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January 28, 2000

U. S. Nuclear Regulatory Commission, Region IV
Attention: Mr. E. W. Merschoff, Regional Administrator
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

Subject: **Docket Nos. 50-361 and 50-362**
Hazardous Cargo Monitoring Report
San Onofre Nuclear Generating Station Units 2 and 3

Dear Mr. Merschoff:

San Onofre Units 2 and 3 Technical Specification 5.7.1.7, "Hazardous Cargo Traffic Report," requires that "Hazardous cargo traffic on Interstate 5 (I-5) and the AT&SF (Atchison, Topeka and Santa Fe) Railway (now the Burlington, Northern and Santa Fe (BN&SF) Railway) shall be monitored and the results submitted to the NRC Regional Administrator once every three years." The purpose of this letter is to forward the results from the most recently completed hazardous cargo monitoring effort. Enclosed is our report entitled "1999 Offsite Hazards Update," dated December 1999. This report summarizes the methods, results, and conclusions of the monitoring effort.

The monitoring effort consisted of a roadside survey along Interstate 5 and written correspondence with representatives from the United States Marine Corps, Departments of the Air Force, Army, and Navy, and the BN&SF Railway, formerly the AT&SF Railway.

The types of hazards which could affect plant safety resulting from shipment of hazardous materials past the plant which were evaluated include: 1) asphyxiant, 2) toxic, 3) explosive, and 4) flammable. The results of this effort found the hazard to the plant from shipment of materials along Interstate 5 and the BN&SF Railway remains within the acceptance criteria of Standard Review Plan 2.2.3 and is therefore acceptable. No additional design basis events were identified.

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If you have any questions or need additional information regarding this matter, please feel free to contact me or Mr. Jack Rainsberry at (949) 368-7420.

Sincerely,

Enclosure

cc: Document Control Desk, U. S. Nuclear Regulatory Commission
J. A. Sloan, NRC Senior Resident Inspector, San Onofre Units 2 & 3
L. Raghavan, NRC Project Manager, San Onofre Units 2 and 3

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1.0 INTRODUCTION

The 1999 San Onofre Nuclear Generating Station Units 2 and 3 (SONGS 2/3) Offsite Hazards Analysis (OHA) summary report documents Southern California Edison's (SCE) review of hazards posed to SONGS 2/3 from transportation of hazardous materials near the facility. The 1999 report represents the sixth tri-annual update of hazardous materials transported past the SONGS 2/3 site.

The United States Nuclear Regulatory Commission (NRC) requires that a utility filing an application for authority to operate a nuclear power plant include information regarding potential offsite hazards which could affect safe operation of the plant. The hazards to be specifically evaluated include the potential release of asphyxiant and toxic materials in close proximity to the plant, which could potentially jeopardize continued occupancy of the control room. In addition, consideration must be given to the potential release of explosive and flammable chemical mixtures that could adversely affect the plant's physical structure and consequently, plant safety.

To perform the original licensing review for SONGS 2/3, the NRC considered information submitted in the UFSAR Chapter 2 [Reference 1]. Specifically, UFSAR Paragraph 2.2.2.2 summarized the consideration of potentially hazardous materials carried on Interstate 5 (I-5) and the railway adjacent to the SONGS 2/3 site that is currently operated by the Burlington, Northern and Santa Fe Railway (BN&SF). The railway was previously operated by the Santa Fe Pacific Corporation under its Atchison, Topeka and Santa Fe Railway (AT&SF) subsidiary. However, in 1995, Burlington Northern, Inc., merged with the Santa Fe Pacific Corporation and formed the BN&SF. The change in corporate ownership has not had an effect on the types of hazardous materials shipments made on the railway.

The NRC published the results of their review in NUREG-0712 [Reference 2] which concluded that the analysis was adequate based in part on the knowledge of shipment frequencies. The NRC noted the dependence on supporting data regarding the size and frequency of hazardous cargo shipments. As a result of the potential variability in transport rates, cargoes, accident rates, and shipment sizes, the NRC requires the SONGS 2/3 OHA to be updated every three years by Technical Specification Number 5.7.1.7 [References 3 and 4].

The first offsite hazards analysis update was performed in 1984. The analysis was updated again in 1987, 1990, 1993, and 1996. The purpose of this report is to document the nature, frequency, and size of hazardous material transported near the SONGS 2/3 site in 1999 and update the quantitative analysis of off-site hazard frequency based on these findings.

2.0 ACCEPTANCE CRITERIA

The Standard Review Plan (SRP) Section 2.2.3 [Reference 5] states that initiating events leading to potential consequences in excess of 10 CFR Part 100 exposure guidelines should be estimated using assumptions that are as representative of the specific site as practicable. Accordingly, the expected rate of occurrence of potential exposures in excess of the 10 CFR Part 100 guidelines must not exceed 1.0E-7 per year based upon a realistic analysis, or 1.0E-6 per year based on a conservative analysis. Any hazard category (e.g., asphyxiant, toxic, explosive, and flammable cloud) which results in the cumulative risk exceeding the SRP guidelines is classified as a design basis event. Each hazard classified as a design basis event is reviewed to determine that the effects of the hazard on the safety features of the plant have been adequately accommodated in the design of the plant.

