SOUTHERN CALIFORNIA EDISON
SAN ONOFRE
NUCLEAR GENERATING STATION
1996 OFFSITE HAZARDS UPDATE

Summary Report

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INTRODUCTION

The 1996 Offsite Hazards Analysis (OHA) Update documents Southern California Edison's (Edison) review of hazards posed to the San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 from transportation of hazardous materials by the facility. The 1996 report represents the fifth tri-annual update of hazardous materials transported by the SONGS site on Interstate Highway 5 and the Atchison, Topeka and Santa Fe (AT&SF) Railway. The following summarizes the purpose of this study, methodology used to perform the study, and results obtained.

The United States Nuclear Regulatory Commission requires that a utility filing an application for authority to operate a nuclear power plant include in the application information regarding potential offsite hazards which could affect safe operation of the plant. The hazards to be specifically evaluated include the potential release of toxic and asphyxiant 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 which could adversely affect the plant's physical structure and, consequently, plant safety.

For SONGS Units 2 and 3, the analysis of offsite hazards is documented in Chapter 2 of the SONGS Units 2 and 3 Updated Final Safety Analysis Report (UFSAR). Upon original submittal and review of this analysis, 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 hazards analysis to be updated every three years by Technical Specification 5.7.1.7.

The first offsite hazards analysis update was performed in 1984. The analysis was updated again in 1987, 1990, and 1993. The purpose of this report is to document the nature,

frequency, and size of hazardous material transported near the SONGS site in 1996 and update the quantitative analysis of off-site hazard frequency based on these findings.

ACCEPTANCE CRITERIA

The Standard Review Plan (SRP) Section 2.2.3 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 10^{-7} per year based upon a realistic analysis, or 10^{-6} per year based on a conservative analysis. Any events exceeding these guidelines are classified as design basis events. Each hazard classified as a design basis event is reviewed to determine that the effects of the event on the safety features of the plant have been adequately accommodated in the design of the plant.

METHODOLOGY

The methodology for evaluation of the potential risk to the safe operation of the SONGS Units 2 and 3 from the shipment of hazardous cargo past the plant is described in the SONGS Units 2 and 3 UFSAR Section 2.2.2.2. The evaluation consists of determining hazards posed by truck traffic on Interstate Highway 5 and railway traffic on the AT&SF Railway. The highway is located within 585 feet and the railway within 490 feet of the closest safety-related plant structure.

Those types of hazards resulting from the shipment of hazardous materials past the plant are categorized as follows:

- toxic gases and liquids which could reach the control room in concentrations which exceed their toxic limit and could cause the control room to become uninhabitable,

- asphyxiant gases and liquids which could reach the control room in concentrations which could decrease the control room oxygen concentration to hazardous levels

- solids, liquids, or gases (including transient vapor clouds) which could explode and create an overpressure greater than the design allowable at plant safety-related structures which could affect plant safety, and

- solids, liquids, or gases which could arrive at the plant at flammable concentrations and potentially be swept into the air intake of a plant safety-related structure which could also affect plant safety.

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

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

where,

P = the hazard frequency (risk/yr)

N_{sh} = the annual frequency of shipments of the hazardous material (vehicles/yr)

P_{sp} = the probability of having an accident per unit length of the transportation route (accidents/vehicle-mi)

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 summed over 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

Equation 1-1 is directly applied for previously unanalyzed hazards and cases where the hazardous cargo shipment size was determined to be greater than previously analyzed. If the hazardous cargo shipment size is determined to remain constant based on correspondence with the chemical transporters, a modified form of Equation 1-1 is applied.

In Equation 1-1, the only two variables that change are shipment frequency, N_{sh}, and 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 as follows:

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

where, P_{curr} = current hazard frequency (events/yr)

P_{base} = baseline hazard frequency (events/yr)

$N_{ship,curr}$ = current shipment frequency (vehicles/yr)

$N_{ship,base}$ = baseline shipment frequency (vehicles/yr)

$P_{sp,curr}$ = 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 rates were not updated and are assumed to be the same as the rate determined in the 1992 LPG Rail Hazards Update. Therefore, the last term 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 AT&SF Railway. For truck shipments, the toxic, explosive and flammable evaluations for truck shipments were all normalized with respect to the current, site specific accident data. Other factors affecting the frequency of plant hazard such as conditional spill probability, source emission rates, dispersion modeling, etc., were not changed during this update. The following equations were derived for use in the "ratioing" process:

I-5 Truck Toxic Hazard

$$P_{curr} = 35.0\, P_{base}\left(\frac{N_{ship,obs}}{N_{ship,base}}\right) \qquad (1\text{-}3)$$

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

$$P_{curr} = 16.2\, P_{base}\left(\frac{N_{ship,obs}}{N_{ship,base}}\right) \qquad (1\text{-}4)$$

I-5 Truck Explosive/Flammable Hazard (Gases)

$$P_{curr} = 13.7\, P_{base}\left(\frac{N_{ship,obs}}{N_{ship,base}}\right) \qquad (1\text{-}5)$$

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

HAZARD IDENTIFICATION

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

- the railroad and military authorities believed to be transporting hazardous materials, and
- a roadside survey of truck traffic.

