Private Fuel Storage, L.L.C.

P.O. Box C4010, La Crosse, WI 54602-4010
John D. Parkyn, Chairman of the Board

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

July 18, 2000

LICENSE APPLICATION AMENDMENT No. 14
DOCKET NO. 72-22/TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

The purpose of this letter is to submit Amendment No. 14 to the Private Fuel Storage Facility (PFSF) License Application (LA). This amendment updates the PFSF Safety Analysis Report (SAR) to reflect changes to the postulated propane tank rupture analysis (SAR Section 8.2.4), as discussed in a phone call between the NRC, CNWRA and Stone & Webster dated July 18, 2000.

If you have any questions regarding this submittal, please contact me at 608-787-1236 or Mr. J. L. Donnell, Project Director, at 303-741-7009.

Sincerely,

John L Donnell for

John D. Parkyn, Chairman
Private Fuel Storage L.L.C.

JDP:JRJ
Enclosure

NMSS01 Publi

PREFACE

PRIVATE FUEL STORAGE FACILITY

LICENSE APPLICATION

AMENDMENT 14

Enclosed are the following revisions to the Private Fuel Storage Facility License Application documents:

Safety Analysis Report – Revision 14

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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 approximately 45, based on Figure 4-12 of Reference 52 and 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 group of propane storage tanks will not exceed 1.0 psi at important-to-safety structures, systems and components (SSC) as long as the postulated propane vapor-air cloud is located a distance of at least 1,384 ft from the Canister Transfer Building and storage casks. Dispersion of propane postulated to be released from the group of tanks that supplies propane to heat the Canister Transfer Building and Security and Health Physics Building was modeled, assuming the wind is moving in the direction of the Canister Transfer Building, and the results of this dispersion modeling are discussed in the following paragraphs. The propane storage tanks 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 group of storage tanks will not produce

overpressures greater than 1.0 psi at important to safety structures and equipment 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 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.

Postulated Explosion Involving up to 20,000 Gallons Propane, Including Dispersion Modeling

The objective of the dispersion modeling was to determine the maximum downwind distance from the tank that the concentration of propane in the plume could be above the lower explosive limit (LEL), and to determine the overpressure created by delayed ignition of the resulting cloud. The LEL for propane is 2.1% by volume and the upper explosive limit (UEL) is 9.5% by volume (Reference 77).

Four different scenarios for the release were evaluated (Reference 76). These were: (1) a 2 inch diameter hole in the top of the tank allowing only propane gas to be released; (2) a 2 inch diameter hole in the bottom of the tank allowing liquid propane to

be released; (3) an instantaneous release of the entire contents of a hypothetical full 20,000 gallon tank; and (4) an instantaneous release of the entire contents of a full 5,000 gallon tank. For each case the tank was assumed to be full of liquid and gaseous propane (2-phases), at a temperature of 20° C (68° F), and at 8.4 atmospheres of pressure. This is the saturation vapor pressure for propane at 20° C. Atmospheric conditions were assumed to be the worst case for dispersion (i.e. nighttime with very stable conditions – stability class F, 20° C, and low wind speeds). The wind speeds used in the different model runs varied between 1-5 m/s, but were in each case the wind speed that caused the highest predicted concentration at a distance of 549 m (1800 ft). This is the minimum distance from the proposed group of tanks to the Canister Transfer Building and nearest storage casks.

Two different models were used for the dispersion analysis. These were the **TSCREEN** model and the **SLAB** model. The TSCREEN model was developed by the United States Environmental Protection Agency (EPA) for use in predicting maximum concentrations resulting from toxic chemical releases. It has algorithms to predict the release rate of 2-phase chemicals (like propane) from pressurized tanks with holes of various sizes and uses the Britter & McQuade (B&M) dispersion model to predict the dispersion of denser-than-air plumes. The TSCREEN model was used to calculate the release rates of propane from a 2 inch diameter hole in the tank, and the ambient concentrations resulting from the release. The SLAB model was developed by the University of California (Riverside) to predict the dispersion of large scale releases of 2-phase, denser-than-air plumes from tank spills. The SLAB model is recommended in the TSCREEN users manual for this use. It has been compared with data obtained from field-scale heavy gas dispersion experiments. In these comparisons, SLAB performed well, predicting the lower flammability limit distance in LNG tests to within approximately 15%. Both of these models are commonly used and widely accepted for such applications.

The explosion overpressure calculations applied the TNT energy equivalent method using a scaled ground distance parameter (Z) value of 45 for a hemispherical surface explosion overpressure of 1 psi. Based on Figure 4-12 of Reference 52:

$R = Z\,(W_e^{1/3})$

R = distance from center of cloud

W_e = TNT equivalent mass = Y (W) (Hc)/(Hc_{TNT})

Y = explosion yield (0.03 for propane)

W = mass of propane in cloud

Hc = Heat of combustion of propane (21,591 Btu/lb)

Hc_{TNT} = heat of combustion of TNT (1,890 Btu/lb)

The results of the modeling are summarized below for each scenario showing the distance downwind to the LEL, and the distance from the tank to reach a 1 psi overpressure.