3.0 METHODOLOGY

The methodology for evaluation of the potential risk to the safe operation of SONGS 2/3 from the shipment of hazardous materials past the plant is described in the SONGS 2/3 UFSAR Section 2.2.2.2. The evaluation consists of determining hazards posed by truck traffic on I-5 and railway traffic on the BN&SF Railway.

The types of hazards potentially resulting from accidents involving the shipment of hazardous materials past the plant by highway and railway, are categorized as:

- *Asphyxiant* - liquids (that boil or evaporate) and gases that could drift to the plant, build up in the control room, and reduce the oxygen concentration to below 18%.
- *Toxic* - liquids (that boil or evaporate) and gases that could drift to the plant and build up in the control room at concentrations exceeding toxicity limits.
- *Explosive* - solids, liquids and gases (including transient vapor clouds) that could explode and create an overpressure in excess of 7-psi peak reflective overpressure at plant safety related structures.
- *Flammable Cloud* – liquids (that boil or evaporate) and gases that could drift to the plant and reach the air intakes of plant safety related structures at concentrations in excess of the lower flammability limits.

The risk, or frequency of hazard, associated with each type of hazard can be estimated using the following general relationship:

$$P = N_{sh} P_{sp} L_c \sum_{QJ} P_Q P_{imp}(l, Q) \quad (1-1)$$

where, P = the hazard frequency (events per year)

N_{sh} = the annual frequency of shipments of the hazardous material (vehicles per year)

P_{sp}	=	the probability of having an accident per unit length of the transportation route (accidents/vehicle-mile)
L_c	=	the critical length of the transportation route where a spill could result in a hazard to the plant (miles)
l	=	the release location
Q	=	the quantity released
P_Q	=	the probability of having a spill of quantity Q given an accident
$P_{imp}(l,Q)$	=	the overall probability that a release could impact the plant; this is determined for all release quantities and locations encompassed by the critical length of the transportation route; for asphyxiant, toxic and drifting vapor cloud explosion or fire hazards; this factor is also a function of the probability of wind direction; explosions occurring at the accident site are independent of wind direction

The relationship in Equation 1-1 is directly applied for new or unanalyzed hazards and cases where the hazardous cargo shipment size was determined to be greater than previously analyzed.

If the current hazardous cargo shipment size is bounded by previous analyses, a modified form of Equation 1-1 is applied. In Equation 1-1, the only two variables that change are the shipment frequency, N_{sh}, and the accident probability, P_{sp}. Therefore, the updated hazard frequency can be obtained by taking the ratio of current shipment frequencies and accident data to the baseline values and multiplying by the baseline risk. This is illustrated with Equation 1-2:

$$P_{curr} = P_{base}\left(\frac{N_{ship,curr}}{N_{ship,base}}\right)\left(\frac{P_{sp,curr}}{P_{sp,base}}\right) \qquad [1\text{-}2]$$

where,

P_{curr}	=	current hazard frequency (events per year)
P_{base}	=	baseline hazard frequency (events per year)

$N_{ship,curr}$ = current shipment frequency (vehicles per year)

$N_{ship,base}$ = baseline shipment frequency (vehicles per year)

$P_{sp,curr}$ = current accident spill probability per mile

$P_{sp,base}$ = baseline accident spill probability per mile

Equation 1-2 serves as the starting point for the "ratioing" process. For rail shipments, the accident probability was not updated. The rail accident probability was computed in PRA-23-92-007 [Reference 6] and is based on rail data from 1982 through 1990. More recent data collected by the United States Department of Transportation [Reference 7] indicate that the accident rates for railcars have shown a small downtrend between 1990 and 1996. The probabilistic spill factors determined in the PRA-23-92-007 are based on engineering judgment that is still valid. Conservatively, it is assumed that the railcar accident with spill probability is constant. Therefore, the last term in Equation 1-2 is set to 1.0 and the only factor that needs to be updated is the current shipment frequency, $N_{ship,curr}$, which is obtained from the BN&SF Railway. For truck shipments, the accident rate has been updated using current data collected from the California State Department of Transportation [References 8 and 9].

