Private Fuel Storage, L.L.C.

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COMMITMENT RESOLUTION LETTER #27
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PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

Reference: March 1, 2000 telephone call between Stone and Webster (S&W) and the NRC/CNWRA

A conference call was held on March 1, 2000 between the NRC/CNWRA and Stone and Webster (S&W). The purpose of the call was for the NRC to identify open items/outstanding issues remaining in their review of the Private Fuel Storage Facility (PFSF) Safety Analysis Report. The NRC questions/comments are documented below followed by the Private Fuel Storage (PFS) response.

NRC Questions and Comments

1. PFS needs to justify why NFPA 801 will not be applicable for the PFSF. NFPA 801 is usually applicable to all locations where radioactive material is stored. NFPA 801 requires a Fire Hazard Analysis (FHA) and criticality calculation for all those areas with fissile materials.

RESPONSE – In response to this question, an evaluation was performed to compare the differences between NFPA 801 and the Uniform Building Code. The following table highlights the major differences:

Subject	NFPA 801 and referenced NFPA codes	Uniform Building Code
Bldg. Classification		
Operations / Cask Load/Unload Bay	Special Purpose Industrial Occupancy (NFPA 101, 4-1.9) – Ordinary Hazard (NFPA 101, 4-2)	Group H, Div. 3 – Hazardous -Moderate Hazardous (UBC 307.1)

NMSS01 Public

Subject	NFPA 801 and referenced NFPA codes	Uniform Building Code
LLW Storage Area	Storage Occupancy (NFPA 101) – Ordinary Hazard (NFPA 101, 4.2)	Group S, Div. 1 – Storage – Moderate Hazard (UBC 311.1)
Office / Equip Rooms	New Business Occupancy (NFPA 101) – Ordinary Hazard (NFPA 101, 4.2)	Group B – Business - Low Hazard (UBC 304.1)
Construction Type		
Type	Type II – Bldg. with approved noncombustible or limited combustible materials (NFPA 220)	Type II-FR - Bldg. with noncombustible fire-resistive construction (UBC 603.1).
Fire Barriers		
Between Office/Equip. Rms & Ops / Cask Load / Unload Bay	Walls - 1 hour (NFPA 101, 26-3.2.1) Doors – ¾ hour (NFPA 101, 26-3.2.1)	Walls – 1 hour (UBC Table 3B) Doors – 1 hour (UBC 302.3.4)
Between Storage & Ops./Cask Load/Unload Bay	Walls – 1 hour (NFPA 101, 6-4.1.1) Doors – ¾ hour (NFPA 101, 6-4.1.3)	Walls – 1 hour (UBC Table 3B) Doors – 1 hour (UBC 302.3.4)
Between Office/Equip. Rms & Storage Area	Walls - 1 hour (NFPA 101, 26-3.2.1) Doors – ¾ hour (NFPA 101, 26-3.2.1)	Walls – 1 hour (UBC Table 3B) Doors – 1 hour (UBC 302.3.4)
Fire Protection		
Fire Suppression Requirements	Required unless FHA dictates otherwise (NFPA 801, 4-1.2) Standpipes and hose systems required per NFPA 14 as determined by FHA (NFPA 801, 4-5.1)	Required in Group H, Div. 1 buildings (UBC 904.2.6.1) Standpipes and hose systems are required in accordance with UBC Table 9A.
Fire Detection	Required per NFPA 72 as determined by FHA (NFPA 801, 4-8.2)	Required in Group H occupancies as required by the local fire code (UBC 307.9)

Based on the evaluation of the major differences in the above table, PFS has determined that the Canister Transfer Building (CTB) will be designed with fire protection systems

in areas of the building where it is in the best overall interest of fire, life, and nuclear safety. Therefore, the CTB will be designed to meet the following criteria:

a. NFPA 101 Life Safety code requirements to maintain the protection of all personnel.
b. NFPA 801 requirements as required for nuclear material handling facilities.
c. UBC, as appropriate to protect against the loss of property.
d. Fire barriers will be designed to the worst case code, i.e. 1 hour fire rated walls and doors per the UBC.
e. A fire suppression system as required by NFPA-801 will be installed in the Cask Load/Unload Bays of the CTB to suppress a possible fire from a 300 gallon diesel fuel spill. The system will consist of a foam-water system per NFPA-16, which is specifically designed for the suppression of fuel type fires. This type of fire suppression is an extremely conservative approach since a 300 gallon leak is highly unlikely (the fuel is contained in two 150 gallon side saddle truck tanks) and the shipping cask system are designed to withstand accidents per 10CFR71 that bound the worst case postulated fire for the building.
f. The foam-water system will be designed to discharge for a minimum of 30 minutes in accordance with NFPA 801.
g. Standpipes with hose systems as required by NFPA-801 will be installed at either end of the office area corridor and adjacent to the cask transporter bay, crane bay, and load/unload bay exit locations so that every portion of the building is reachable by a firewater stream from a 100 ft. hose.
h. The transfer cell rooms will not be provided with automatic fire suppression systems in order to prevent any possible radioactive contamination on the canisters from being dislodged by the water spray. It was determined that the transfer cells do not require automatic fire suppression because the rooms will primarily contain only components that are constructed of noncombustible fire resistive materials (e.g. the storage or shipping cask) that have been analyzed for fires that bound the worst case postulated fire for the building (Ref. storage system SARs).
i. Portable fire extinguishers as required by NFPA-801 will be installed in appropriate locations throughout the building.
j. A fire detection system as required by NFPA-801 will be installed in the all areas of the building in accordance with NFPA 72.

