UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION REPORT

INDEPENDENT SPENT FUEL STORAGE INSTALLATION
MATERIALS LICENSE NO. SNM-2509
AMENDMENT NO. 7

SUMMARY

This safety evaluation report (SER) documents the review and evaluation of a license amendment request to Materials License No. SNM-2509 for the Trojan Independent Spent Fuel Storage Installation (ISFSI). By letter dated March 10, 2020 (Agencywide Documents Access and Management System Accession (ADAMS) No. ML20083G798), Portland General Electric (PGE or the applicant) submitted an amendment to the NRC in accordance with Title 10 of the *Code of Federal Regulation* (10 CFR) 72.56, to change the Trojan ISFSI Safety Analysis Report (SAR) description of the explosion accident event evaluation due to cargo transported by rail and waterborne vessels that could potentially affect the ISFSI.

The NRC staff (staff) evaluated the requested change is based on ensuring the Trojan ISFSI continues to meet the applicable requirements of 10 CFR Part 72 for independent storage of spent fuel and of 10 CFR Part 20 for radiation protection. Staff followed the guidelines provided in NUREG-2215 "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities" in conducting the evaluation. Staff's evaluation focused only on changes to SNM-2509 requested in the licensee's amendment request and did not reassess previously approved portions of the license, technical specification, the final safety analysis report (FSAR) or those areas of the FSAR modified by the licensee as allowed by 10 CFR 72.48 which are not associated with this amendment request. The objectives for the following review disciplines are as described below for the requested change.

Staff has reviewed the license amendment request including the justifications for the requested changes. As discussed in further detail below, based on the statements and representations in the application, as supplemented, staff finds that the requested amendment to Materials License No. SNM-2509 for the Trojan ISFSI meets the regulatory requirements of 10 CFR Part 72.

1.0 GENERAL INFORMATION EVALUATION

The requested changes did not impact any previous general information evaluation. Therefore, an evaluation was not required.

2.0 SITE CHARACTERISTICS EVALUATION

The requested changes did not impact any previous site characteristics evaluation. Therefore, an evaluation was not required.

3.0 PRINCIPAL DESIGN CRITERIA EVALUATION

The requested changes did not impact any previous design criteria evaluation. Therefore, an evaluation was not required.

4.0 STRUCTURAL EVALUATION

The requested changes did not impact any previous structural evaluation. Therefore, an evaluation was not required.

5.0 THERMAL EVALUATION

The requested changes did not impact any previous thermal evaluation. Therefore, an evaluation was not required.

6.0 SHIELDING EVALUATION

The requested changes did not impact any previous shielding evaluation. Therefore, an evaluation was not required.

7.0 CRITICALITY EVALUATION

The requested changes did not impact any previous criticality evaluation. Therefore, an evaluation was not required.

8.0 MATERIALS EVALUATION

The requested changes did not impact any previous materials evaluation. Therefore, an evaluation was not required.

9.0 CONFINEMENT EVALUATION

The requested changes did not impact any previous confinement evaluation. Therefore, an evaluation was not required.

10.0 RADIATION PROTECTION EVALUATION

The requested changes did not impact any previous radiation protection evaluation. Therefore, an evaluation was not required.

11.0 OPERATION PROCEDURES AND SYSTEMS EVALUATION

The requested changes did not impact any previous operation procedures and systems evaluation. Therefore, an evaluation was not required.

12.0 CONDUCT OF OPERATIONS EVALUATION

The requested changes did not impact any previous conduct of operations evaluation. Therefore, an evaluation was not required.

13.0 WASTE MANAGEMENT EVALUATION

The requested changes did not impact any previous waste management evaluation. Therefore, an evaluation was not required.

14.0 DECOMMISSIONING EVALUATION

The requested changes did not impact any previous decommissioning evaluation. Therefore, an evaluation was not required.

15.0 QUALITY ASSURANCE EVALUATION

The requested changes did not impact any previous quality assurance evaluation. Therefore, an evaluation was not required.