With the appropriate factors determined in the analysis, the following equations were derived in the final report [Reference 10] for use in the "ratioing" process:

I-5 Truck Toxic Hazard

$$P_{curr} = (P_{base})(N_{ship,obs})(60.1)/(N_{ship,base}) \quad (1\text{-}3)$$

I-5 Truck Explosive/Flammable Hazard (Refrigerated Liquids and Compressed Gases)

$$P_{curr} = (P_{base})(N_{ship,obs})(27.7)/(N_{ship,base}) \quad (1\text{-}4)$$

I-5 Truck Explosive/Flammable Hazard (Gases)

$$P_{curr} = (P_{base})(N_{ship,obs})(23.4)/(N_{ship,base}) \qquad (1\text{-}5)$$

where, $N_{ship,obs}$ = number of shipments of individual hazardous material observed during the 2-week truck survey (vehicles)

4.0 HAZARD IDENTIFICATION

The update of the offsite hazards analysis was based on information obtained from:

- A roadside survey of truck traffic on I-5,
- Correspondence with the BN&SF Railway, and
- Correspondence with military establishments that may transport hazardous materials.

4.1 I-5 Truck Survey

The truck survey was conducted over a two week period from August 23rd to September 3rd, 1999 at the San Onofre Inspection Facility operated by the California Highway Patrol (CHP) located on the Northbound and Southbound sides of I-5 approximately three miles south of San Clemente. There are no on-ramps or off-ramps between the survey location and the site. Therefore, trucks that pass through the weigh station will also drive past the SONGS 2/3 site.

Survey personnel were stationed at the weigh stations to determine truck contents as trucks passed through the weigh station. All trucks entering the weigh stations were considered. Trucks displaying a hazardous cargo placard were detained briefly and questioned regarding the types and quantities of materials being transported. Data sheets were used to record the pertinent information on each truck displaying a hazardous cargo placard.

4.2 BN&SF Survey

In order to update the rail hazards, the hazardous materials division of the BN&SF was contacted and asked to provide available shipment information since the previous update. This included information on the types, quantities, and frequencies of hazardous material shipments.

4.3 Military Survey

The United States military operates several bases in the vicinity of the SONGS 2/3 site. As with commercial shipments, hazardous materials shipped by the military could also be made by truck and by rail. These shipments are not made on specific frequencies and data obtained during the visual surveys may not be complete or representative of the annual transportation rates. In addition, military transporters are not required to stop at weigh stations and therefore the surveyors would not be able to determine contents of these vehicles. Therefore, the hazard from shipments of military ordnance and toxic materials was determined from information collected directly from the military. This included information on the types, quantities, and frequencies of hazardous material shipments.

5.0 SURVEY RESULTS

5.1 I-5 Survey Results

Approximately 1,605 potentially hazardous materials truck shipments were identified in the survey. Some of these shipments were immediately screened from further analysis based on two criteria:

> *Shipment Size* - Regulatory Guide 1.78 [Reference 11] only requires hazard analyses for materials found within 0.3 miles of a site in quantities in excess of 100 pounds. Materials that were shipped in containers smaller than 100 pounds were, therefore, eliminated from further analysis.
>
> *Not an Acute Hazard* - In reviewing the properties of the materials surveyed, many substances were found to have properties that precluded them from posing an acute hazard to the plant. The term "acute" refers to the ability of the material to significantly impair plant operators in a rapid manner. Although all of the chemicals identified in the survey were classified as hazardous, some are primarily hazards by contact (e.g., battery acid). Others had vapor pressures that were too low for them to vaporize at a sufficient rate to arrive at the plant in concentrations that would pose a hazard. Therefore, each material was evaluated in a qualitative manner by considering both the vapor pressure and toxic limit to assess the ability to impact the plant. Materials with low vapor pressures and low or moderate toxicity levels were also excluded from further evaluation. In addition, materials with moderate vapor pressures and low toxicity were excluded. This process was repeated for explosive and flammable materials in a similar manner.

Following this initial screening, approximately 1,078 of the hazardous materials were determined to pose a potential hazard to the facility. For these materials, an in-depth review was conducted in order to assess whether or not an accident involving these materials might be capable of producing an explosive, fire, asphyxiant, or toxic gas hazard. The review identified the chemical composition and physical state of the material as well as a description of its potential hazard thresholds (e.g., toxic limits, flammability limits, etc.). The identification of material characteristics permitted the grouping of potential hazardous materials into one of the parent chemical groups identified in the original analysis.

Once all of the materials were placed into a parent chemical group, the maximum shipment size for individual hazardous material shipments was reviewed with respect to shipment sizes evaluated in the baseline offsite hazards analyses performed in 1981 [References 12 and 13] or in the rebaselining effort in 1996 [Reference 14]. Increased shipment sizes were found for a number of the previously analyzed hazardous materials. However, for those materials that are liquids at ambient temperature, the hazard frequency is independent of shipment size. This is because the evaporation rate was assumed in the original analysis to be limited due to the constraints of the road topography. Therefore, the only materials that could be affected by increased shipment size are those that are shipped either as gases (e.g., acetylene) or as compressed gases (e.g., propane). In the 1999 survey, the only gas or compressed gas that exhibited an increase in shipment size was argon which is an asphyxiant. However, based on the results of the 1996 rebaselining evaluation, there was sufficient margin in the asphyxiant hazard analysis for argon, which precluded an impact to the control room given the marginal increase in shipment size.