In both cases, questionnaires were used to obtain specific information related to the type of material being transported, as well as shipment size and frequency.

I-5 Truck Survey

The roadside survey was conducted over a two week period from August 5-16, 1996, at the truck weigh stations located on either side of Interstate Highway 5 (I-5) approximately three miles south of SONGS. There are no highway entrances or exits between the weigh stations and the plant site. Survey personnel were stationed at the weigh stations to determine truck content as trucks passed through the weigh station. All trucks entering the weigh stations were considered. Those 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.

AT&SF Survey

In order to update the rail hazards, the hazardous materials division of the AT&SF was contacted and asked to provide shipment information for the prior three years.

Military Survey

The United States military operates several bases in the vicinity of SONGS. Shipments of hazardous materials are made both 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 military ordnance and toxic materials was determined from correspondence with the military.

In the prior updates, the only four military installations that were contacted were the Naval Weapons Stations in Concord and Seal Beach, Camp Pendleton Marine Corps Base, and the Navy in San Diego. In the 1996 OHA update, the list was expanded to include other active bases in Southern California. Also, the information request was expanded to include shipments of toxic materials as well as military ordnance.

The following authorities were contacted through correspondence:

- United States Marine Corps - Camp Pendleton MCB, MTMC, MCRD
- United States Air Force - Fairfield Recruiting Office, Vandenberg AFB, Edwards AFB, Los Angeles AFB, March AFB
- United States Army - Concord Recruiting Office
- United States Navy - Concord NWS, Seal Beach NWS, San Diego Naval Station, Naval Amphibious Base, Sub Base, NAS Miramar, NAS North Island
- Atchison, Topeka and Santa Fe Railroad - Topeka, Kansas

Information relating to shipment of asphyxiant, toxic, and explosive materials being shipped by truck or rail was requested. Agencies were requested to provide annual shipment numbers as well as average and maximum net explosive weights for explosive material

shipments. Phone conversations were held as necessary to supplement and clarify written correspondence.

SURVEY RESULTS

Interstate 5 Survey Results

Approximately 1,977 potentially hazardous materials were identified in the truck survey. An in-depth review of each material 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 use and/or characteristics.

The identification of material characteristics permitted the grouping of potential hazardous materials into one of the parent chemical groups identified in the original analysis or dispositioned as not hazardous based on the following criteria:

Shipment Size - Reg Guide 1.78 specifies that materials less than 100 pounds do not need to be considered in the analysis of offsite hazards. 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 materials surveyed, many substances were found to have properties that precluded them from posing an actual hazard to the plant. The term "acute" refers to the ability of the material to significantly impair plant operations. Although many of the chemicals identified in the survey were classified as toxic or flammable, their vapor pressures were too low for them to vaporize at a sufficient rate to arrive at the plant in concentrations that would pose a hazard.

Approximately 1,162 of the potential hazardous materials were determined to pose a hazard to the facility. The surveyed number of shipments of each material displaying similar properties was added together. Thus, the shipment frequency of each previously evaluated material was increased to include any similar substances. Solid materials were excluded from further consideration as inhalants due to their poor dispersion capabilities. In this manner, all of the potentially hazardous materials which were identified were dispositioned. The revised shipment totals (including similar substances) were then utilized in Equations 1-1 to 1-5 as appropriate to determine the updated hazard frequency.

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[1,2]. 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[1] to be limited due to the constraints of the road topography. Therefore, the only materials that are affected by increased shipment size are those that are shipped either as gases (e.g., acetylene) or as compressed gases (e.g., propane). The following provides a list of those chemicals that were reanalyzed based on increased shipment sizes:

HAZARDOUS MATERIAL	PREVIOUSLY ANALYZED SHIPMENT SIZE	1996 OBSERVED SHIPMENT SIZE
Ammonia	2,950 gal	5,000 gal
Carbon Dioxide	1,500 gal	48,500 lbs
Chlorine	2,000 lbs (153 gal)	34,000 lbs (2,601 gal)
Hydrogen Liquid	5,020 lbs (8,500 gal)	10,120 lbs
Hydrogen Gas	As Hydrogen Gas 1: 16,425 ft^3 As Hydrogen Gas 2: 14,000 ft^3 (640 lbs)	2,600 lbs
Propane	10,000 gal	11,000 gal