16.0 ACCIDENT ANALYSIS EVALUATION

16.1 Background

In August 2012, the US Army Corps of Engineers (USACE) installed an anchor buoy for a new Prescott Anchorage Area on the Columbia River just outside the Trojan ISFSI Controlled Area Boundary. During a 2015 inspection, an NRC inspector questioned if the supporting analyses for Trojan FSAR Sections 2.2.3.1 "Explosions" and Section 8.2.8 "Explosions of Chemicals, Flammable Gasses, and Munitions" remained bounding due to the new anchorage. To address this issue, PGE reviewed the Trojan FSAR explosion event evaluation description, and concluded that certain statements pertaining to the deterministic evaluation of the design basis explosion event could not be confirmed. Therefore, PGE commissioned a comprehensive new evaluation of potential impacts on the Trojan ISFSI due to explosion events from both rail and waterborne vessel traffic. The evaluation also accounted for waterborne vessels periodically moored at the new Prescott Anchorage Area. PGE submitted a License Change Application (LCA) to update the Trojan FSAR evaluation of explosion accident events originating from cargo transported by rail and waterborne vessels that could potentially affect the ISFSI and requested NRC approval of the subject FSAR change.

16.2 License Change Application

In their application, the applicant described the approach and calculations for assessing the potential impacts of explosions on the ISFSI due to nearby rail traffic and waterborne vessels. The description included assumptions regarding physical constants, meteorological conditions, and methodologies. The analysis used both deterministic and probabilistic approaches, and included explosions located at the source (railcar or waterborne vessels) as well as the ignition of a vapor cloud traveling from the source to the ISFSI site.

During the acceptance review of the application, staff asked if the applicant had evaluated the possibility of toxic chemical levels reaching the ISFSI. The applicant responded that a toxic gas event had not been evaluated. They explained that a toxic gas event would not affect the safe storage of spent nuclear fuel because, as described in the Updated Final Safety Analysis Report, Revision 7 (ADAMS Accession No. ML070370123), there are no off-normal or credible accidents that require operator action within a prescribed time period.

Additionally, staff asked if the heat flux generated by an explosion had been evaluated as part of the analysis. The applicant explained that the heat flux generated by an off-site explosion would not adversely impact the safe storage of spent nuclear fuel because it would quickly dissipate to insignificant levels. The applicant also stated that, if an off-site transportation accident released chemicals, no heat flux would be generated because the wind conditions would not allow a vapor cloud capable of exploding to arrive at the ISFSI. Therefore, the applicant screened out this scenario (see SER section 16.5).

16.2.1 Acceptance Criteria

The applicant followed Regulatory Guide (RG) 1.91, "Evaluations of Explosions Postulated to Occur at Nearby Facilities and on Transportation Routes Near Nuclear Power Plants," Revision 2, in evaluating explosions. RG 1.91 describes three methods to demonstrate the acceptability of postulated explosions at nearby facilities and transportation routes which are paraphrased below:

1. Demonstrate deterministically that the shortest distance between site safety-related structures, systems and components and the explosion source is greater than the minimum safe distance (i.e., standoff distance) required to ensure the blast overpressure remains below one psig.

2. If the deterministic analysis does not satisfy the standoff acceptance criteria, demonstrate probabilistically that the hazard frequency is less than 1×10^{-6} per year.

3. Demonstrate that safety-related structures can withstand the blast and missile effects due to explosions.

Besides using the RG 1.91 one psig overpressure acceptance criteria for blast induced missiles and ground motion effects at the ISFSI, the applicant used 2.2 psig at the ISFSI for the overpressure deterministic acceptance criteria as referenced in FSAR Section 2.2.3.1 to demonstrate that safety-related structures can withstand the blast effects due to explosions. In addition, the applicant explained that, because they are ventilated, an external pressure limit is not associated with the concrete casks. The applicant also stated that the amount of overpressure to cause sliding of the casks is 5.87 psig and that the overpressure design basis limit for the Holtec canisters is 60 psig. Staff also finds the applicant's 2.2 psig overpressure value is conservative since it provides a factor of safety of over 2.5 against sliding and over 25 against the external pressure limit.