See the response to question 2 for relevant information concerning a Fire Hazards Analysis and criticality calculation.

The SAR will be revised to incorporate the above information.

2. PFS should perform a Fire Hazards Analysis to demonstrate the effectiveness of the sprinkler systems proposed for the Canister Transfer Building and Security/Health Physics Building.

RESPONSE –PFS will perform a Fire Hazards Analysis (FHA) in accordance with NFPA-801 prior to detailed design of the facility. A review of the list of items recommended for inclusion into the FHA determined that a majority of the analyses and information required in the FHA have already been presented in the SAR, EP, and supporting calculations. Specific information includes:

- Fire protection system and performance criteria (SAR Section 4.3.8).
- Design considerations for fire in the storage systems and PFSF buildings (SAR Sections 4.2.1.5.1J, 4.2.2.5.1J, 4.7.1.5.1G, 4.7.3.5.1E, and 4.7.4.5.1D, which show that the spent fuel storage system and transportation systems are already qualified for potential fires that bound the fires at the PFSF).
- Methods for fire prevention, extinguishing, and control (SAR Section 4.3.8).
- Types of potential fires (SAR Section 8.2.5)
- That there are no essential power requirements because of the passive safety design of the components (SAR Section 4.3).
- Available offsite fire protection (EP Section 1.3 and 3.2D).
- Inspection, testing and maintenance (See response to Question 18).
- Life safety, protection of critical SSCs, and radioactivity releases are included in the above references.

A fire loading calculation has not been prepared by PFS and will be required for the FHA. However, in preparation of the license documents, PFS has already performed evaluations that determined that the combustible loading in the building is negligible and that a fire at the site will not adversely affect nuclear safety of the facility nor the health and safety of the public.

NFPA-801 also requires a criticality calculation to show that no fire will present a criticality hazard. SAR Sections 4.2.1.5.4 and 4.2.2.5.4 show that criticality control is maintained by the design of the storage systems. Therefore, a separate analysis is not required.

Based on the reasons stated above, it is anticipated that the FHA will conclude that the design of the PFSF will provide an adequate defense against major fires due to the low fire loading, passive fire barriers, compartmentalization, fire suppression systems, and fire detection; the design meets the requirements of the Uniform Building Code and applicable NFPA standards; and that the analysis will clearly demonstrate that the level of protection provided for the PFSF is very conservative relative to the level of fire risk.

The SAR will be revised to incorporate the above information.

3. PFS needs to justify the rational for designating the Canister Transfer Building with a construction Type 2 fire rating. What is the basis for selecting Type 2?

RESPONSE – The UBC Construction Type II-FR (fire rated) was selected because 1) it is consistent with the concrete shield wall requirements of the canister transfer operations and 2) it is the most economical type of structure of those that meet the maximum allowable floor area requirements of Table 5-A.

It is recognized that NFPA utilizes a similar construction classification system through NFPA-220, which is referenced in NFPA-801. Under this classification, the Canister Transfer Building would be classified as a Type II building. However, PFS chose to utilize the UBC construction Type II-FR classification because it is more restrictive and has higher fire-resistance requirements than the NFPA-220 construction Type II classification.

The SAR will be revised to incorporate the above information.

4. PFS needs to provide the rational for designating the spent nuclear fuel as an "other health hazard" as defined in Table 3E of the Uniform Building Code (UBC). This requirement would not be necessary if NFPA 801 was adopted.

RESPONSE – The UBC is concerned about hazards other than fire that could affect the health of the building occupants. NFPA 801 is only concerned with fire protection and therefore, the UBC was used for this case. This designation will have no bearing on the building's fire protection systems. The amount of these health hazards present could impact the building design features such as ventilation systems, egress paths and building materials. Radiation from the spent nuclear fuel is not included in the specific list of health hazards presented in UBC Table 3-E and therefore must be considered as an "other health hazard." As noted in the Table, there are no limitations to the amount of spent nuclear fuel in the building as long as it is contained in a closed system such as the canister.

The SAR will be revised to incorporate the above information.