Each material was evaluated on a case-by-case basis to determine the impact on plant risk. For each of the materials the plant risk was calculated to be below the 10^{-6} per year

threshold. In the majority of these cases, the reevaluation resulted in a net decrease in plant risk. This is because consideration was given to a range of meteorological conditions as opposed to one single meteorological condition as was done in the past. This approach provides a more representative estimate of plant risk which is less conservative than previous updates but is still considered conservative based on the assumptions contained in this summary report.

AT&SF Survey Results

The only materials shipped in frequencies that require analysis (i.e., greater than 30/year) were ethanol, propane, butane, and LPG. The response from the AT&SF revealed that the highest number of shipments of LPG, including propane and butane, in the prior three years occurred during 1995, when 1,936 shipments were made. This value is used in updating the explosive/flammable hazard from LPG. A separate value is also needed for butane rail shipments since it poses a potential toxic hazard, whereas propane is a simple asphyxiant. The maximum number of shipments of butane was 108 in 1994. Although potassium nitrate was shipped in excess of the 30/yr frequency, the material does not possess sufficient vapor pressure in order for it to become airborne at hazardous levels. In addition, potassium nitrate is classified as Department of Transportation (DOT) Class 5.1, which represents oxidizing materials, as opposed to DOT Class 1.1, which represents high explosives. Therefore, potassium nitrate is excluded from further analysis.

The number of ethanol rail shipments also exceeded 30/yr in the prior three years. Ethanol is a potential toxic, explosive, and flammable hazard that was previously unanalyzed. The maximum shipment frequency of ethanol identified in the correspondence was 91 in 1995. It is noted that in 1993, the AT&SF Railway did not record shipment information on an individual chemical basis. Rather, the data was grouped according to the DOT Classes. Each DOT Class incorporates several materials. For instance, DOT Class 3, which encompasses flammable liquids, includes materials like ethanol and gasoline. In 1995 there were 134 shipments of Class 3 materials which included 91 shipments of ethanol. In

1993, there were 121 shipments of Class 3 materials. Since there were fewer shipments of Class 3 materials in 1993 than in 1995, it is assumed that the maximum number of shipments of ethanol was in 1995 (91 shipments).

Military Survey Results

The correspondence from the military indicated that the maximum weight of any military shipment by truck during the period from 1993 through the middle of 1996 was 26,190 lbs net explosive weight (N.E.W.). 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 Units 2 and 3, these 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.

Assuming a per pound equivalence with tri-nitro-toluene (TNT), the peak reflected overpressure at the plant site produced by the surface detonation of a 26,190 pound charge of TNT at a distance of 585 feet (distance from I-5 to the closest safety-related structure, the Fuel Handling Building) is less than 7 psi. In order to exceed the 7 psi capability of the SONGS Units 2 and 3 safety related structures, a shipment weight exceeding 65,000 pounds of TNT is required. 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 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.

ASSUMPTIONS

The SONGS Offsite Hazards Analysis (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 flammable 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 the more likely mechanism of a small rupture or crack (resulting in a minimal leakage and/or leak rate) and the less likely severe rupture (which presents the more significant hazards to the plant) [applies to toxic, explosive, and flammable 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 which 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. Analysis of toxic hazards assumed that all shipments of a parent chemical were equivalent to the analyzed container size in the baseline analysis. 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].

7. Binning of materials into parent groups was typically done in a conservative manner such that the hazardous properties of binned materials were less than 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 baseline analyses].

During the 1996 OHA Update, 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 specific details of the re-analysis are included in Appendix C of the main report. 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 baseline evaluations.

1. The asphyxiation hazard is explicitly evaluated in the 1996 OHA Update. Asphyxiation is assumed to occur when the oxygen concentration drops below 18% [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. No credit is taken for the immediate dilution experienced in puff type releases due to rapid air entrainment which is in the range of 3:1 air to contaminant. This factor was credited in the original explosive/flammable hazards analysis [applies to explosive and flammable 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 result are assumed to be bounded by a 10,000 ft^2 pool area [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 which corresponds to the highest average wind speed recorded for any of the stability classes observed at SONGS as reported in Table 2.3-18 of the SONGS Units 2 and 3 UFSAR [applies to asphyxiant, toxic, explosive, and flammable 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 hazard analyses].