The applicant also used probabilistic criteria for explosion scenarios not meeting the deterministic criteria discussed above. The applicant stated that for an explosion event to be considered non-credible, the frequency of occurrence must be less than 1×10^{-6} per year as referenced in RG 1.91. Based on its review, staff finds the applicant's use of probabilistic acceptance criteria to be acceptable because it follows the guidance in RG 1.91.

16.2.2 Analysis Input Data and Assumptions

The applicant used distances obtained from drawings, charts and on-line maps for the hazard analysis. The applicant provided meteorological data taken from the ISFSI SAR and defined atmospheric stability classes using Revision 1 of RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants." The applicant also provided chemical properties. The applicant listed the assumptions used for the analysis in section 5.0 of Calculation No. 2017-09306

(ADAMS Accession No. ML20083G802). Staff reviewed these assumptions and found them acceptable because they either followed NRC guidance, produced conservative results (e.g., calculating vapor masses at the upper explosive limit) or were reasonable (e.g., assuming atmospheric pressure at sea level).

16.2.3 Hazard Sources

Potential explosion events in reasonable proximity to the ISFSI site identified by the applicant included explosions from two nearby railroad lines: the Burlington North and Santa Fe Railroad and the Portland and Western Railroad. The applicant also identified potential explosion events from waterborne vessels transporting cargo on the Columbia River and moored at a new anchorage in the Columbia River just outside the Trojan ISFSI Controlled Area Boundary.

The applicant obtained information on the types of commodities transported by the two railroads and by waterborne vessels and identified the following types of explosion events for both railroad lines and waterborne vessels:

- stationary explosions,
- stationary vapor cloud explosions (VCEs),
- boiling liquid expanding vapor explosions (BLEVEs), and
- travelling VCEs.

Stationary explosions could occur when a commodity detonates where it is located. Stationary VCEs could occur when a flammable vapor cloud ignites at the location at which the gas is released. BLEVEs could occur when a pressure vessel ruptures allowing the pressurized saturated liquid within the pressure vessel to transform into a gas and ignite at the release site. Travelling VCEs could occur when a flammable vapor cloud ignites after leaving the location at which the gas was released. In reviewing the application, staff noted that the applicant consistently referenced a reputable source, the Society of Fire Protection Engineer's Fire Protection Handbook, in its hazard source evaluation. Staff reviewed the handbook and determined that the hazard sources identified by the applicant are bounding. As a result, staff finds that the applicant identified the applicable explosion hazards related to the commodities transported by railway and waterborne vessels.

16.2.4 Screening of Commodities

For commodities transported by rail, each rail company provided the applicant information on the chemicals and materials transported. For commodities transported by waterborne vessels, the applicant used information from the USACE to identify the various materials transported. The applicant conducted a commodities hazard evaluation by first compiling the material property data and then tabulating the chemical and physical properties for each commodity. The applicant screened out chemicals and materials that are not a hazard to the ISFSI using the following criteria from the properties data:

- The material is not explosive, and
- The material cannot cause any type of vapor explosion (i.e., the material has a vapor pressure less than 10mm Hg [0.013 atm] at 100^{o}F consistent with RG 1.78).

The applicant identified that 101 commodities were shipped by rail near the Trojan ISFSI in 2016. Applying the screening criteria above to these commodities, the applicant determined that 28 were non-explosive, 17 were bounded by similar commodities, and seven were eliminated because they were chemicals with a low vapor pressure. The applicant analyzed the remaining 49 commodities for explosion impacts. The applicant identified a total of 136 commodities that are transported on the Columbia River using the USACE data. Applying the screening criteria above to the USACE data, the applicant indicated that 107 commodities were non-explosive (e.g., fruits, wood, steel and dairy products) and eight screened out due to low vapor pressure (e.g., fuel oil and petroleum crude oil) according to guidance in RG 1.78 for a postulated hazardous chemical external release from mobile or stationary sources that are either offsite or onsite. The applicant evaluated the remaining 21 commodities for explosion impacts. Staff reviewed the commodities evaluated by the applicant and finds that the applicant correctly screened out non-explosive commodities (e.g., fruit, wood, etc.). For all remaining commodities, staff finds that the screening criteria employed by the applicant followed NRC guidance. For these reasons, staff finds the applicant's methodology for screening of commodities to be reasonable.

