Private Fuel Storage, L.L.C.

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COMMITMENT RESOLUTION LETTER #30
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PRIVATE FUEL STORAGE FACILITY
<u>PRIVATE FUEL STORAGE L.L.C.</u>

In accordance with our April 4, 2000 conference call, Private Fuel Storage (PFS) submits the following resolution to NRC/CNWRA questions and comments regarding the effects of a postulated propane vapor cloud explosion on the Private Fuel Storage Facility (PFSF) Canister Transfer Building. The NRC questions/comments are documented below followed by the PFS response.

NRC Questions and Comments

1. In SAR Section 8.2.4 PFS concluded that by locating the 2,000 gallon propane tank a minimum distance of 460 ft from the Canister Transfer Building, the peak incident overpressure at the building from rupture of the tank and resulting ignition of the propane-air cloud would not exceed 1.5 psi. Since the Canister Transfer Building is required to be designed to withstand a 1.5 psi differential pressure from a tornado, PFS concluded that the building would retain its structural integrity in the event of this postulated explosion. However, PFS's assessment of effects on the building is not in accordance with the guidance in Regulatory Guide 1.91. This guidance directs that building effects be assessed by either a static analysis using twice the appropriate pressure loading or an elastic analysis using dynamic load factors.

<u>RESPONSE</u>

In lieu of performing a dynamic analysis, in accordance with the guidance of Regulatory Guide 1.91, to determine the effects of the blast from the accident involving the 2,000 gallon propane tank inventory for the Canister Transfer Building, PFS has elected to pursue a more conservative alternate approach. This alternate approach is in accordance with the guidance in Regulatory Guide 1.91 for assessing effects on the building. The alternate approach involves locating the propane tank a sufficient distance from the

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Canister Transfer Building and storage casks (important to safety structures) to assure that the peak positive incident overpressure at these structures, assessed using the TNT energy equivalent method, is less than 1.0 psi. PFS has decided to pipe propane to the Canister Transfer Building and the Security and Health Physics Buildings from a distribution system that uses a centralized and larger propane tank (or group of tanks). This tank(s) shall be located a minimum distance of 1,800 ft south or south-west of the Canister Transfer Building, and shall be a minimum distance of 1,800 ft from the nearest cask storage pads. In addition, the propane storage tank(s) will be located approximately 1,000 ft west of the Operations and Maintenance Building (it will be further from the Administration Building). The storage tank(s) will have a total volume of no greater than 20,000 gallons. The storage tank(s) will be above-ground, designed in accordance with the requirements of NFPA 58. Due to the relatively large distances from the propane storage tank(s) to the PFSF buildings, the design of the propane distribution system will include a compressor, located near the storage tank(s), to provide the motive force necessary to transfer propane vapor from the storage tank(s) to these buildings.

The potential effects of a vapor cloud explosion accident associated with this storage tank(s) were assessed, using the TNT energy equivalent method. Postulating the occurrence of a vapor cloud explosion conservatively assumed to involve 20,000 gallons of liquid propane (which vaporizes and mixes with air to form a flammable concentration), the peak positive incident overpressure decreases below 1.0 psi at a radial distance of 1,384 ft from the center of the vapor cloud. Overpressures from this postulated vapor cloud explosion would be below 1.0 psi at the Canister Transfer Building and the nearest storage casks. An overpressure of 1.0 psi would not cause significant damage to the important to safety structures. Regulatory Guide 1.91 states that for peak positive overpressures below 1 psi no significant damage to important-to-safety structures, systems, and components would be expected and analysis of the blast effects is not required.

The attachment to this letter includes the proposed text that will be incorporated/revised in PFSF SAR Sections 8.2.4.1 and 8.2.4.2 to describe the propane storage tank(s) and the analysis of a postulated accident involving tank(s) rupture, mixture of propane gas with air, ignition of the flammable gas, vapor cloud explosion, and the effects on the Canister Transfer Building.

PFS will include the attached information in the next update to the SAR currently scheduled for issue by April 14, 2000. If you have any questions regarding this response, please contact me at 303-741-7009.

Sincerely,

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Project Director
Private Fuel Storage L.L.C.