Two chemicals, chloropicrin and phosphorus oxychloride, required new analyses as part of the 1999 update. These chemicals were identified in prior surveys but were not shipped in quantities requiring analysis until the 1999 survey. The hazard frequencies for these chemicals were determined using Equation 1-1. For all other materials, Equations 1-3 through 1-5 were used as appropriate to determine the updated hazard frequency.

5.2 BN&SF Survey Results

The only material shipped in frequencies that require analysis (i.e., greater than 30 per year) was liquefied petroleum gas (LPG). The response from the BN&SF revealed that there were 1,106 shipments of LPG, (including shipments identified as liquefied petroleum gas (1,046), propane (25), propylene (9), and butane (26)) made from July 1998 through June 1999 (the BN&SF only retains one year worth of data) [Reference 15]. This value is used in updating the explosive/flammable hazard from LPG. With the exception of butane, which is a potential toxic hazard, all of the chemicals grouped with LPG are classified as asphyxiants. Therefore, the 1,080 non-butane LPG shipment value is used to update the propane asphyxiant hazard.

Although the number of shipments of butane was below the 30 per year frequency cutoff specified in Regulatory Guide 1.78, butane was shipped in higher frequencies in the past and the toxic hazard frequency from past surveys was large. Therefore, for completeness, the butane toxic hazard from rail shipments is included in this update.

5.3 Military Survey Results

The correspondence from the military indicated that the maximum weight of any military shipment by truck during the period from 1996 through the middle of 1999 was 43,304 lbs net explosive weight (N.E.W.) [References 16 through 34]. In addition, several bases indicated that they use commercial carriers to transport explosives on behalf of the military. If these shipments were made near SONGS 2/3, these commercial carriers would be required to stop at the weigh station where the truck survey was conducted. Therefore, these trucks would be captured during the hazardous materials truck survey and would not represent an additional hazard source. There were no shipments of military ordnance by rail since the last update.

Based on the 1996 rebaselining calculations, an explosion involving a shipment of 43,304 lbs N.E.W. is not sufficient to exceed the overpressure capabilities of the SONGS 2/3 safety related structures. Therefore, based on a deterministic evaluation, the potential hazard from shipment of military ordnance past the plant on I-5 is zero.

Responses gathered from the military also indicated that toxic materials are not shipped via military transport. However, several respondents indicated that toxic materials are transported by commercial carriers on behalf of the military. As with commercial carriers of military explosives, these commercial carriers of toxic materials for the military would be captured as part of the hazardous materials truck survey and therefore do not represent an additional hazard source.

6.0 ASSUMPTIONS

The SONGS 2/3 OHA is judged to be a conservative evaluation of plant hazards. The following provides a summary list of the assumptions made in the baseline analyses and in the current OHA Update for materials that did not exhibit an increase in shipment size:

1. All explosions from liquid spills from tank trucks were assumed to release the energy to the air and not have any energy absorbed by the ground, yielding the maximum possible pressure [applies to explosive baseline analysis].

2. Release statistics used did not distinguish between small ruptures or cracks (resulting in a minimal leakage and/or leak rate) and the severe rupture mechanism (which presents the more significant hazards to the plant) [applies to toxic, explosive and flammable cloud baseline analyses].

3. Topography effects in the vicinity of the plant such as the effects of ground roughness are not taken into consideration [applies to toxic baseline analysis].

4. No credit was taken for control room air volume dilution or mask breathing devices. The hazards analysis methodology assumes the operators are disabled in the event that a sufficient concentration of toxic material exists at the control room air intake. This is conservative in that it does not credit mixing of the toxic material with the control room air volume that will act to dilute the toxic concentration. In addition, operators have access to protective breathing devices which will limit exposure and reduce the likelihood of being disabled [applies to toxic baseline analysis].

5. The analysis assumes that loss of control room habitability will lead to core damage. No credit is taken for recovery actions by alternate personnel other than control room operators, and no credit is taken for use of the remote shutdown panel to safely shut down the plant [applies to toxic baseline analysis].

6. Each of the chemicals evaluated in the original hazards analyses is considered a parent chemical or parent group. Chemicals not evaluated in the original analyses are grouped into these parent chemical bins based on their chemical properties. Binning of materials into parent chemical bins was typically done in a conservative manner such that the properties of binned materials were less hazardous in comparison to those of the parent group. All materials in a bin were assumed to be equivalent to the parent chemical, thus overestimating the

hazards for many of the binned materials [applies to toxic, explosive and flammable cloud baseline analyses].