16.3 Transportation Explosion Modeling

16.3.1 Trinitrotoluene (TNT) Equivalency Method

For calculating the blast wave energy from explosions, the applicant used the TNT equivalency method where, as described in RG 1.91, the chemical mass that explodes is converted into an equivalent mass of TNT. The applicant used this method for all explosion scenarios including both confined and unconfined vapor clouds formed due to the presence of potentially explosive materials. The mass equivalent of TNT for a chemical depends on the parameters listed below:

- Yield fraction,
- Heat of combustion of the chemical being considered,
- Heat of combustion of TNT (4500 kJ/kg),
- Mass of chemical exploded.

The applicant obtained values for the yield fraction, the chemical heat of combustion, and analytical methods from publicly available sources such as the Society of Fire Protection Engineer's Fire Protection Handbook. Consistent with the published data and RG 1.91 guidance, the applicant used 4500 kJ/kg for the heat of combustion of TNT. The chemical mass that is converted into the equivalent mass of TNT depended on the amount of the specific chemical being transported. For cargo transported by railway, the applicant conservatively used the railcar gross weight (286,000 lb_m.) as the cargo mass. For cargos transported by vessel, the applicant obtained the annual mass of each commodity from the USACE. In addition, the storage method for chemicals (unconfined, confined, under pressure, etc.) also impacted how much mass was converted. The applicant took these factors into consideration when calculating the mass of the chemical participating in the following explosion descriptions using assumptions listed in section 5.0 of Calculation No. 2017-09306.

Based on its review, the staff finds the applicant's use of the TNT equivalency method acceptable since it follows the guidance in RG 1.91. Staff also finds the values used by the applicant for the yield fraction, the chemical heat of combustion, and analytical methods in the calculations reasonable because they were obtained from reputable sources. Additionally, the staff finds the mass values used by the applicant in the calculations reasonable because they were either obtained from reputable sources or were derived using reasonable assumptions.

16.3.2 Stationary VCE

The applicant analyzed solid commodities (e.g., explosives, dry sulfur, nitrogenous fertilizer) as stationary explosions. In addition, since there is a potential for ignition of a flammable gas vapor cloud (e.g., gasoline, solvents) if large chemical spills occur during transport, the applicant performed an analysis for VCE hazards. The applicant obtained spill size probabilities for each chemical evaluated from NUREG/CR-6624 and Marine Information for Safety and Law Enforcement data. The VCE evaluations required analyzing combinations for different spill rates and spill size. If a chemical was normally stored as a pressurized liquid (e.g., methane), the applicant also analyzed it for VCE. In evaluating these chemicals, the applicant followed the methods in RG 1.91 and NUREG-0800. Based on its review, staff finds the applicant's methodologies are consistent with applicable NRC guidance. The staff also finds the data used by the applicant acceptable since it was obtained from reputable sources.

16.3.3 BLEVE

The applicant calculated the BLEVE hazard, a subset of stationary explosions, for chemicals normally stored as a pressurized liquid (e.g., methane) based on guidance from the Society of Fire Protection Engineer's Fire Protection Handbook. The applicant based the explosion pressure wave evaluation on frequency for a violent rupture, energy release in the fluid expansion, mass of chemical, and fraction of initial liquid mass which flashes to vapor. For these explosion types, the applicant computed the mass of fluid available for detonation using the saturated liquid density versus the density associated with the chemical's storage temperature. This resulted in a conservative estimate of the chemical mass available for detonation. Accordingly, the staff finds this methodology appropriate. In addition, the applicant maximized the chemical mass contributing to the explosion by assuming that the chemical temperature when the storage vessel ruptures is the ambient temperature external to the storage vessel even though the chemical temperature may be less than the ambient temperature due to the storage vessel being insulated. Using the ambient temperature is conservative because it assumes a greater mass is detonated as compared to the actual conditions under which the chemical is stored. Accordingly, the staff finds this assumption reasonable.