5. PFS needs to explain why the ¾ hour fire rated doors are adequate when the UBC states that 1 hour fire rated doors are required.

RESPONSE - The designation of ¾ hour fire doors in accordance with UBC was incorrect and should be 1 hour ratings in accordance with UBC 302.3.4. The SAR will be revised to show a 1 hour fire rating for the doors.

6. PFS needs to verify that the 1 inch high diesel fuel retention threshold shown on SAR Figure 4.3-1 is adequate to contain the 300 gallon diesel fuel leak plus the foam water

mixture that will be discharged from the sprinkler system. The UBC requires that the design consider a 20 minute discharge from the sprinkler system while NFPA requires a 30 minute discharge.

RESPONSE – The fire protection system in the load/unload bays of the Canister Transfer Building is a foam-water sprinkler system. The foam-water sprinkler system is a special system that is connected by piping to a source of foam concentrate and to a water supply through a control valve that is actuated by an automatic detector. When the valve opens, water flows into the piping system where foam is injected into the water, resulting in a foam solution discharging through special sprinkler heads. The foam-water discharge continues until shut off manually.

The total floor area of the cask load/unload bays is 200 ft. by 50 ft. for a total of 10,000 sq. ft. NFPA-16, for a foam-water sprinkler system, allows a maximum of 5000 sq. ft. per zone. Therefore, the bays will require 2 foam-water sprinkler zones. The 2 zones were selected as the east half of both bays and the west half of both bays, an area of 5000 sq. ft. One sump will be located in the center of each zone centered along Column 9 and will be 90 ft long. The floor of each bay will be sloped 0.25 in./ft. in the north/south direction to one of the two sumps. The floor of each sump will be sloped 0.25 in./ft. toward the ends of the bays, away from the center of the building where a shipping cask, crane lifting cables, or the threshold into the crane bay / transfer cell area are located.

NFPA 16 requires that the design discharge density of water be no less than 0.16 gal/min./sq. ft. Assuming the total volume of free water is maintained at 0.16 gal/min./sq. ft. and is not lost by the production of foam plus the 300 gallons of diesel fuel spill, the maximum volume assuming a discharge for 30 minutes in accordance with NFPA 801 is:

Vol. = (0.16 gpm/sq. ft. x 30 min. x 5000 sq. ft. + 300 gal diesel) / 7.48 gal/cu. ft.

Vol. = 3,250 cu. ft.

(Note: Typically these calculations include water from the discharge from hose streams. However, NFPA 801, 3-10.2.1(c) excludes this requirement where an automatic fire suppression system is provided throughout. In addition, it is reasonably anticipated that the FHA will determine that the water discharged by the foam-water system (24,000 gal) is abundantly more than necessary to extinguish a fire from a mere 300 gallons of diesel fuel).

If the floors of the bay are sloped 0.25 in. per ft. toward the sumps, then the depth of the floor at Column line 9 will be (assume a 3 ft. dry egress perimeter around the bays):

Pooling depth = (25 ft. – 3 ft.) x 0.25 in. / ft. = 5.5 in.

Then the total volume of fluid that the floor will hold is:

Floor capacity = (50 ft. – 6 ft.) x 5.5/12 ft. x (100 ft. – 6 ft.) / 2 = 948 cu. ft.

Therefore, the sumps must be designed to hold a minimum volume of:

Sump capacity = 3,250 – 948 = 2302 cu. ft.

If the sumps are designed with a maximum width of 4 ft., then the depth of each sump at the shallow end will have a minimum depth of:

Sump depth = 2302 cu. ft. / (90 ft. x 4 ft.) - (90 x 0.25/12/2) = 5.5 ft.

Under this design, the threshold between the load/unload bay and the crane bay will be designed at a maximum height of 1 inch, which will provide ample protection (along with the 3 ft. dry egress path) against fluids crossing the threshold. The threshold will not rise abruptly like a curb but rather will gradually raise to 1 inch and lower flush to the floor over a 2 ft. wide area so as not to be a personnel tripping hazard.

The SAR will be revised to incorporate the above information.

7. PFS should provide a discussion of the design requirements for the cask load/unload bay floor that will be utilized to direct leaking diesel fuel from a heavy haul tractor-trailer away from the shipping cask. The discussion should include the slope (and direction of slope) of the floor, location of floor sumps/pits relative to the transfer cask, and crane lifting cables.

RESPONSE – See the response to question 5 above.

8. UBC Section 904.2.5.1 requires automatic fire extinguishing systems for areas designated as Fire zone 1, Class H, Division 3. To avoid dislodging contamination, the SAR states that the Transfer Cells will not have automatic sprinkler systems. This is inconsistent with the fire classification. How is PFS going to provide equivalent fire fighting capability?