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Proposed Text for Portions of PFSF SAR Sections 8.2.4.1 and 8.2.4.2 that Deal With the Propane Storage Tank and Postulated Explosion Involving Propane

8.2.4.1 Cause of Accident

Propane for heating the Canister Transfer Building and the Security and Health Physics Building will be stored in a centralized propane fuel storage tank (or group of tanks) having a total volume of no greater than 20,000 gallons. This tank(s) shall be located a minimum distance of 1,800 ft south or southwest of the Canister Transfer Building, and shall be a minimum distance of 1,800 ft from the nearest cask storage pads. In addition, the propane storage tank(s) will be located approximately 1,000 ft west of the Operations and Maintenance Building (it will be further from the Administration Building). This provides a conservative safe standoff distance to assure that a postulated explosion involving the full inventory of propane in this tank(s) will not result in significant damage to the Canister Transfer Building or to loaded storage casks, as discussed in Section 8.2.4.2. The storage tank(s) will be above-ground, designed in accordance with the requirements of NFPA 58.

Propane will be supplied to the Canister Transfer Building and the Security and Health Physics Building from the propane storage tank(s) by means of buried all-welded steel piping to minimize the possibility of propane leakage. Due to the relatively large distances from the propane storage tank(s) to the Canister Transfer Building and the Security and Health Physics Building, the design of the propane distribution system will include a compressor, located near the storage tank(s), to provide the motive force necessary to transfer propane vapor from the storage tank(s) to these buildings. An excess flow control feature will be installed at the storage tank(s) that will isolate flow of propane into the affected distribution line in the event a flow rate detector senses an abnormally high flow rate, which could be indicative of a large leak or pipe rupture. The propane heaters at the Canister Transfer Building will be roof-mounted, configured such that the propane gas does not enter the building itself, but heats air that is blown down into the building by means of fans and ducting.

Propane is stored as a liquefied petroleum gas with the tank(s) pressurized to the vapor pressure of the propane liquid, whose temperature will be close to the average ambient temperature. The vapor pressure of commercial propane is 132 psig at 70ºF and 216 psig at 105ºF (Table 5-5E of Reference 49). Propane gas will be supplied from the vapor space on top of the storage tank(s) into the distribution piping which carries it to the Canister Transfer Building and the Security and Health Physics Building. As noted above, a gas compressor located near the storage tank(s) will be used to transfer the propane gas the relatively large distance (>1800 ft) from the storage tank(s) to the buildings. Relief valves on the tank will be set at approximately 275 psig. Propane is classified as a flammable liquid, and at standard atmospheric pressure (14.7 psia) commercial propane has a boiling point of minus 51ºF (Table 5-5E of Reference 49). It is heavier than air, with propane vapor having a specific gravity of 1.52 at 60ºF (Table 5-5E of Reference 49, with specific gravity air = 1). NFPA 58 requires that propane tanks having a capacity of between 2,001 and 30,000 gallons be located at least 50 ft away from any building or adjacent property or 5 ft away from any adjacent container. The maximum number of tanks will be limited to six in accordance with NFPA 58.

8.2.4.2 Accident Analysis

It is conservatively assumed that the propane storage tank(s), which supplies propane for heating the Canister Transfer Building and the Security and Health Physics Building, contains 20,000 gallons of liquefied propane and that it ruptures. While such rupture is unlikely, it is considered possible should a projectile, such as a tornado-driven missile, strike the tank. It is not considered possible that a vehicle could collide with the propane storage tank(s), since vehicle barriers will be installed around the tank(s) designed to prevent such an occurrence. At 60ºF, one gallon of propane liquid weighs 4.24 lbs (Table 5-5E of Reference 49). The total weight of 20,000 gallons of liquefied propane is (20,000 gal) (4.24 lb/gal) = 84,800 lbs. It is also conservatively assumed that a large fraction of this propane mixes with air so that it is in an explosive concentration (in range of 2.15% to 9.60%, per Table 5-5E of Reference 49), ignites, and is involved in a vapor cloud explosion. The magnitude of the postulated explosion is assessed using the TNT energy equivalent methodology, with the TNT energy equivalence of 84,800 lbs of propane estimated as follows: Based on Table 5-5E of Reference 49, the total heating value of commercial propane after vaporization is 21,591 Btu/lb. Therefore, 84,800 lbs of propane has a total heating value of 1.831 E9 Btu, which is equal to 4.614 E11 calories. Regulatory Guide 1.91 (Reference 17) states: "Most assessments of this type have led to estimates that less than one percent of the calorific energy of the substance was released in blast effects. ... However, there have been accidents in which estimates of the calorific energy released were as high as 10 percent." The blast energy realized depends on phenomena specific to the accident being considered, including the size and shape of the cloud, concentration of fuel in the cloud, the location and strength of the ignition source(s), and to a large extent the degree of confinement of the air-gas mixture. Since the propane tanks will be located in the open on flat ground, with the nearest structure approximately 1,000 ft away, the propane-air mixture resulting from postulated tank(s) rupture will have little or no confinement. The Federal Emergency Management Agency (FEMA) specifies an explosive yield factor of 3% for propane-air vapor cloud explosions in Reference 58 (FEMA applies the 3% yield to numerous hydrocarbons mixed with air including methane, ethane, propane, and butane, while a value of 6% applies to several hydrocarbon compounds mixed with air including cyclohexane, ethylene, and propylene oxide). Assuming that 3% of the combustion energy from conflagration of the propane-air mixture contributes to blast effects, (4.614 E11 calories)(0.03) = 1.384 E10 calories would contribute to blast effects.