Scenario	Distance to LEL meters (ft)	Distance to 1 psi meters (ft)
(1) 2" hole in top of tank (Gas Phase Only)	< 200 (656)	177 (580)
(2) 2" hole in bottom of tank (2-phase release)	450 (1476)	438 (1437)
(3) 20,000 gallon instantaneous release	700 (2296)	628 (2061)
(4) 5,000 gallon instantaneous release	400 (1312)	363 (1192)

The instantaneous release of 20,000 gallons of propane is the only scenario predicted to have concentrations exceeding the LEL beyond 549 meters (1800 ft.). The other scenarios do not produce concentrations above the LEL at this distance.

Scenario (1) is a 2" hole in the top of a hypothetical 20,000 gallon propane tank above the liquid level. In this circumstance, gases will exit the tank initially under 8.4 atmospheres of pressure, and at sonic velocities. As the pressure drops, liquid

propane will flash to vapor (essentially boil) producing more gas phase propane until the liquid is cooled to its boiling point of minus 42° C (Reference 77). If the tank is initially at + 20° C temperature, there is enough heat capacity in the liquid propane to vaporize 37% of the total mass of propane in the tank, leaving 63% of the propane as a sub-cooled liquid in the tank. The emission rate of gaseous propane was calculated using TSCREEN to be 3.49 kg/s. The duration of emissions was predicted to be 66.8 minutes. This duration represents the gas phase release. As the propane evaporated the liquid will cool leaving liquid in the tank after the evaporative cooling. The remaining liquid will boil off but at a much slower rate. The emissions were modeled as if the hole pointed downward minimizing plume rise. It was determined that a wind speed of 3 m/s resulted in the furthest extension of the LEL from the emission source. Ground level concentrations of propane were predicted to exceed the LEL at 100 meters downwind, but not at 200 meters downwind. Based on a 3 m/s wind speed and a travel distance of 200 m, the mass of the cloud was calculated as 67 sec X 3.49 kg/s, or 234 kg (515 lbs.) It was conservatively assumed that all of the propane released from the tank in the 67 second time interval to achieve steady state plume conditions was involved in an explosion. However, some of the propane-air mixture would be below the LEL concentration, and unable to contribute energy to an explosion. In modeling the effects of an explosion, it was assumed that ignition occurred at a point near the center of the plume, and the equivalent energy of a TNT explosion was assumed to be released from this point. The center of the plume was estimated simply by taking one half the distance from the tank to the edge of the plume at the LEL concentration. Although it is very unlikely for a cloud of this mass to develop a pressure wave, the radius of a 1 psi overpressure was calculated using the TNT energy equivalent method (Z = 45 for 1 psi) as 252 ft from the center of the cloud or 580 ft from the tank.

Scenario (2) is a 2" hole in the bottom of a hypothetical 20,000 gallon propane tank (below the liquid level). In this circumstance, liquid will flash to vapor and liquid as it exits the tank in a foam-like state. The TSCREEN model predicted a 20,000 gallon

tank would empty in 19 minutes. The propane emission rate was calculated by TSCREEN to be 33.2 kg/s. The release was modeled as 37% vapor and 63% aerosol droplets of propane at –42 ° C. As the mixture is warmed by the ground and the atmosphere, the droplets vaporize. The emissions were modeled as if the hole pointed downward minimizing plume rise. Ground level concentrations of propane were predicted to exceed the LEL to a distance of 450 meters (1476 ft). Based on the worst case 3 m/s wind speed and a travel distance of 450 m, the mass of the cloud was calculated as 150 sec X 33.2 kg/s, or 4980 kg (10,956 lbs.) The radius of a 1 psi overpressure was calculated using the TNT equivalency method as 213 m (699 ft) from the center of the cloud, or 438 m (1437 ft) from the tank.