7. Analysis of toxic hazards assumed that all shipments of a parent chemical were equivalent to the largest container size. Most parent groups consisted of a wide range of container sizes, many of which were significantly smaller than the analyzed container [applies to toxic baseline analysis].

8. The original toxic hazards analysis only reported hazard frequency values for the handful of chemicals that contributed greater than 0.1% of the total hazard frequency. In subsequent updates, all other chemical families from the original analysis were assumed to have a hazard frequency equivalent to 0.1% of the total hazard frequency from the original analysis although it could also be significantly less than 0.1%. This potential overstatement of the risk from these "other" chemicals ensures that the risk estimate is conservative [applies to toxic baseline analysis].

During the 1996 SONGS 2/3 OHA, it was determined that re-analysis of several materials was required because of increased shipment sizes. In addition, an additional evaluation for potential asphyxiation hazards was conducted due to the large quantities of these types of materials transported by truck and rail. The following provides a summary list of the key assumptions in the re-analysis that were either new assumptions or significantly different assumptions from the 1981 baseline evaluations.

1. The asphyxiation hazard is explicitly evaluated in the 1996 SONGS 2/3 OHA. Asphyxiation is assumed to occur when the oxygen concentration drops below 18% [Reference 35] [applies to asphyxiant analysis].

2. Propane was originally classified as a toxic gas in Regulatory Guide 1.78. However, more recent information has classified propane as an asphyxiant gas [applies to asphyxiant and toxic analyses].

3. Puff releases occur when compressed gases such as chlorine or anhydrous ammonia are stored under pressure as liquids and are released to the atmosphere. The puff portion results when the stored liquid immediately changes into vapor. Typically, rapid air entrainment occurs during this

process. However, no credit is taken for the immediate dilution experienced in puff type releases due to rapid air entrainment that is in the range of 3:1 air to contaminant. This factor was credited in the original explosive/flammable cloud hazards analysis for puff releases [Reference 13]. This is not applicable for releases involving liquids such as isopropyl alcohol that involves only pool evaporation. [applies to asphyxiant, toxic, explosive and flammable cloud analyses].

4. In accordance with the original toxic hazards analysis, truck accidents resulting in evaporating or boiling pools are assumed to be limited to a 3,600 ft^2 pool area based on considerations of the highway topography. Based on a visual survey of the trackside topography, railroad accidents resulting in evaporating or boiling pools are assumed to be bounded by a 10,000 ft^2 pool area [Reference 36] [applies to toxic hazard analysis].

5. Evaporation and boiling rates of materials stored at ambient temperature are convection dominated, in which case the wind speed is a factor. A conservative wind speed of 4 m/s was used. This corresponds to the highest average wind speed for any of the stability classes observed at the SONGS 2/3 site as reported in Table 2.3-18 of the SONGS 2/3 UFSAR [Reference 1] [applies to asphyxiant, toxic, explosive and flammable cloud hazard analyses].

6. For refrigerated (cryogenic) liquids, the rate that the material is transferred to the air is considered heat transfer limited. The initial rate is high and would rapidly drop as the surface below freezes. The material boiled off in the first minute is taken as equivalent to a puff release while the remainder is assumed to boil off at a slow constant rate [applies to asphyxiant, explosive and flammable cloud hazard analyses].

7. The 1996 probabilistic re-analyses evaluate a range of meteorological conditions representative of the SONGS 2/3 site. The original baseline evaluations assumed single cases involving only pessimistic meteorological conditions which results in the worst case consequences [applies to asphyxiant, toxic, explosive and flammable cloud hazard analyses].

8. Perfect mixing is assumed to occur in the control room for scenarios where the control room concentration is of concern. For toxic materials, the incapacitation criterion is if there are 2 minutes between the time the material is sensed in the control room and when the concentration reaches the toxicity limit. This is a conservative interpretation of Regulatory Guide 1.78, which

uses an acceptance criterion of "the maximum concentration that can be tolerated for two minutes without physical incapacitation of an average human". In Regulatory Guide 1.78, the time-averaged concentration is used whereas the toxic hazard analysis performed for this update reflects the instantaneous concentration.

9. The evaluation of explosive hazards in the 1996 re-analyses evaluated the maximum shipment size and a fixed explosive yield based on published references. The explosive yield is material dependent and is an estimate of the percentage of available energy that is actually released in an explosion. In the baseline explosive hazards evaluation a range of yields was used. However, the baseline evaluation also considered a range of smaller spill sizes which would negate the effect of possibly having a larger yield estimate [applies to explosive hazard analysis].

Based on the application of these conservative assumptions, the threshold value for classification of design basis events is 1.0E-6 per year. Any hazard exceeding this value will be evaluated to determine that the effects of the event on plant safety features have been adequately accommodated in the plant design.