Trinitrotoluene (TNT) has a "heat of explosion" of 1,050 cal/g (Reference 51). The equivalent weight of TNT that would release 1.384 E10 calories of heat energy is:

(1.384 E10 calories) / (1.05 E3 cal/g) = 1.318 E7 g = 29,060 lbs

The overpressure effects of postulated detonation of this weight of TNT can be assessed using Figure 4-12 of Reference 52, "Shock-Wave Parameters for Hemispherical TNT Surface Explosion at Sea Level". This Reference 52, Army Technical Manual on Explosion Effects is Reference 1 of Reg. Guide 1.91, and provides the basis for Figure 1 of the Reg. Guide. Figure 4-12 of Reference 52 presents overpressures at various scaled ground distances from TNT detonations, with varying weights of TNT, and defines the scaled ground distance as $Z_G = R_G / W^{1/3}$, where R_G is the actual ground distance and W is the weight of TNT (lbs). $W^{1/3} = (29,060)^{1/3} = 30.75$.

Reg. Guide 1.91 states "A method for establishing the distances referred to above can be based on a level of peak positive incident overpressure (designated as P_{so} in Ref. 1) below which no significant damage would be expected. It is the judgement of the NRC staff that, for the structures, systems, and components of concern, this level can be conservatively chosen at 1 psi (approximately 7 kPa)." It is considered that the 1 psi overpressure selected in the Reg. Guide is conservative for the structures of concern at the PFSF. A 1.0 psi peak positive incident pressure corresponds to a scaled ground distance, Z_G, of 45, based on Figure 4-12 of Reference 52 and on Reg. Guide 1.91. Solving the above equation for R_G:

$$Z_G, = R_G / W^{1/3}\ ,\ 45 = R_G / 30.75\ ,\ R_G = (45)\ (30.75) = 1,384 \text{ ft}$$

Thus, based on the TNT energy equivalence approach and Reference 52, the resulting overpressure from a propane explosion involving 84,800 lbs of propane (equivalent to 29,060 lbs of TNT) leaked from the propane storage tank(s) will not exceed 1.0 psi at important-to-safety structures, systems and components (SSC) as long as the tank(s) is located a distance of at least 1,384 ft from the Canister Transfer Building and storage casks. The propane storage tank(s) shall be sited a minimum distance of 1,800 ft from the Canister Transfer Building and from the nearest storage casks. This assures that postulated worst case explosion of propane assumed to have leaked from the storage tank(s) will not produce overpressures greater than 1.0 psi and will not challenge the integrity of the storage casks or the Canister Transfer Building.

The above evaluation is conservative for several reasons: 1) a 20,000 gallon propane storage tank is assumed to be completely full of liquid propane at the time of the postulated tank rupture accident, 2) an ignition source is assumed to be available near the ruptured tank that does not function at the time of tank rupture, since this would produce a propane-fed fire and not a vapor cloud explosion, 3) it is assumed that the entire inventory of the ruptured tank spills out and mixes with air before ignition occurs, minimizing the quantity of propane in a concentration above the upper flammable limit thus maximizing the flammable concentration, 4) it is assumed that the propane-air cloud is ignited before there is time for dispersal and dissipation wherein a significant fraction of the propane could be mixed with air at a concentration below the lower flammable limit, and 5) combustion of the propane-air mixture is assumed to produce effects equivalent to a detonation of TNT, although it is extremely unlikely that a largely unconfined propane-air mixture would detonate and produce a shock wave similar to that associated with a TNT explosion.