7. The probabilistic re-analyses evaluate a range of meteorological conditions representative of SONGS. The baseline evaluations assumed single cases involving only pessimistic meteorological conditions [applies to asphyxiant, toxic, explosive, and flammable 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 criteria 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, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," 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 average concentration is used, whereas the toxic hazard analysis performed for this update reflects the instantaneous concentration.

9. The evaluation of explosive hazards in the 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 quantity of 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 spill sizes which would negate the effect of 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 10^{-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.

SUMMARY OF RESULTS

Asphyxiant Hazard Frequency

Table 1 illustrates the results of the asphyxiant hazard frequency. The chemical, number of shipments observed in the survey period, and associated frequency of plant hazards are provided. The only material which 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.

Toxic Hazard Frequency

Table 2 illustrates the results of the updated toxic hazard frequency. The chemical, number of shipments observed in the survey period, and associated frequency of plant hazards are provided. Monitoring and automatic control room isolation provisions are provided for hydrocarbons (e.g., gasoline), ammonia and chlorine by the Control Room Toxic Gas Isolation System. Thus, the sum of the chemical risks from unmonitored chemicals is 4.5E-7 per year. This risk value allows a factor of 2 margin in shipment frequency prior to reaching the threshold value of 1.0×10^{-6} per year.

Explosive/Flammable Hazard Frequency

Tables 3 and 4 illustrate the results of the updated flammable cloud and explosive hazards. Explosive materials identified in the survey include liquefied petroleum gas (LPG), liquid hydrogen, and acetylene. These materials also have properties which pose a flammable vapor cloud hazard. As such, the chemicals were evaluated for their contribution in both explosive and flammable vapor cloud risks. Other compressed and liquefied gases were also considered for evaluation of the risk of a flammable gas mixture reaching the control room heating, ventilation and air conditioning (HVAC) air intake. Liquefied natural gas (LNG) was identified in prior offsite hazards updates but was not observed in the 1993 survey. In addition, no chemicals other than LPG, liquid hydrogen, and acetylene were observed in the 1996 survey which could pose a flammable cloud hazard. The contribution of these materials to the flammable cloud hazard was calculated to be 4.0×10^{-7} per year. The resulting frequency of explosive hazards was calculated to be 1.7×10^{-7} per year. Each of these values is less than the 1×10^{-6} per year threshold.

Also, the original NUS offsite hazards analysis performed in 1979[3] evaluated the potential hazard of all flammable liquids found. The original analysis determined that only formaldehyde, gasoline, and xylene were capable of causing a peak positive normal reflected overpressure (from explosion) at the nearest plant safety-related structure exceeding 3.0 psi. Since the capability of safety-related structures at the plant to withstand overpressure conditions was re-evaluated and revised from 3.0 psi to 7.0 psi, the potential hazard capability from spills of formaldehyde, gasoline, and xylene was re-evaluated. Based on the 1996 survey, these materials are not shipped in quantities which could create an overpressure in excess of the 7.0 psi limit. Therefore, the risk from this particular hazard is zero.

In order to evaluate the explosive hazard from shipment of military ordnance on I-5 by SONGS, questionnaires were sent to active military bases that are known or potentially can ship past SONGS. Based on their responses, the maximum weight of any military shipment

of explosives past SONGS Units 2 and 3 for January 1993 through June 1996 was less than 26,190 pounds. Assuming this maximum weight shipment is composed of materials having a pound per equivalence with TNT (conservative assumption), the peak positive normal reflected overpressure at the plant site produced by the surface detonation of such a shipment at a distance of 585 feet (distance to closest safety-related structure, the Fuel Handling Building) is less than 7.0 psi. Since the safety-related structures of the plant have been determined to be capable of withstanding overpressures of up to 7.0 psi, an explosion of a shipment of military ordinance on I-5 does not pose a hazard to plant safety.

Net Hazard Frequencies

In summary, the frequencies of potential hazards related to the shipment of hazardous materials on the highway and railway adjacent to the plant including toxic, explosive, and flammable cloud hazards were all calculated to be less than 1×10^{-6} per year or determined not to be a hazard on some other defined basis. Based on these results no new design basis events from offsite hazards need to be considered for SONGS.

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	4.5E-7	Screened Out	Screened Out	4.5E-7
Explosions	3.0E-8	1.4E-7	Screened Out	1.7E-7
Flammable Cloud at Plant	1.9E-7	2.1E-7	Screened Out	4.0E-7

REFERENCES

1. "Analysis of the Probability of Toxic Gas Hazard for the San Onofre Nuclear Generating Station as a Result of Truck Accidents Near the Plant," February 28, 1981, E. A. Hughes, A. J. Unione, and R. R. Fullwood, SAI report.