7.0 SUMMARY OF RESULTS

7.1 Asphyxiant Hazard Frequency

Table 1 illustrates the results of the asphyxiant hazard analysis. The chemical, number of shipments observed in the survey period, and associated frequencies of plant hazards are provided. The only material that was determined to pose a potential asphyxiant hazard to the plant was propane shipped by rail. All other transportation sources of asphyxiant materials were screened out from further evaluation because the oxygen concentration was determined to remain at safe levels. However, monitoring and automatic control room isolation provisions are provided for hydrocarbons (e.g., propane), by the Control Room Toxic Gas Isolation System. Thus, the sum of the asphyxiant risks from unmonitored chemicals is zero.

7.2 Toxic Hazard Frequency

Table 2 illustrates the results of the updated toxic hazard analysis. The chemical, number of shipments observed in the survey period, and associated frequencies of plant hazards are provided. Monitoring and automatic control room isolation provisions are provided for several chemicals such as hydrocarbons (e.g., gasoline) and chlorine by the Control Room Toxic Gas Isolation System. Thus, the sum of the chemical risks from unmonitored chemicals is 4.2E-7 per year. This risk value allows a factor of 2 margin in shipment frequency prior to reaching the threshold value of 1.0E-6 per year.

7.3 Explosive/Flammable Hazard Frequency

Tables 3 and 4 illustrate the results of the updated explosive and flammable cloud hazards analyses. Explosive materials identified in the survey include LPG, hydrogen, and acetylene. These materials also have properties that pose a flammable vapor cloud hazard. As such, the chemicals were evaluated for their contribution in both explosive and flammable cloud risks. The contribution of these materials to the explosive hazard was calculated to be 1.2E-7 per year. The resulting frequency of flammable cloud hazard was calculated to be 3.4E-7 per year. Each of these values is less than the 1.0E-6 per year threshold. Liquefied natural gas (LNG) was identified in prior offsite hazards updates as a potential flammable cloud hazard but was not observed in the 1999 survey.

7.4 Net Hazard Frequencies

As shown in Table 5, the frequencies of potential hazards related to the shipment of hazardous materials on the highway and railway adjacent to the plant including asphyxiant, toxic, explosive, and flammable cloud hazards were all calculated to be less than 1.0E-6 per year or screened out from the analysis. Based on these results no new design basis events from offsite hazards need to be considered for SONGS 2/3.

Table 1
Asphyxiant Hazard Frequency

Chemical	P_{base} Baseline Hazard Frequency [Note 1]	$N_{ship,base}$ Baseline Shipments [Note 2]	$N_{ship,obs}$ 1999 Shipments [Note 3]	P_{curr} Monitored
Acetylene (I-5)	N/A	N/A	5	N/A
Argon (I-5)	N/A	N/A	11	N/A
Hydrogen Liquid (I-5)	N/A	N/A	4	N/A
Hydrogen Gas (I-5)	N/A	N/A	5	N/A
Nitrogen (I-5)	N/A	N/A	69	N/A
Propane (I-5)	N/A	N/A	79	N/A
Propane (BN&SF)	2.4E-5	2,123	1,080 (annual)	1.2E-5

Notes:

1. All potentially asphyxiant chemicals shipped on I-5 were screened out deterministically from further analysis in the 1996 analysis. Hydrogen gas was the bounding chemical shipped on I-5 but was determined to not pose an asphyxiant hazard. Argon was shipped in higher quantities in the current truck survey than previously analyzed. However, there would be no impacts to the conclusions since the asphyxiation potential was much higher for hydrogen gas than the other chemicals of concern. The baseline asphyxiant hazard frequency for propane shipped by rail was determined in LA-22-01 [Reference 37].

2. Since the chemicals shipped on I-5 were deterministically screened from further analysis, there is no baseline shipment frequency used in determining the risk for shipments on I-5. The baseline asphyxiant hazard frequency for propane was based on 2,123 railcar shipments.

3. This column represents the number of shipments observed during the 1999 I-5 truck survey with the exception of the propane BN&SF shipment value which was obtained directly from the BN&SF.

