Get some *fresh air*

Kyle D. Shotts, Zeeco Inc., USA, outlines the company's recent work designing a retrofit air injection system for an LNG project on the US Gulf Coast.

When faced with a flare system retrofit, LNG plants must solve multiple challenges to avoid shutting down the facility to accomplish the changeover. From daily tank breathing streams to providing sufficient capacity for emergency reliefs, temporary flaring solutions have to meet significant operational challenges.

Zeeco was contacted by an LNG producer on the US Gulf Coast regarding a large flare system that was originally designed for flaring light hydrocarbons – which typically burn smokeless without any assist medium such as steam, air, or pressure. However, process conditions changed over time, introducing heavier hydrocarbons to the flare gas piping, and resulting in a constant stream of smoke from the flare during day-to-day relieving events.

Figure 1. ZEECO Zephyr™ fully-automated, trailer mounted vapour combustor system.

Zeeco engineers designed a retrofit air injection system that could be added to the existing flare to eliminate smoking. The retrofit would consist of a new flare tip, external air piping along the side of the existing stack, and a blower that would be mounted near the base of the flare stack. The blower would supply enough air to eliminate air-starved conditions in the flame and thereby eliminate smoking from the flare.

Challenges

While the retrofit was a direct solution for the customer's issue, it posed a challenge in that it required the flare system – the only emergency relief system for the entire facility – to be removed from service. This challenge presented obvious operational complications. Shutting down the facility entirely was not a possible solution because large ethylene and propane refrigerant storage spheres would still need a route for relief venting to prevent over-pressuring. Day-to-day breathing losses would need to be addressed as well as the potential of a fire in the area around the spheres. An emergency event, such as a fire, would require significant flaring capacity above that required by daily tank venting to adequately address overall personnel safety and plant protection.

An additional project challenge was the requirement that personnel would need constant access around the designated flaring area to install the air injection retrofit system onto the existing flare. As the installation work was estimated as a two-month project, a solution needed to address access plus all potential relieving cases involving the spheres and operating equipment.

Upon consideration of the various challenges, engineers in Zeeco's Combustion Rental Group developed a custom temporary rental flaring package that could be installed with minimal effort and meet the project challenges.

Solution

To address day-to-day flaring events in conjunction with construction crew access and equipment, Zeeco supplied a trailer mounted enclosed flare system known as a Zephyr™. These units provide smokeless enclosed flaring and incineration via a completely pre-piped and pre-wired combustion chamber mounted to a trailer. The only installation requirement was firm soil; no concrete work or cranes were required. The unit arrived with the combustion chamber in a horizontal travelling position, but upon arrival at the site, the combustion chamber lifted into a vertical operating position via the built-in hydraulic lifting system. Due to the low temperature ethylene and propane gases expected, all piping on the Zephyr was fabricated from 304 SS.

The Zephyr unit had the capacity to flare off the daily breathing losses from the refrigerant spheres along with other relief points that would normally be routed to the permanent flare system which would be taken offline during construction work. Since all flaring would be contained inside the combustion chamber, there would be zero radiation from the flames so use of the Zephyr did not restrict site access for construction crews working on the retrofit project.

While the Zephyr addressed day-to-day flaring events, it did not have the capacity for potential emergency reliefs emanating from a fire in or around the refrigerant liquid containing spheres. A larger capacity open flare system was the only feasible solution to that challenge.

To address this scenario, Zeeco provided a 60 ft tall trailer-mounted open flare system. As with the Zephyr, the open flare trailer did not require any concrete or cranes to erect and required only firm soil for installation. The unit arrived as a complete flare system compactly mounted onto a trailer. Upon arrival at the site, outriggers were unfolded from the trailer and the upper stack section was connected to the base stack section, and then bolted in place. The complete 60 ft tall stack was then lifted into its operating position with an on board hydraulic lifting system. Once upright, guy wires were

Figure 2. 60 ft trailer-mounted guy-wire supported temporary flaring system, typical of system supplied by Zeeco for this rental application at an LNG facility.

connected to the outriggers to create a temporary open flare capable of withstanding wind speeds of up to 120 mph. As with the Zephyr, the stack and all waste gas piping on the trailer were constructed from 304 SS to withstand the low temperatures associated with the refrigerant gas flaring.

Zeeco performed thermal radiation calculations based on the maximum expected emergency flaring conditions to determine the necessary height of the flare and distance the flare needed to be placed from the construction work. The 60 ft height was chosen based on these calculations to ensure personnel in the vicinity would have adequate time to seek shelter in the event of an emergency relief to the open flare.

With an enclosed flare to relieve daily flaring and an open flare to relieve higher rates chosen as the optimum temporary equipment for the project, the remaining issue was determining how flows would be diverted between the two pieces of equipment. Zeeco supplied a portable temporary rental staging skid, which included a pressure switch and diverter valve to switch between the two flare systems.

The staging skid directed daily non-emergency flaring event flows to the Zephyr enclosed flare system. An orifice plate was installed in the header piping upstream from the Zephyr to ensure its designed operating capacity and pressure was not exceeded, and the flare system would not be overfired. When the flow capacity of the Zephyr was reached, the pressure switch on the staging skid would open the diverter valve on the staging skid to allow flow to the 60 ft open flare trailer.

To design for fail-safe operation, including the potential for the staging valve to fail to open upon rising pressure, a safety bypass line with a rupture disc was installed to bypass the staging valve. In the event the staging valve failed, thus increasing pressure in the header piping, the rupture disc would burst and full flow would be directed around the staging valve and directed safely to the open flare system, protecting upstream equipment.

Results

Due to the similarity to standard Zeeco stocked rental equipment, Zeeco modified existing equipment within a few weeks to prepare it for this service. Once onsite, the company supplied a stainless steel flex hose for the major connection points, while the customer installed header piping leading from the staging skid to the 60 ft flare trailer. An adequate amount of onsite preparation took place prior to the temporary equipment's arrival to ensure subsequent installation only required a few days. After several system safety reviews, the pilots on the Zephyr and 60 ft open flare trailer were lit and plant operators diverted flows from the permanent flare to the temporary installation without issue.

Due to the critical nature of the installation, Zeeco provided 24/7 operator attendance of the equipment for the entire time it was on location.

Once in service, the Zephyr handled all the flaring conditions encountered over the 45-day rental period. The 60 ft trailer, while prepared for the need, did not experience a flaring event. Upon completion of the permanent flare tip retrofit, the rental equipment was kept onsite for a few days to ensure proper operation of the permanent flare. The new retrofitted air flare performed as needed to ensure smokeless day-to-day flaring for the facility.

Conclusion

In conclusion, careful planning combined with a solid engineering-based approach to flare retrofits or other possible temporary equipment scenarios at LNG facilities is critical to keeping people safe and keeping facilities in compliance with applicable regulations. LNG