16.3.4 Traveling VCE

The applicant analyzed chemicals with explosive vapors (e.g., gasoline) as traveling VCE hazards as well as stationary VCE hazards. The applicant addressed the scenario of a traveling VCE at the ISFSI using methods found in RG 1.78 and NUREG-0570. The applicant discussed three methods to model chemical vapor formation: puff release, plume release and puff-plume release. The applicant explained that, in a puff release, the chemical is assumed to be released all at once. For a plume release, the applicant explained that the chemical is assumed to leak from its container and evaporate over time. For a puff-plume release, the applicant explained that the chemical release is assumed to combine an initial puff release with a subsequent plume release. The applicant used both the puff method and the puff-plume method in their analyses. The applicant used the puff method for chemicals such as hydrogen and methane while the applicant used the puff-plume methods for all other chemicals. The applicant followed the NUREG-0570 methodology to determine the mass release rate and limited the maximum vertical dispersion to 5000 meters per EPA-454/B-95-003b, "User's Guide for the Industrial Source Complex (ISC3) Dispersion Models." Finally, the applicant assumed that spill volumes were as large as plausibly possible. Based on its review, staff finds the use of these conditions acceptable because it is consistent with applicable NRC guidance.

The applicant stated that for an explosion to occur at the ISFSI, the concentration of a flammable vapor would have to be above the lower explosive limit (LEL). Since the atmospheric conditions (e.g., weather stability class, and frequency of wind direction) in the vicinity of a chemical leak influence the concentration of the chemical as it travels away from the source of the leak, the applicant employed the meteorological conditions described in RG 1.78, which suggests that the worst case weather conditions that are exceeded less than five percent of the year should be used, to estimate the atmospheric dispersion. The applicant also used RG 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,” to evaluate meandering of the plume. Based on its review, staff finds the use of these meteorological conditions acceptable since it is consistent with applicable NRC guidance.

16.3.5 Railway Transportations

The applicant identified that the shortest distance from an ISFSI cask to the Portland and Western Railroad rail line is 745 ft. (0.14 miles), and that the shortest distance from an ISFSI cask to the Burlington North and Santa Fe rail line is 5,760 ft. (1.09 miles). Since shipment weights were not provided by the railways, the applicant used the railcar gross weight (286,000 lb_m.) as the cargo mass that explodes. After reviewing the application, staff finds the distances used in the evaluations reasonable. Staff also finds the cargo mass assumption conservative because the maximum cargo capacity is less than the gross railcar weight.

16.3.6 Cargo Ship Transportations

The applicant identified that the shortest distance from a waterborne vessel on the Columbia River to a cask at the Trojan ISFSI is 957 ft (0.18 miles). The applicant obtained this distance from multiple sources including a National Oceanic and Atmospheric Administration chart. The applicant used information from the USACE to estimate the shipment frequencies of these materials, and information from the Board of Maritime Pilots to estimate accident rates for cargo transported on the Columbia River. The applicant relied on the Marine Information for Safety and Law Enforcement database system, which is managed and used by the United States Coast Guard to store data on marine accidental and deliberate pollution and other shipping and port accidents in US territorial waters, to evaluate the frequency of hazardous explosions. After reviewing the application, staff finds the distance used in the evaluations reasonable since it was obtained from reliable sources. Staff also finds the data used to estimate accident rates and hazardous explosion frequencies acceptable because they also come from reputable sources.

16.4 Probabilistic Analysis

The applicant’s explosion analyses determined that only commodities transported by waterborne vessels had the potential to exceed the deterministic criteria in SER Section 16.2.1. For cargos that could not meet the deterministic acceptance criteria identified in SER Section 16.2.1, the applicant performed a probabilistic evaluation to determine if the explosion hazard frequency from each individual cargo met the RG-1.91 low frequency limit acceptance criteria (i.e., less than 1×10^{-6} per year).

After identifying which commodities required probabilistic analysis, the applicant performed the following steps:

- determine spill size probability, and probability of spill per mile (for chemicals only)
- determine number of trips, and mass per trip
- evaluate possible explosion types
- determine explosion frequency per trip
- compare the product of hazard per trip and the number of expected trips to 1 x 10^{-6} per year.

