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Letter to the Editor

## Re: "Exposure of a liquefied gas container to an external fire" by Phani K. Raj, J. Hazard Mater. A122 (2005) 37–49

This paper proposes an analytical basis to the NFPA 58 separation distance requirements between a LPG tank and a line of adjoining property. It does so by modeling the transient response of the tank's vapour wetted wall (VWW) temperature to the influence of a large pool fire, located on the perimeter boundary. Results from the model for different sizes of ASME (LP-Gas) containers are presented.

It is stated that the VWW temperatures never reach the critical temperature of steel (∼810 K) and so catastrophic vessel failure can never occur. For a 1000 usg vessel and a 30.5 m diameter hydrocarbon pool fire of 100 kW/m$^2$ located at the NFPA 58 stipulated property boundary distances the maximum VWW temperature is calculated to be 654.3 K (381 °C). The paper makes no attempt to address the question of between tank separation distances nor of the required separation distances from structures located within the property—for a single 1000 usg vessel, this distance is 3.1 and 7.6 m for buildings with fire resistive and non fire resistive walls, respectively. For the multitude of vessels in the 125–500 usg range, the distance is 3.1 m and for the majority of vessels in service, those of less than 125 usg, the vessel may be placed adjacent to the walls of the structure [1].

I have several concerns relating to the analysis and conclusions of this paper and the validity of some sections of NFPA 58, though the author does not address this last item.

It is argued that "the tanks are relatively safe even under the very severe exposure conditions considered in this assessment" due to the fact that "very conservative assumptions have been made". This statement appears to apply only to those vessels 1000 usg or greater as these were the types of ASME vessels analysed—for the vast majority of domestic installations, numbering many many millions, the analysis is not applicable.

(1) It is stated that the experimental effective emissive powers for visible flames for the type of fire assumed in the analysis are typically 30–50 kW/m$^2$ (853–970 K) not the 100 kW/m$^2$ used. Clear flame temperatures measured in some hydrocarbon flames and wooden frame fires have been in the range 1100–1400 K, i.e. 83–218 kW/m$^2$—see, for example [2] for a comprehensive set of references.

(2) The 0.3 absorbtivity used for white paint is that for solar radiation; the value should be ∼0.7 to 0.8 for radiation in the wavelength range of hydrocarbon fires [3]. This means that the maximum VWW temperatures computed are understated.

(3) Although the maximum VWW temperatures are computed to be safe from the point of view of the critical temperature of steel, the same cannot be said for the fittings used on most tanks. The multi-valves, piping and pressure relief valves are required to have melting temperatures in excess of 1090 K [1]. However, the first stage regulators permitted [1][1]—some consisting of zinc (and some even plastic!) bodies have softening temperatures in, or below, the VWW temperature ranges computed. Even if the multi-valves were fitted with an optional [1] excess flow valve, a significant jet fire (surface heat fluxes from 125 to over 250 kW/m$^2$ [2]) could surround, usually the central portion of the tank. Such a fire can cause the tank to rupture and BLEVE [4].

Thus, though the analyses attempt to portray the effectiveness of the NFPA 58 spacing regulations on the basis of the VWW temperature, the paper does not address the safety and dangers of the vast majority of LPG installations to these exposures – perhaps this was not within the remit of the original NPGA grant – and if not it perhaps should have been.

### References

[1] LPG-Gas Code Handbook, fifth ed., Ed T Lemoff, NFPA, Quincy Mass, 1998.

[2] L.T. Cowley, A.D. Johnson, Oil and Gas Fires: Characteristics and Impact, Work Package No. FL1, Shell Research, Chester, UK, February 1991.

[3] H.C. Hottel, F.A. Sarofim, Radiative Transfer, McGraw-Hill, New York, NY, 1967.

[4] D.M. Tan, J. Xu, J.E.S. Venart, Fire-induced failure of a propane tank: some lessons to be learnt, J. Process Mech. Eng. I Mech. E, Part E 217 (2003) 79–91.

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[1] These are to be close coupled to the multi-flow valve usually with a copper pigtail [1] and thus on or very close to the top of the vessel.

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