Scenario (3) is an instantaneous release of the entire contents of a hypothetical 20,000 gallon propane tank. In this circumstance, liquid will flash to vapor, and vapor and liquid will exit the tank in a foam-like state. While it is anticipated that a substantial fraction of the liquid propane would pool on the ground, then vaporize in time as it is heated by the ground and air, it was conservatively assumed that all of the liquid propane is airborne in the vapor cloud, in the form of aerosol droplets. Thus, the release was modeled as 37% vapor and 63% aerosol droplets of propane at –42 ° C. As the mixture is warmed by the atmosphere, the droplets vaporize. The emissions were modeled as a cold dense cloud of propane gas and droplets being transported downwind by the wind using the SLAB model. The initial cloud dimensions are 4 meters high x 38 meters in diameter. The SLAB model requires terrain roughness as an input. A value of .0003 meters was used as suggested in the SLAB users manual for "level dessert". The SLAB model predicted a maximum concentration exceeding the LEL out to a distance of 700 meters (2296 ft), with a worst case wind speed of 3 m/s. Thus at distances beyond 700 m, the cloud has dispersed beyond ignitable. Within 42 seconds the entire release was determined to be evaporated, yielding a cloud propane mass of 37,850 kg (83,270 lbs). In order to model the effects of a postulated explosion, it was assumed that the cloud is ignited at its center point when the concentration of

propane vapor at this point has decreased to the upper explosive limit (UEL). This point of ignition was selected as the farthest distance from the tank at which most of the cloud would still be in the explosive range. Although a significant fraction of propane would be at a concentration below the LEL at the time when the center point concentration has decreased to the UEL, it was conservatively assumed that the entire propane inventory is involved in the postulated explosion. Based on a cloud propane mass of 37,850 kg (83,270 lbs), 100% of the initial tank contents, the radius of a 1 psi overpressure was calculated using the TNT equivalency method as 418 m (1371 ft) from the center of the cloud. At the time when the SLAB code indicated that the propane concentration at the cloud center point decreased to the UEL, the cloud center point had drifted 210 m (690 ft) from the tank (release point). This yielded a 1 psi overpressure 628 m (2061 ft) from the tank. At 549 m (1800 ft) the scaled ground distance, Z, was calculated as 36.4, yielding an overpressure less than 2 psi at the Canister Transfer Building.

Scenario (4) is an instantaneous release of the entire contents of a 5,000 gallon propane tank. In this circumstance, liquid will flash to vapor, and vapor and liquid will exit the tank in a foam-like state. While it is anticipated that a substantial fraction of the liquid propane would pool on the ground, then vaporize in time as it is heated by the ground and air, it was conservatively assumed that all of the liquid propane is airborne in the vapor cloud, in the form of aerosol droplets. Thus, the release was modeled as 37% vapor and 63% aerosol droplets of propane at –42 ° C. As the mixture is warmed by the atmosphere, the droplets vaporize. The emissions were modeled as a cold dense cloud of propane gas and droplets being transported downwind by the wind using the SLAB model. The initial cloud dimensions are 4 meters high x 19 meters diameter. The SLAB model requires terrain roughness as an input. A value of .0003 meters was used as suggested in the SLAB users manual for “level dessert”. The SLAB model predicted a maximum concentration exceeding the LEL out to a distance of 400 meters. Within 24 seconds the entire release has evaporated yielding a cloud

propane mass of 9,460 kg (20,820 lbs). As with scenario 3, it was assumed that the cloud is ignited at its center point when the concentration of propane vapor at this point has decreased to the UEL. Although a significant fraction of propane would be at a concentration below the LEL at the time when the center point concentration has decreased to the UEL, it was conservatively assumed that the entire propane inventory is involved in the postulated explosion. Based on a cloud propane mass of 9,460 kg (20,820 lbs), 100% of the initial tank contents, the radius of a 1 psi overpressure was calculated using the TNT equivalency method as 263 m (864 ft) from the center of the cloud. At the time when the SLAB code indicated that the propane concentration at the cloud center point decreased to the UEL, the cloud center point had drifted 100 m (328 ft) from the tank (release point). This yielded a 1 psi overpressure radius of 363 m (1192 ft) from the tank.

In all cases analyzed, with the exception of postulated rupture of a hypothetical 20,000 gallon tank, propane-air concentrations diminished to below the LEL at distances much shorter than the 1,800 ft minimum distance from the tank(s) to the Canister Transfer Building and the nearest storage casks. In the case of postulated rupture of a 20,000 gallon tank, explosive concentrations of propane traveled to distances beyond 1,800 ft under the worst case meteorological conditions evaluated. For this reason, PFS will design the propane storage system for supplying propane to heat the Canister Transfer Building and Security and Health Physics Building with 4 separate tanks, with each tank having a capacity of less than or equal to 5,000 gallons for a total capacity of not more than 20,000 gallons. The 4 tanks shall be separated by missile walls to ensure that a single missile driven by the design tornado can not rupture more than one tank. The design will assure that it is not credible that more than one of the tanks could rupture at any given time.

Each propane tank shall have an excess flow shutoff valve that automatically isolates upon sensing high flow that could be due to a downstream line rupture or large leak. In

addition, a single excess flow shutoff valve shall be located on the 2 inch piping header that supplies propane to the Canister Transfer Building and Security and Health Physics Building, downstream of the connection points of the lines from the 4 propane tanks. This valve shall also be designed to automatically close upon sensing high flow conditions indicative of a line rupture or large leak. This system of automatic isolation valves will serve to automatically isolate pipeline ruptures, thus preventing significant leakage of propane in the vicinity of the Canister Transfer Building or Security and Health Physics Building.