16.4.2 Determine Spill Size Probability and Probability of Spill for Vessel Mile

Since only a fraction of waterborne vessel incidents that occur result in chemical spills, the applicant calculated a spill size probability from statistics compiled by the U.S. Coast Guard for the year 1970. The applicant calculated probabilities for spill sizes ranging from zero to greater than 287,000 gallons. The applicant then multiplied these spill size probabilities by 1.8 x 10^{-6} (i.e., the accident rate in NUREG/CR-6624) in order to obtain the number of spills per mile. The applicant provided both the spill size probabilities and the spills per mile in Table 7.3-1 of Calculation No. 2017-09306.

16.4.3 Determine Number of Trips and Mass

In calculating the number of trips per year as well as the amount of material shipped, the applicant used USACE data for the total number of waterborne vessel trips in a year as well as the yearly mass shipped for each commodity. The applicant's analysis assumed that the mass was evenly distributed volumetrically across the total number of trips in a year. The applicant provided the annual number of trips as well as the mass per waterborne vessel in Table 7.4-2 of Calculation No. 2017-09306.

16.4.4 Evaluate Possible Explosion Types

The applicant identified the explosive hazard for each chemical in Table 7.2-3 of Calculation No. 2017-09306. Since each chemical cargo could undergo one or more explosion types, the applicant calculated an occurrence frequency for each type of explosion and summed explosion type frequencies to determine the explosion frequency for each chemical.

16.4.5 Evaluate Hazard (Explosion) Frequency per Trip

The applicant evaluated the explosion probability for each hazardous chemical that could exceed the blast pressure limit on an explosions per trip basis by determining the frequency for each explosion hazard identified in 16.2.3. The applicant performed the probability evaluation using values calculated for the following multipliers:

<u>Incidents per mile</u>
the frequency of incidents based on statistics for barges on inland waterways that were compiled by the U.S. Coast Guard for the year 1970. – NUREG/CR 6624, "Recommendations for Revision of Regulatory Guide 1.78" (p. 16)

<u>Spill per Incident</u>
the probability of a spill if an incident occurs from statistics compiled by the U.S. Coast Guard for the year 1970. – NUREG/CR 6624 (p. 16)

Explosion per Spill
the probability of an explosion once a spill occurs from statistics compiled by the U.S. Coast Guard for the year 1970. – NUREG/CR 6624 (p. 16).

Mile per Shipment
the distance on the river where an explosion would exceed the 1.0 psig limit at the ISFSI (this value is different for each hazardous chemical).

Explosion per Trip (hazard frequency)
the product of the four probabilities above.

$$\text{Explosion per Trip} = \left(\frac{\text{Incident}}{\text{Miles}}\right)\left(\frac{\text{Spill}}{\text{Incident}}\right)\left(\frac{\text{Explosion}}{\text{Spill}}\right)\left(\frac{\text{Miles}}{\text{Trip}}\right)$$

16.4.6 Staff Probabilistic Analysis Assessment

After reviewing the information in the application, staff finds that the applicant used methodologies that are consistent with applicable NRC guidance. Staff also finds that the applicant used data from reliable sources. Therefore, staff finds the applicant's probabilistic approach reasonable.

16.5 Applicant Conclusions

Rail
For cargo transported by rail, the applicant found that the overpressure from stationary explosions, stationary VCEs and BLEVEs did not exceed the RG 1.91 deterministic criteria. The applicant provided these results in Tables 8.1-1 and 8.1-2 of Calculation No. 2017-09306. For travelling VCEs, the applicant provided the peak concentration of chemical vapor reaching the site in Table 8.1-3 of Calculation No. 2017-09306. The applicant determined that the vapor cloud reaching the ISFSI was below the LEL for all chemicals except for butane, butylene, isobutene, isobutylene, propane and propylene.