RESPONSE – As stated in the response to question 1, the transfer cell rooms will not be provided with automatic fire suppression systems in order to prevent the highly unlikely event of dislodging any possible external radioactive contamination on the canisters by the fire water sprinklers. It was determined that the transfer cells will not include automatic fire suppression because the rooms will primarily contain only components that are constructed of noncombustible fire resistive materials (e.g. the storage or shipping cask. From a hazard standpoint, dislodging contamination would likely be a more significant hazard than a potential fire within a transfer cell. Housing only the cask

components, it is unlikely that a fire of any magnitude could occur in the transfer cells. The only combustible source in a transfer cell will be from the cask transporter when it is needed to move a storage cask from the cell to the storage pad. This will only occur after the canister is safely contained in the concrete storage cask. The cask storage systems have been analyzed for a fire that bounds a fire from a 50 gallon diesel fuel source as explained in SAR 8.2.5. However, to provide equivalent fire protection in the event this fire does occur, standpipes with 100-ft. hoses will be installed adjacent to the crane bay and cask transporter bay exit locations in accordance with NFPA-801. This will ensure that all areas within the transfer cells will be reachable by a firewater stream in the unlikely event a fire occurs.

The SAR will be revised to incorporate the above information.

9. What is the capacity of the diesel tank in the Security and Health Physics Building? What are the fire protection provisions and fire ratings for the Security/Health Physics Building?

RESPONSE – The actual diesel-generator that will be located in the Security and Health Physics Building has not been selected at this time. However, the unit will be no larger than 150 kW as stated in Chapter 9 of the Environmental Report. Comparing several manufacturers' literature for 150 kW diesel-generator sets, the maximum fuel consumption is approximately 12 gal/hr. Since the unit is required to provide a minimum of 24 hours backup power per IEEE 692 and NUREG-0908 plus the required 30 minute monthly tests per NUREG/CR-0509 (conservatively assume 1 hour test for up to 3 months), then the minimum required fuel tank size must be:

$$(24 \text{ hr} \times 12 \text{ gal/hr}) + (3 \text{ tests} \times 1 \text{ hr/test} \times 12 \text{ gal/hr}) = 324 \text{ gallons}$$

Assume 350 gallons for the purposes of determining the Security and health Physics Building UBC building classification and fire zone requirements. The fuel will be contained in a dual wall sub-base tank, which is pre-designed to meet NFPA-37, "Installation and Use of Stationary Combustion Engines and Gas Turbines," requirements on tanks and spill containment requirements.

The Security and Health Physics Building fire protection provisions will be designed in accordance with the requirements of the UBC and NFPA 101 (The Life Safety Code). The building is classified as Group B – for business related functions. The building as a whole will not require any automatic fire suppression systems based on the occupancy of less than 50 (UBC 304.1) and allowable floor area of less than 12,000 sq. ft. (UBC Table 5-B). The building construction is classified as a Type II N, which does not require any special fire rated components for this building (UBC Table 6-A).

As addressed above, the diesel generator tank will hold approximately 350 gallons, which exceeds the exempt amount of 120 gallons for closed systems in UBC Table 3-D. Therefore, the diesel generator room, which is classified as a hazardous material control area, will be provided with a fire sprinkler system in accordance with NFPA 13 and will be separated from all other adjacent interior spaces by a 1 hour fire resistive barrier in accordance with UBC Table 3-D.

Where combustible liquids are present in Group B structures, the UBC requires that the storage and use of such combustibles be in accordance with the fire code, i.e. the NFPA. As noted above, the diesel fuel will be contained in a dual wall tank that will meet all the fire prevention controls required per the NFPA-37 and therefore, will not require any other provisions for fire protection.

The SAR will be revised to incorporate the above information.

10. Page 8.2-26a of the PFSF SAR states that "All other diesel fuel sources would be farther than 100 ft inside the edge of the crested wheat grass barrier, and would similarly not be threatened by a wildfire due to their distance from a fire, even if it were assumed the wildfire somehow penetrated this grass barrier." What are the other diesel sources mentioned in this section of the SAR.

RESPONSE – The other diesel fuel oil sources referred to in this section that would normally be located inside the Restricted Area are the cask transporter and the switch yard locomotive. Additionally the heavy haul tractor-trailer or the mainline locomotives would be inside the Restricted Area while delivering transportation casks to the site. All of these vehicles will normally be farther than 100 ft inside the edge of the crested wheat grass barrier, and would not be threatened by a wildfire.

The SAR will be revised to include the above information.