Table 2
Updated Toxic Hazard Frequency

Chemical [Note 2]	P_{base} [Note 5]	$N_{ship,obs}$ Observed 99 [Note 6]	$N_{ship,base}$ Annual 77	"Constant" [Note 13]	P_{curr} Unmonitored	P_{curr} Monitored
Batteries	Note 3	n/a	490	n/a	n/a	n/a
Crude Oil	Note 1	n/a	43	n/a	n/a	n/a
Hydraulic Oil	Note 1	n/a	43	n/a	n/a	n/a
Motor Oil	Note 1	n/a	43	n/a	n/a	n/a
Naphtha	Note 1	n/a	43	n/a	n/a	n/a
Benzene	2.3E-8	0	43	60.1	0.0E+0	
Butyl Acetate	<2.3E-9	0	43	60.1	0.0E+0	
Formaldehyde	2.0E-8	0	14	60.1	0.0E+0	
Hydrochloric Acid	<2.3E-9	0 [Note 7]	133	60.1	0.0E+0	
Methyl Bromide	<2.3E-9	0	48	60.1	0.0E+0	
Xylene	<2.3E-9	0	24	60.1	0.0E+0	
Vikane	<2.3E-9	1	43	60.1	<3.2E-9	
Chloropicrin [Note 9]	N/A	1	N/A	N/A	5.3E-9	
Perchloroethylene	<2.3E-9	3	43	60.1	<9.6E-9	
Sulfuric Acid	<2.3E-9	11	130	60.1	<1.2E-8	
Methyl Ethyl Ketone	<2.3E-9	4	43	60.1	<1.3E-8	
Phosphorus Oxychloride [Note 9]	N/A	1	N/A	N/A	1.5E-8	
Methylene Chloride	<2.3E-9	5	43	60.1	<1.6E-8	
Acetone	<2.3E-9	7	43	60.1	<2.3E-8	
Carbon Dioxide	2.3E-8 [Note 4]	64	2,835 [Note 8]	60.1	3.1E-8	
Isopropyl Alcohol	<2.3E-9	13	43	60.1	<4.2E-8	
Toluene	<2.3E-9	19	43	60.1	<6.1E-8	
Muriatic Acid	<2.3E-9	23 [Note 7]	43	60.1	<7.4E-8	
Ammonia (anhydrous) [Note 10]	8.2E-8 [Note 4]	6	350 [Note 8]	60.1	8.5E-8	
Butane	3.9E-7	4	2,200	60.1		4.3E-8
Jet Fuel	2.0E-8	86	910	60.1		1.1E-7
Diesel Fuel	1.2E-8	215	650	60.1		2.4E-7
Gasoline	3.9E-7	362	17,000	60.1		5.0E-7
Chlorine [Note 11]	4.0E-7 [Note 4]	25	1,085 [Note 8]	60.1	2.8E-8	5.3E-7
Butane (BN&SF)	1.1E-5 [Note 4]	26 (annual)	382 (annual)	n/a		7.6E-7 [Note 12]
				Total	<4.2E-7	2.2E-6

Notes:

1. Not evaluated, not readily formed into a vapor cloud. See Reference 12.
2. The chemicals listed were identified in the I-5 truck survey except where noted.
3. Not evaluated, non-toxic. See Reference 12.
4. New baseline developed for 1996 SONGS 2/3 OHA [Reference 14].
5. Includes adjustment factor of 0.39 accounting for the appropriate highway type. This factor was derived and utilized in the 1984 SONGS 2/3 OHA [Reference 38].

The values provided in this table equal the frequencies from the original toxic hazards analysis times 0.39. For those materials that represented less than 0.1% of the cumulative risk in the original toxic hazards analysis, a hazard frequency of 2.3E-9 per year was assigned.

6. This column represents the number of shipments observed during the 1999 I-5 truck survey with the exception of the butane BN&SF shipment values that were obtained directly from the BN&SF.
7. Hydrochloric acid and muriatic acid are the same material. Since muriatic acid is predicted to have a higher risk per shipment, it is conservative to include all shipments of this type in the muriatic acid chemical bin.
8. Carbon dioxide, anhydrous ammonia, and chlorine each had revised toxic hazard baselines developed in the 1996 SONGS 2/3 OHA [Reference 14]. The effective number of base shipments is equal to the product of the number of shipments observed during the 1996 SONGS 2/3 OHA truck survey and the multiplier derived in 1996 (35.0). Multiplication of the number of shipments of carbon dioxide (81), anhydrous ammonia (10), and chlorine (31) by the 1996 multiplier yields the base shipment value.
9. New analyses developed during 1999 SONGS 2/3 OHA [Reference 39].
10. Anhydrous ammonia is considered unprotected for the purposes of this analysis. The TGIS ammonia monitor setpoint is based on an accident involving onsite storage of aqueous ammonia as opposed to offsite transport of anhydrous ammonia [Reference 40].
11. A portion of the chlorine risk is considered unprotected for the purposes of this analysis. The TGIS chlorine monitor setpoint is based on an accident involving transport of chlorine in 1-ton cylinders [Reference 40]. Shipments involving 17-tons of chlorine in an individual container have been identified in the current and previous surveys.
12. The TGIS butane monitor setpoint was originally determined assuming a spill of butane on the freeway [Reference 40]. However, based on current hazards, the bounding hazard is considered butane shipped by rail. A reevaluation of the TGIS butane monitor setpoint problem determined that there is sufficient margin to protect the control operator from releases involving railcar inventories of butane [Reference 41].
13. Constant to account for updated accident and truck survey shipment data using the "ratioing" method. Updating of the butane (BN&SF) risk value did not involve the use of the constant since the only factor updated was the annual shipment frequency of butane by rail.