For releases of butane, butylene, isobutene, and isobutylene the applicant evaluated these chemicals following the guidance in RG 1.78. The applicant determined that, at any wind speed, a concentration greater than the chemical LEL will not reach the Trojan ISFSI site for Stability Classes A through E. For Stability Class F, the applicant determined releases of butane, butylene, isobutene and isobutylene will result in a concentration greater than the chemical LEL at the Trojan site for wind speeds greater than 3.01 meters/second. The applicant identified that these conditions exist 0.24% of the time irrespective of direction. Additionally, postulating that the LEL would be exceeded by all wind speeds of Stability Class G, which occur with a 0.88% frequency, the applicant determined that the combined frequency for these chemicals to exceed the LEL for these chemicals is 1.12% of the time. Therefore, the applicant concluded that shipments of butane, butylene, isobutene and isobutylene are acceptable per the guidance in Regulatory Guide 1.78 because the weather conditions which lead to a hazard occur less than 5% of the time.

For releases of propane and propylene, the applicant also evaluated these chemicals following the guidance in RG 1.78. The applicant determined that, for Stability Classes A through E at any wind speed, a concentration greater than the chemical LEL will not reach the Trojan ISFSI site. For Stability Class F, the applicant determined releases will result in a concentration greater than the chemical LEL at the Trojan site for wind speeds greater than 2.01

meters/second. The applicant identified that these conditions exist 0.84% of the time irrespective of direction. Additionally, postulating that all wind speeds of Stability Class G, which occur with a 0.88% frequency, the applicant determined that the combined frequency for these chemicals exceed the LEL is 1.72% of the time. Therefore, the applicant concluded that shipments of propane and propylene are acceptable per the guidance in Regulatory Guide 1. 78 because the weather conditions which lead to a hazard occur less than 5% of the time.

Waterborne Vessels
For waterborne vessels either traversing the Columbia River or moored at the Prescott Anchorage just outside the Trojan ISFSI controlled area boundary, the applicant found that all cargo exceeded the deterministic criteria in RG 1.91 except for petroleum coke and sulfur. Consequently, for each commodity other than petroleum coke and sulfur, the applicant evaluated the probability that an explosion event would occur in the vicinity of the Trojan ISFSI as described in SER Section 16.4.

For solid cargo (i.e., explosives) and ammonium nitrate, the applicant found the total hazard per trip. Next, the applicant determined the total number of allowable shipments by dividing 1×10^{-6} per year by the hazard frequency (explosions per trip). The applicant provided the results of these calculations in Table 8.2-1 of Calculation No. 2017-09306. The applicant also provided the total number of annual shipments for these commodities per year. Because the annual number of shipments was below the allowable number of trips per year, the applicant concluded that these commodities meet the RG-1.91 criteria of not exceeding a hazard frequency of 1×10^{-6} per year.

For chemical cargo other than ammonium nitrate, the applicant calculated the probability of stationary VCEs and provided the results in Table 8.2-1 of Calculation No. 2017-09306. Table 8.2-1 included the chemicals ammonia, methane, propane and vinyl chloride. Since these chemicals are transported within a pressure vessel, the applicant also calculated the probability that these chemicals caused a BLEVE. The applicant determined that the probability of a BLEVE hazard for each of these chemicals is 1.96×10^{-10}. In addition, each chemical in Table 8.2-1 had the potential to generate a traveling VCE; therefore, the applicant needed to evaluate the traveling VCE hazard frequency for each chemical. The applicant provided the travelling VCE evaluation results in Section 8.2.3 of Calculation No. 2017-09306.

To find the total hazard per trip for each chemical, the applicant summed the stationary VCE hazard frequency and the travelling VCE hazard frequency. For ammonia, methane, propane and vinyl chloride, the applicant used the stationary VCE hazard frequency because it bounded the BLEVE hazard frequency. After finding the total hazard per trip for each chemical, the applicant determined the total number of allowable shipments for each chemical by dividing 1×10^{-6} per year by the combined hazard frequency (explosions per trip). The applicant provided the results of this calculation in Table 8.2-10 of Calculation No. 2017-09306. The applicant also provided the total number of annual shipments of each chemical per year. Because the annual number of shipments was below the allowable number of trips for each of the chemicals, the applicant concluded that each of these chemicals meet the RG-1.91 criteria of not exceeding a hazard frequency of 1×10^{-6} per year.