11. What is the basis for concluding that only 25% of the propane vapor cloud will be in an explosive concentration?

RESPONSE – Based on Table 5-5E of the Fire Protection Handbook (Sixteenth Edition, National Fire Protection Association, 1986), propane mixed with air has a lower flammable limit of 2.15% and an upper flammable limit of 9.60%. Propane is heavier than air, so that postulated rupture of a propane tank would result in a blanket of propane forming on the ground, generally centered around the ruptured tank. Propane in the immediate vicinity of the tank would have a higher concentration, while propane that has dispersed further outward from the tank toward the periphery of the propane-air cloud would have mixed with air to a greater extent, and would be at a lesser concentration. Thus, propane concentration would be expected to vary spatially, at any given time following the tank rupture, and there would be a concentration gradient which is

dependent on distance from the source. Assuming a uniform concentration gradient in which propane concentration varies linearly with distance from the source (i.e., 10% of the total weight of the propane-air cloud falls in the 90-100% concentration, 10 % is in the 80 – 90% concentration, ... and 10 % is in the 0 – 10% concentration), approximately (9.60% - 2.15% =) 7.45% of the propane-air cloud would be in the flammable range. The average concentration of propane in the flammable range is about 6%. Thus, approximately (7.45% X 6%=) 0.45%, or less than 1% of the total propane inventory would be in the flammable range considering this simplistic spatial concentration gradient. In addition to the spatial variation of propane concentration out from the source, there would also be temporal variation, with propane concentration generally decreasing with time throughout the volume of the propane-air cloud. While there is uncertainty in projecting the fraction of the total propane inventory released from the postulated rupture of a tank that is in the flammable range at any given time, 25% is considered to be conservative.

If it is assumed that 100% of the propane released from postulated rupture of the 2,000 gallon tank burns during conflagration of the propane-air cloud, 8,480 lbs of propane would be involved in the combustion process, with a total heating value of 1.83 E8 Btu (4.61 E10 calories), as discussed in PFSF SAR Section 8.2.4.2. NRC Regulatory Guide 1.91, Revision 1, 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 current evaluation in PFSF SAR Section 8.2.4.2 assumes that 10% of the total heat of combustion of the propane released from the 2,000 gallon tank that is assumed to be in the flammable range contributes to blast effects. 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 surfaced with compacted gravel, the propane-air mixture resulting from postulated rupture of a tank 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 its Handbook of Chemical Hazards Analysis, dated 1989 (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, (4.61 E10 calories)(0.03) = 1.38 E9 calories would contribute to blast effects (versus the 1.15 E9 calories identified in PFSF SAR Section 8.2.4.2, which assumed combustion of 25% propane in the flammable range and 10% contribution to blast effects). Since TNT has a heat of explosion of 1,050 cal/g, as discussed in the PFSF SAR, the equivalent weight of TNT that would release 1.38 E9 calories of heat energy is:

$$(1.38 \text{ E9 calories}) / (1.05 \text{ E3 cal/g}) = 1.314 \text{ E6 g} = 2{,}897 \text{ lbs}$$

As was done in PFSF SAR Section 8.2.4.2, the overpressure effects of postulated detonation of this weight of TNT can be assessed using Figure 4-12 of the Army Technical Manual on Explosion Effects (Reference 52 of PFSF SAR Chapter 8 and Reference 1 of Reg. Guide 1.91). This figure 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). $W^{1/3} = (2{,}897)^{1/3} = 14.25$.

While the storage casks can withstand a much higher overpressure before they begin to slide or tip, the Canister Transfer Building is designed to withstand a pressure differential of 1.5 psi due to a tornado (PFSF SAR Sections 3.2.8.1 and 3.2.8.3) and an even higher load due to a seismic event. Therefore, the limiting overpressure for important-to-safety structures that could be impacted by a propane explosion is considered to be 1.5 psi. A 1.5 psi peak positive incident pressure corresponds to a scaled ground distance, Z_G, of approximately 32, based on Figure 4-12 of the Army Technical Manual. Solving the above equation for R_G:

$$Z_{G,} = R_G / W^{1/3} \text{ , } 32 = R_G / 14.25 \text{ , } R_G = (32)\ (14.25) = 456 \text{ ft}$$

Thus, based on the TNT energy equivalent approach, the resulting overpressure from a propane explosion involving 8,480 lbs of propane (equivalent to 2,897 lbs of TNT) leaked from the larger of the two propane storage tanks will not exceed 1.5 psi at important-to-safety structures, systems and components (SSCs) as long as the 2,000 gallon propane tank is located a minimum distance of 456 ft from the Canister Transfer Building and storage casks. Both the 2,000 gallon propane tank that will supply the Canister Transfer Building and the 1,000 gallon propane tank that will supply the Security and Health Physics Building will be sited at a minimum distance of 460 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 larger tank will not produce overpressures greater than 1.5 psi at important to safety SSCs and will not challenge the integrity of the storage casks or the Canister Transfer Building. The scenario evaluated above is bounding, in that postulated leakage and explosion of the 1,000 gallon propane inventory associated with the smaller storage tank would generate lower overpressures at the important to safety SSCs.

The above evaluation is conservative for several reasons: 1) the 2,000 gallon propane tank is assumed to be completely full 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, 3) 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 4) 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.

