - or "fish mouths" - located around the top of the tank. Water lines were deployed in an attempt to extinguish the burning vapor emitting from a single remaining vent. As the foam poured out of the tank it was obvious that the foam blanket had trapped a considerable amount of gasoline vapor as fire ghosted within and around the foam. As a result the foam blanket in the diked area ignited (no hydrocarbon liquid escaped from the tank). The saturated foam blanket burned for a brief period (5 mins.) in the dike area until the fuel-contaminated foam blanket was consumed. At this point the decision was made to halt all operations until the Williams' equipment and foam concentrate arrived.

Finding an aircraft large enough to haul the required equipment to make the attack proved to be difficult. During initial communications with the facility, it was reported that firewater reserves were consumed (200,000 gallons) and a portable firewater pump would be required. Once a C-130 transport aircraft was located, a 14-hour turnaround window was required in order to fly the aircraft into Beaumont, load the required equipment, and then fly to Guatemala. Our crew arrived on Sunday night – July 27 at approx 5:00 P.M.

The following day we staged for another foam attack. The foam blanket once again was going to be applied via the foam chambers, however, ThunderStorm® ATC would be the foam of choice. The 1%-3% ThunderStorm® ATC/AFFF required an orifice modification on the existing foam proportioning system. In addition to the foam chambers, three 125-gpm-foam wands were deployed in various vent holes in the tank. Daspit™ Tools — Williams' proprietary portable monitor design with foam conversion capabilities — were also deployed to "scrub" the vapors emitting from the tank roof openings. Two Hydro-Chem™ hand lines were positioned, one on the landing of the burning tank, and one on a adjacent tank, in the event the vapors continued to burn at the tank roof openings.

The foam attack was initiated at approx. 8:15 P.M. Monday, July 28, and flame collapse began shortly thereafter. All fire was extinguished with the foam blanket, and

three of the vents were "shot out" utilizing dry chemical in conjunction with Hydro-Chem™ technology. At 8:45 P.M. no visible flames were present. Cooling of the tank roof continued for a predetermined period of time with intermittent foam applications. The following morning, the tank was inspected and recommendations were made for the transfer of the gasoline.

The vapor space within this cone roof tank demands a thorough knowledge of tank construction and fire dynamics — and of course ThunderStorm® ATC!

The Dilemma

To understand the problem associated with this incident we must first look at factors present on a burning fixed roof or covered floating roof tanks. If the floating roof has sunk or if improper storage of fuel is present, (as in the incident described above) the result will be full surface fuel exposure. The column of the vapor space will determine the resulting damage to the tank accordingly at the time of ignition. If the vapor space is in the flammable range a vapor air explosion will normally occur in the tank. If the outage is significant, damage at the weak seam is likely or the loss of the total roof is not uncommon … resulting in a full surface tank fire.

If the vapor space is in the flammable range at the time of ignition, but the outage is minimal or the vapor space is rich, fire at the vents is normally the result; the latter defines the incident in Guatemala. Although the full surface is not covered the vapor space inside the tank is too rich to burn. The flames occur once the vapor leans out with atmospheric air as it passes through the tank vents (see photo).

Once the system is deployed via the foam system's chambers the foam enters the vapor rich atmosphere and begins to flow across the surface. During this process the foam blanket entrains large amounts of flammable/combustible vapors. This is what caused the foam blanket to burn as it was expelled through the vents and fell to the diked area.

What must be considered is the vapor space above the blanket; the foam blanket will suppress and prevent the yield of additional vapors, however, the vapors that were present remain above the foam blanket. The vapors travel through the vents, (in this case 10 ea. / 18 inch.) mix with the air and burn. The volume of burning vapor is miniscule; the 4-feet of outage in the Guatemalan tank fire was roughly 42,000 cubic feet. Based on the vapor pressure of the product and the 10 - 18-inch vents, the vapor duration could easily last for over 12 hours. The foam blanket will break down long before the vapor is depleted, and the process starts all over again, depleting the facility's foam supply.

If — by chance — a company is able to produce a foam blanket with the long duration to provide vapor suppression throughout the ordeal, this could itself create a problem that would escalate the damage already suffered in the incident. If the foam blanket prevents the vapor yield and the fire is consuming vapor, the vapor inside the tank will be displaced with atmospheric air via the vents. As the vapors continue to be consumed the vapor space continues to lean out until the point it reaches the flammable range, at this point a vapor air explosion can occur resulting in the loss of the roof and a full surface fire.

Either of the two results is negative. What must be realized is that the systems as we know today must be augmented to handle the scenario.