16.6 NRC Review

Staff reviewed the application including reference materials used by the applicant. The staff's review focused on ensuring that the applicant properly followed methods and guidance for evaluating explosions. Staff reviewed spreadsheets and Mathcad files for overpressure, mass release rate and dispersion calculations. Staff confirmed that the chemical properties such as specific gravity, density, vapor density, boiling point, heat of combustion, and TNT equivalent mass provided by the applicant were reasonable and correct. Staff ran without error the applicant's Mathcad calculations including several scripts used in the file. Knowing that equation 2.2-1 in NUREG-0570 incorrectly used an exponent of ¾ (ADAMS Accession No. ML20010D233), the staff verified that the applicant used the correct value of 1.5.

Staff also reviewed the applicant's evaluation of travelling VCEs from chemicals transported by railway. Staff found that the applicant followed the guidance in RG 1.78 in determining that the weather conditions necessary to cause a travelling VCE at the Trojan ISFSI site occur less than 5% of the time.

In demonstrating that the annual hazard for off-site explosions from transporting cargo by waterborne vessel on the Columbia River is less than 1×10^{-6} per year, staff determined that the applicant followed the RG 1.91 guidance and used accident rates in NUREG /CR-6624. Staff also noted that the applicant used several conservatisms in calculating the annual hazard for off-site explosions including the following:

1. used the maximum spill size in the range of spill sizes,
2. used data for the entire Columbia River System versus only traffic passing by the Trojan ISFSI site,
3. biased estimates of the number of shipments for each chemical high in the calculation,
4. selected chemical storage conditions to maximize the concentration at the Trojan site,
5. modeled chemicals that are typically stored or transported in liquid form as gases (e.g., propane, methane, etc.),
6. assumed a probability of 1.0 for adverse wind speed in probability calculations, and
7. used a conservative estimate for the number of explosions per spill.

Because the applicant followed NRC guidance and used conservative assumptions in evaluating and calculating the hazard frequency for explosions transported by railway and by waterborne vessels, staff finds the applicant's results reasonable. Based on its review, staff finds that the methods and parameters used by the applicant to evaluate explosions (i.e., stationary, stationary VCE, BLEVE and travelling VCE) of commodities transported by railway and by waterborne vessels are acceptable.

16.6 Evaluation Findings

F16.1 The SAR includes acceptable analyses of the design and performance of confinement and SSCs important to safety, and other SSCs that affect SSCs important to safety, under off-normal and accident scenarios to meet the requirements in 10 CFR 72.24 for the Trojan ISFSI. Applicable accident events analyzed in the SAR are off-site explosions accidents.

F16.2 The analyses of accident events and conditions, as well as reasonable combinations of these conditions, show that the design of the Trojan ISFSI will acceptably meet the applicable regulatory requirements without endangering the public health and safety in compliance with the overall requirements in 10 CFR 72.122.

Staff concludes that the accident design criteria for the Trojan ISFSI comply with 10 CFR Part 72, and the accident design and acceptance criteria have been satisfied. The applicant's accident evaluation of the Trojan ISFSI adequately demonstrates that it will provide for the safe storage of radioactive materials during accident conditions. This finding is based on a review that considered independent confirmatory calculations, the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

17.0 TECHNICAL SPECIFICATIONS EVALUATION

The requested changes did not impact any previous technical specification evaluation. Therefore, an evaluation was not required.

ENVIRONMENTAL REVIEW

In their application, the applicant asserted that the amendment met the categorical exclusion criteria of 10 CFR 51.22(c)(11). For an amendment to meet the 10 CFR 51.22(c)(11) criteria, it must be both minor and routine. Although staff determined the amendment was minor, staff determined that the amendment was not routine. Therefore, pursuant to 10 CFR Part 51, an environmental assessment (EA, ML20287A234) has been prepared for this action and a finding of no significant impact (FONSI) was issued. The EA and FONSI were published in the *Federal Register* on November 17, 2020 (85 FR 73298).

CONCLUSION

Staff reviewed the license amendment request for SNM-2509, as supplemented, including the engineering analyses, proposed FSAR revisions, and other supporting documents submitted with the application. Based on the information provided in the application, as supplemented, staff concludes that SNM-2509, as amended, meets the requirements of 10 CFR Part 72.

Issued with Materials License No. 2509, Amendment No. 7, on December 11, 2020.