The PFSF SAR will be updated to incorporate a 460 ft minimum required distance of the propane storage tanks from the Canister Transfer Building and from the storage casks, along with the above discussion explaining how this distance was arrived at using the TNT energy equivalent approach with the modified assumptions for the fraction involved in combustion and the blast efficiency of propane.

12. What is the basis for concluding separation of 300 ft. between propane tanks is sufficient to prevent simultaneous rupture of both tanks?

RESPONSE – PFSF SAR Section 8.2.4.1 states that a 2,000 gallon propane storage tank will be used to supply propane for heating the Canister Transfer Building, and a 1,000 gallon propane storage tank will be used to supply propane for heating the Security and Health Physics Building, with a requirement that the two tanks will be separated from each other by a minimum distance of 300 ft. As stated in PFSF SAR Section 8.2.4.1, this "is considered more than sufficient distance to prevent a single projectile, such as a tornado-driven missile, from impacting both tanks. … The storage tanks will be above-ground, designed in accordance with the requirements of NFPA 58. … NFPA 58 requires that propane tanks between 50 and 2,000 gallon capacity be located at least 25 ft away from any building, adjacent container, or adjacent property." As stated in the response to NRC Question #11, both tanks will be located a minimum distance of 460 ft away from the Canister Transfer Building.

A distance of 300 ft is sufficient to provide assurance that a single tornado-driven missile will not cause the rupture of both tanks. The postulated tornado missiles for the design of the Canister Transfer Building are in accordance with NUREG-0800, Section 3.5.1.4, Spectrum II missiles for Tornado Region III. The tornado-driven missile with the highest speed for Region III is the 115 lb. wood plank (3.6" x 11.4" x 12' long) with a horizontal velocity of 190 ft/sec. At a speed of 190 ft/sec, it would take a missile with an initial horizontal trajectory (300 ft/190ft/sec =) 1.58 sec to travel the 300 ft distance between tanks, during which time the missile would drop a vertical distance of ($1/2\ gt^2$=) 40.2 ft, due to the force of gravity. Since the tanks will be pad mounted, and stand less than 6 ft high, Spectrum II design basis missiles starting from the top of one tank with a horizontal trajectory would contact the ground before striking the other tank 300 ft away. Were a tornado-driven missile to strike one of the propane tanks in a manner that would result in penetration of the tank and not simply a glancing blow, it would likely expend most or all of its kinetic energy in the collision with this tank and would not have sufficient energy

remaining to inflict damage on a tank 300 ft away. Based on the above, it is not considered credible that a single tornado-driven missile could cause rupture of both propane tanks.

PFS has also evaluated the possibility of a postulated explosion of one of the tanks causing explosion of the other tank, and subjection of the Canister Transfer Building to the cumulative effects of both explosions. The postulated explosion of the contents of one tank would generate a pressure wave travelling out in all directions at the speed of sound through air, approximately 1100 ft/sec. Based on information regarding explosion blast overpressure effects on refinery equipment from a publication by the Office of Oil and Gas of the U.S. Department of the Interior, dated February 1970, the minimum overpressure at which significant damage begins to occur to a horizontally mounted pressure vessel is 5.5 psi. Using the same TNT energy equivalent methodology described in the response to NRC Question #11 above for the postulated explosion of 2,000 gallons of propane, the overpressure can be determined at a distance of 300 ft (the minimum distance to the 1,000 gallon propane tank that supplies the Security and Health Physics Building). Since Z_G (the scaled ground distance) = $R_G / W^{1/3}$, and $W^{1/3} = 14.25$ as demonstrated above, $Z_G = 300 / 14.25 = 21.1$. Based on Figure 4-12 of the Army Technical Manual, a scaled ground distance of 21.1 corresponds to a peak positive incident overpressure of 2.7 psi. This overpressure will not significantly damage the horizontally mounted propane storage tank that supplies the Security and Health Physics Building, and it would retain its structural integrity in the event of the postulated propane-air explosion associated with the 2,000 gallon propane tank.

Traveling at the speed of sound in air, it would take the pressure wave approximately (460 ft/1100 ft/sec=) 0.42 sec to reach the Canister Transfer Building, and at least (300 ft/1100 ft/sec=) 0.27 sec to reach the other propane tank. If it were conservatively postulated that the effects of explosion of propane from the larger tank were to cause rupture of the second tank, some finite amount of time would have to elapse in order for the pure propane released from the second tank to disperse and mix with air, becoming sufficiently diluted so that a significant fraction of the propane is in a combustible mixture, then ignite. Even if this were assumed to occur in only several seconds, the pressure wave from explosion of the propane from the first tank would have already moved beyond the Canister Transfer Building. After propane from the second tank is assumed to mix with air to achieve an explosive concentration and ignite, it would take the pressure wave from this tank approximately 0.42 seconds to reach the Canister Transfer Building (both tanks are assumed to be located at the minimum permissible distance of 460 ft from this building). Thus, even if it were postulated that explosion of one tank could somehow cause rupture of the other tank, the time delays inherent in the 300 ft tank separation distance and in the mixing process so that propane reaches an explosive concentration with air assure that the effects of the two explosions on the Canister Transfer Building would be independent and not cumulative.