Table 3
Updated Explosive Hazard Frequency

Chemical	Route	P_{base}	$N_{ship,obs}$ Observed 99 [Note 5]	$N_{ship,base}$ Annual 77	"Constant" [Note 3]	P_{curr}
Acetylene	I-5	2.0E-10	5	241	23.4	9.7E-11
Hydrogen, Comp.	I-5	1.2E-9 [Note 1]	5	97 [Note 6]	27.7	1.7E-9
Hydrogen, Liq.	I-5	1.4E-9 [Note 1]	4	113 [Note 6]	27.7	1.4E-9
LPG [Note 4]	I-5	2.8E-8 [Note 1]	83	1814 [Note 6]	27.7	3.6E-8
LPG [Note 4]	BN&SF	1.6E-7 [Note 2]	1,106 [Annual]	2,329 [Note 2]	n/a	7.6E-8
					Total	1.2E-7

Notes:

1. Baseline developed for 1996 SONGS 2/3 Offsite Hazards Update [Reference 14].
2. Baseline value used in the table corresponds to NSG/PRA Report PRA-23-920-007 [Reference 6]. The baseline shipment frequency was updated in that analysis to 2,329. Since the accident frequency is assumed to remain constant, the updated hazard frequency is merely the product of the base frequency and the ratio of current shipment data to 2,329.
3. Constant to account for updated accident and truck survey shipment data using the "ratioing" method. Updating of the LPG (BN&SF) risk value did not involve use of the constant since the only factor updated was the annual shipment frequency of LPG by rail.
4. Includes shipments of LPG, butane, propane and propylene.
5. Number of shipments observed during two-week truck survey except for the LPG shipped by the BN&SF that is an annualized figure.
6. Compressed hydrogen, liquefied hydrogen, and LPG (shipped by truck on I-5) each had revised explosive hazard baselines developed in the 1996 SONGS 2/3 OHA. The effective number of base shipments is equal to the product of the number of shipments observed during the 1996 SONGS 2/3 OHA truck survey and the multiplier derived in 1996 (16.2). Multiplication of the number of shipments of compressed hydrogen (6), liquefied hydrogen (7), and LPG (112) by the 1996 multiplier yields the base shipment value.

Table 4
Updated Flammable Vapor Cloud Hazard Frequency

Chemical	Route	P_{base}	$N_{ship,obs}$ Observed 99 [Note 5]	$N_{ship,base}$ Annual 77	"Constant" [Note 3]	P_{curr}
Acetylene	I-5	3.0E-9	5	241	23.4	1.5E-9
Hydrogen, Comp.	I-5	8.8E-9 [Note 1]	5	97 [Note 6]	27.7	1.3E-8
Hydrogen, Liq.	I-5	9.0E-9 [Note 1]	4	113 [Note 6]	27.7	8.8E-9
LNG	I-5	1.6E-8	0	420	27.7	n/a
LPG [Note 4]	I-5	1.7E-7 [Note 1]	83	1,814 [Note 6]	27.7	2.2E-7
LPG [Note 4]	BN&SF	1.3E-8 [Note 2]	1,106 [Annual]	124 [Note 2]	n/a	1.0E-7
					Total	3.4E-7

Notes:

1. Baseline developed for 1996 SONGS 2/3 Offsite Hazards Update [Reference 14].
2. Baseline value used in the table has been adjusted here to account for a difference in accident rates used between the 1992 explosive hazards evaluation and baseline flammable cloud hazards evaluation for LPG rail shipments.
3. Constant to account for updated accident and truck survey shipment data using the "ratioing" method. Updating of the LPG (BN&SF) risk value did not involve use of the constant since the only factor updated was the annual shipment frequency of LPG by rail.
4. Includes shipments of LPG, butane, propane and propylene.
5. Number of shipments observed during two-week truck survey except for the LPG shipped by the BN&SF that is an annualized figure.
6. Compressed hydrogen, liquefied hydrogen, and LPG (shipped by truck on I-5) each had revised flammable cloud hazard baselines developed in the 1996 SONGS 2/3 OHA. The effective number of base shipments is equal to the product of the number of shipments observed during the 1996 SONGS 2/3 OHA truck survey and the multiplier derived in 1996 (16.2). Multiplication of the number of shipments of compressed hydrogen (6), liquefied hydrogen (7), and LPG (112) by the 1996 multiplier yields the base shipment value.

Table 5
Summary of Hazard Frequencies (Per Year)

	Interstate 5	AT&SF Railway	Military Transport	Total
Unmonitored Asphyxiant Materials	Screened Out	Screened Out	Screened Out	Screened Out
Unmonitored Toxic Materials	4.2E-7	Screened Out	Screened Out	4.2E-7
Explosions	3.9E-8	7.6E-8	Screened Out	1.2E-7
Flammable Cloud	2.4E-7	1.0E-7	Screened Out	3.4E-7

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