As discussed above, overpressures were evaluated using the TNT energy equivalent methodology for each of the four propane release scenarios, assuming ignition of the dispersed propane vapor clouds. In all cases analyzed, with the exception of postulated rupture of a 20,000 gallon tank, overpressures decreased to less than 1 psi prior to reaching the Canister Transfer Building and nearest storage casks. Release of the total 20,000 gallons inventory of propane from all four tanks is not a credible scenario.

8.2.4.3 Accident Dose Calculations

Since there is no potential for significant overpressures occurring at structures, systems, and components at the PFSF that are important to safety as a result of nearby explosions, there would be no damage to the cask storage or transfer systems and no resultant dose.

8.2.5 Fire

Fire is classified as a human-induced Design Event IV as defined in ANSI/ANS-57.9.

8.2.5.1 Cause of Accident

The only combustible material at the PFSF storage pads during storage operations is insulation on the temperature monitoring instrumentation wiring, which is present in insignificant quantities at each storage cask. No combustible or explosive materials are allowed to be stored on or near the storage pads. The PFSF Restricted Area (RA) is cleared of vegetation and the entire RA surfaced with compacted gravel. The concrete pads and storage casks are located a minimum distance of 150 ft from the outer edge of the RA (i.e., the inner fence surrounding the RA); the Canister Transfer Building is located a minimum distance of 112 ft from the outer edge of the RA. The area between the outer edge of the RA and the outer edge of the perimeter road (50 ft distance, see Figure 1.2-1) is also covered with crushed rock. The only significant sources of combustibles that would be present inside the RA would be: 1) the diesel fuel in the tanks of the tractor, and tires on the tractor and trailer, of any heavy haul vehicles transporting shipping casks to/from the PFSF site; 2) the diesel fuel in the tanks of any train locomotive transporting shipping casks to/from the PFSF site; 3) the diesel fuel in the cask transporter vehicle that would move casks from the Canister Transfer Building to the storage pads; 4) the diesel generator fuel tank inside the Security and Health Physics Building; and 5) the diesel fuel storage tank, which would be located at least 50 ft inside the inner fence surrounding the RA, approximately 200 ft northeast of the Canister Transfer Building and 700 ft east of the nearest storage casks.

The group of propane storage tanks having relatively large total capacity that will supply propane to heat the Canister Transfer Building and the Security and Health Physics Building (described in Section 8.2.4.1) shall be located a minimum of 1,800 ft south or southwest of the Canister Transfer Building, and a minimum distance of 1,800 ft from

67. NISTIR 5486-1, FPEtool, Version 3.2, U.S. Department of Commerce Technology Administration, National Institute of Standards, April 1995.

68. ASTM E-119, Standard Test Methods for Fire Tests of Building Construction and Materials, 1998.

69. Reinforced Concrete Fire Resistance, Concrete Reinforcing Steel Institute, 1980.

70. PFSF Calculation No. 05996.02-P-007, Radiant Heat Flux Calculations for Canister Transfer Building Heavy Haul Vehicle Tire Fire, Revision 0, Risk Technologies.

71. Society of Fire Protection Engineers (SFPE) Handbook, Second Edition, published by the National Fire Protection Association, Boston MA, 1995.

72. J&R Engineering Company, Inc. fax from R. Johnston to DW Lewis of Stone & Webster, J&R Engineering Drawing No. 1481L001, Rev. B, "Preliminary Layout TL250-40 Commonwealth Edison," with revisions to suit PFSF, dated June 15, 2000.

73. Lift Systems electronic letter from J. Pelkey to DW Lewis of Stone & Webster, Lift Systems Drawing No. MS204, Rev. 6-3-2000, "Nuclear Fuel Crawler Cask Transporter for the NAC Storage Cask at Palo Verde Nuclear Generating Station," dated June 14, 2000.

74. PFSF Calculation No. 05996.02-UR(D)-13, Dose Calculation at 500 Meters for the HI-STORM BWR Canister for Postulated Accident Conditions, Revision 0, Stone & Webster.

75. PFSF Calculation No. 05996.01-UR-1, Accident χ/Qs for the Private Fuel Storage Facility (PFSF), Revision 2, Stone & Webster.

76. PFSF Calculation No. 05996.02-P-008, Propane Release Analysis With Dispersion and Delayed Ignition, Revision 1, Risk Technologies.

77. Material Safety Data Sheet for Commercial Propane, Air Products Corporation, Allentown, Pennsylvania.