The 300 ft required minimum separation distance of the two propane storage tanks nearest the Canister Transfer Building specified in PFSF SAR Section 8.2.4.1 will be retained, and the above information added to the SAR in support of this separation distance.

13. PFS needs to evaluate the consequences of a potential on-site vehicle impacting SSCs important to safety within the facility.

RESPONSE – Key SSCs of concern from the standpoint of vehicle collisions are shipping casks, storage casks and the Canister Transfer Building. Shipping casks outside of the Canister Transfer Building will either be on rail cars or heavy haul vehicle trailers in their certified 10 CFR 71 shipping configuration, with the impact limiters installed. If an on-site vehicle, such as a pickup truck, were to collide with a rail car or heavy haul trailer, it would be no different from a collision occurring during shipment over the public highways, for which 10 CFR 71 requirements provide adequate assurance that the shipping cask will retain its integrity. The designs of both the storage casks and Canister Transfer Building are required to withstand impact by tornado-driven missiles, including automobiles. PFSF SAR Section 3.2.8.4 indicates that the Canister Transfer Building must be designed to withstand the effects of an automobile weighing 3990 lbs (Spectrum II missile) with a horizontal velocity of 134 ft/sec (91 mph). The storage casks are designed for tornadoes having higher wind speeds, and must withstand the effects of a tornado-driven automobile weighing 1,800 kg (3,968 lb, Spectrum I missile) traveling at 126 mph (PFSF SAR Section 8.2.2.2). On-site vehicles will generally be traveling at relatively low speeds, on the order of 15 mph, and the effects of an on-site vehicle striking the Canister Transfer Building are bounded by the effects of tornado-driven missiles, which were evaluated in the storage cask vendor SARs and determined to be acceptable. Based on the above, safety functions performed by SSCs important to safety within the facility will not be challenged by postulated accidents involving on-site vehicles.

In order to prevent an on-site vehicle from running into one of the two propane tanks nearest the Canister Transfer Building (over 460 ft away as discussed above), vehicle barriers will be installed around these propane tanks.

This information will be incorporated in Section 8.4 of the PFSF SAR.

14. PFS needs to do a better job concluding or summarizing that the site specific meteorological data that PFS has collected in conjunction with the historical data that PFS has presented provides assurance that the site specific meteorological conditions are bounded by the vendor thermal analysis. Additionally, information on solar insolation used in the vendor analysis needs to be presented and compared to solar insolation data collected for the PFSF.

RESPONSE – SAR Chapter 2, Section 2.3.1.1, states the following:

> The description of the regional climatology of Skull Valley and the characterization of the PFSF site climate are based on "Climatography of the United States No. 60, Climate of Utah" published by the National Climatic Data Center (NOAA, 1960), long-term meteorological data collected by the National Weather Service at the Salt Lake City International Airport (SLCIA) as summarized by the National Climatic Data Center (NOAA, 1992), and "Utah Climate" published by the Utah Climate Center, Utah State University (Ashcroft et al., 1992). Normals, means, and extremes of temperature, precipitation, relative humidity, and wind speeds are taken from NOAA (1992). The SLCIA is located approximately 50 miles northeast of the site at an elevation of approximately 4,220 ft; the PFSF site is at an elevation of approximately 4,465 ft. Meteorological data collected at SLCIA, within 50 miles of the site, can be considered representative of the general climate of the site.

SAR Chapter 2, Section 2.3.2.1, states the following:

> The meteorology of the Skull Valley site can be partially characterized using long-term meteorological data collected by the National Weather Service at the SLCIA (NOAA, 1992). This climatological data set is the most comprehensive available for this area. The SLCIA is located approximately 50 miles northeast of the site at an elevation of approximately 4,220 ft. With the PFSF site being located at an elevation of approximately 4,465 ft, meteorological data collected at SLCIA can be considered representative of the general climate of the site but need to be supplemented with data more representative of local conditions.
>
> The valley location of the PFSF site has an influence on the local meteorology relative to that of SLCIA with the Stansbury and Oquirrh Mountains rising to elevations of above 10,000 ft between the two locations. The location of the Great Salt Lake to the north of Skull Valley as opposed to west and northwest of SLCIA also probably causes some meteorological differences between the two locations. Therefore, meteorological data collected in Skull Valley are also needed to characterize the local conditions. Monthly average temperature and precipitation data collected at various locations in Skull Valley are available from a book published by the Utah Climate Center (Ashcroft et al., 1992). The data collected at Dugway, located approximately 12 miles south of the PFSF site at an elevation of 4,340 ft, have the longest period of record (1950 - 1992) and appear to be the most reliable. Other useful data were collected at Iosepa South Ranch, which is located about 12 miles north of the PFSF site at an elevation of 4,415 ft, during the period from 1951 - 1958.
>
> The Onsite Meteorological Monitoring Program, described in detail in Section 2.3.3, will provide hourly average data on wind speed, wind direction, temperature, relative

> humidity, precipitation, barometric pressure, and solar radiation for characterization of the local meteorology because many of these parameters are not available from other sources.

As stated above, PFS has evaluated the regional climatology using the data collected at SLCIA. Local conditions were characterized by evaluating data collected at Dugway and Iosepa South Ranch and by performance of the Onsite Meteorological Monitoring Program. PFS believes the data sources evaluated (SLCIA, Dugway, and Iosepa South Ranch) are reliable and provide information representative of the local meteorological conditions. With the inclusion of the data collected by the onsite meteorological monitoring program, PFS believes that accurate and sufficient information has been provided for use in any analyses requiring meteorological values.

With regard to the vendor thermal analysis SAR Chapter 4, Section 4.2.1.5.2 states the following:

> The PFSF site low ambient temperature of -35° F, maximum annual average temperature of 51° F (normal), and average daily maximum temperature of 95° F (off-normal) are bounded by the corresponding temperatures used for the HI-STORM storage system of -40° F, 80° F, and 100° F, respectively. Therefore, the thermal design of the HI-STORM storage system bounds the site specific design requirements.

SAR Chapter 4, Section 4.2.2.5.2 states the following:

> The PFSF site low ambient temperature of -35° F, maximum annual average temperature of 51° F (normal), and average daily maximum temperature of 95° F (off-normal) are bounded by the corresponding temperatures used for the TranStor storage system of -40° F, 75° F, and 100° F, respectively. The heat generation of the fuel to be stored at the PFSF is bounded by the heat generation of the TranStor design basis fuel. Therefore, the thermal design of the TranStor storage system bounds the site specific design requirements.

Solar insolation values recommended in 10CFR71.71 have been included in the thermal analysis performed by both vendors. The total insolation for a 12-hour period recommended by 10CFR71.71 is 800 g cal/cm^2 or 775 watts/m^2 over a 12-hour period. The maximum total solar insolation for a 12-hour period recorded during the onsite meteorological monitoring program at the PFSF is 706.5 g cal/cm^2 or 684.6 watts/m^2 over a 12-hour period. Therefore the solar insolation values used by the vendors in their thermal analyses bound the PFSF site conditions.

The SAR will be updated to include the above information on solar insolation.

15. PFS calculations 05996.02-G(B)–5, Rev. 1, 05996.02-G(B)–4, Rev. 5, and 05996.02-G(B)–13, Rev. 2 are referenced in SAR revision 9. PFS needs to submit these updated calculations.

RESPONSE – The requested calculations are enclosed.

16. The information provided in the Affidavit of Jerry Cooper dated June 7, 1999 concerning protection of the facility from wildfires (i.e., width and depth of crushed rock and the PFS maintenance program to prevent growth of vegetation in the Restricted Area) need to be included in SAR Section 3.3.6 and Chapter 8.

RESPONSE – The information in the referenced affidavit regarding layout of the Restricted Area and dimensions of the crushed rock surface is currently presented in SAR Figure 1.2-1. Chapter 8 of the SAR, Section 8.2.5.1, states that "The PFSF Restricted Area (RA) is cleared of vegetation and the entire RA surfaced with compacted gravel." For clarification purposes SAR Section 3.3.6 and Chapter 8 will be updated as appropriate to include or reference dimensions of the crushed rock surface and clarify the commitment for a maintenance program to prevent growth of vegetation in the Restricted Area.

The SAR will be revised to include the above information.

17. PFS needs to update Chapter 8 of the SAR such that it is consistent with the recent revisions made to Chapter 4 of the SAR concerning fire protection measures for the Canister Transfer Building including UBC and NFPA fire standards.

RESPONSE – Chapter 8 of the SAR will be revised to be consistent with recent revisions in Chapter 4 where fire protection measures were added and discussed.

18. PFS needs to revise the SAR to include reference to the codes/standards to be used for maintenance of the fire protection systems.

RESPONSE – The fire protection equipment at the PFSF including the Canister Transfer Building foam-water system, yard hydrants, fire pumps, water storage tank, service mains, and all associated components will be maintained in accordance with NFPA 25, "Standard for the Inspection, Testing, and maintenance of Water-Based Fire Protection Systems."

The SAR will be revised to incorporate this information.

If you have any questions regarding this response, please contact me at 303-741-7009.

Sincerely

John L. Donnell
Project Director
Private Fuel Storage L.L.C.

Copy to (with enclosure):
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