2. "Analysis of Explosive Vapor Cloud Hazards for Rail and Highway Transportation Routes Near the San Onofre Nuclear Generating Station Units 2 and 3 Using a Best Estimate Analysis," R. H. Broadhurst, and M. C. Cheok, Supplement 1, April 17, 1981.

3. "Analysis of Explosive Vapor Cloud and Missile Hazards for Rail and Highway Transportation Routes Near the San Onofre Nuclear Generating Station Units 2 and 3," R. H. Broadhurst and C. Y. Li, NUS-3367.

Table 1
Asphyxiant Hazard Frequency

Chemical [Note 1]	$N_{ship,obs}$ Observed 96 [Note 2]	P_{curr}, Unmonitored	P_{curr} Monitored
Acatylene	4	[Note 3]	
Argon	25	[Note 3]	
Hydrogen Liquid	7	[Note 3]	
Hydrogen Gas	6	[Note 3]	
Nitrogen	102	[Note 3]	
Propane	112	[Note 3]	
Propane (AT&SF)	2,027 (annual)		2.42E-5

Notes:

1. The chemicals listed we.e identified in the I-5 truck survey except where noted. For argon and nitrogen, shipments c:in be made as liquids as well as gases. The asphyxiant hazard analysis evaluated argon and nitrogen liquid shipments. Asphyxiant hazards from argon and nitrogen gas shipments would be ɔounded by hydrogen gas shipments since hydrogen has a much lower molecular weight than either of these chemicals and would therefore have a greater potential to displace the air from a confined space.

2. This column represents the number of shipments observed during the 1996 I-5 truck survey with the exception of the propane AT&SF shipment value which was obtained directly from the AT&SF.

3. Screened out deterministically from further analysis.

Table 2
Updated Toxic Hazard Frequency

Chemical [Note 2]	P_{base} [Note 6]	$N_{ship,obs}$ Observed 96 [Note 7]	$N_{ship,base}$ Annual 77	"Constant"	P_{curr}, Unmonitored	P_{curr} Monitored
Batteries	Note 3	16	490	n/a	n/a	n/a
Crude Oil	Note 1	0	43	n/a	n/a	n/a
Ethanol (By Rail)	Note 5	91 (annual)	n/a	n/a	n/a	n/a
Hydraulic Oil	Note 1	5	43	n/a	n/a	n/a
Motor Oil	Note 1	75	43	n/a	n/a	n/a
Naphtha	Note 1	24	43	n/a	n/a	n/a
Benzene	2.3E-08	0	43	35.0	0.0E+00	
Muriatic Acid	2.3E-09	0	43	35.0	0.0E+00	
Methyl Bromide	2.3E-09	1	48	35.0	1.7E-09	
Vikane	2.3E-09	2	43	35.0	3.8E-09	
Sulfuric Acid	2.3E-09	13	130	35.0	8.2E-09	
Xylene	2.3E-09	3	24	35.0	1.0E-08	
Butyl Acetate	2.3E-09	9	43	35.0	1.7E-08	
Hydrochloric Acid	2.3E-09	28	133	35.0	1.7E-08	
Methyl Ethyl Ketone	2.3E-09	10	43	35.0	1.9E-08	
Methylene Chloride	2.3E-09	12	43	35.0	2.3E-08	
Perchloroethylene	2.3E-09	13	43	35.0	2.5E-08	
Carbon Dioxide	Note 4	81	n/a	n/a	2.3E-08	
Toluene	2.3E-09	23	43	35.0	4.4E-08	
Acetone	2.3E-09	27	43	35.0	5.1E-08	
Isopropyl Alcohol	2.3E-09	49	43	35.0	9.3E-08	
Formaldehyde	2.0E-08	2	14	35.0	1.0E-07	
Jet Fuel	2.0E-08	39	910	35.0		3.0E-08
Butane	3.9E-07	7	2,200	35.0		4.4E-08
Diesel Fuel	1.2E-08	115	650	35.0		7.4E-08
Ammonia	Note 4	10	n/a	n/a		8.2E-08
Gasoline	3.9E-07	311	17,000	35.0		2.5E-07
Chlorine	Note 4	31	n/a	n/a		4.0E-07
Butane (AT&SF)	Note 4	108 (annual)	n/a	n/a		1.1E-05
				Total	4.5E-07	1.2E-05

Notes:

1. Not evaluated, not readily formed into a vapor cloud.
2. The chemicals listed were identified in the I-5 truck survey except where noted.
3. Not evaluated, non-toxic.
4. New baseline developed for 1996 OHA Update.
5. Ethanol shipped by rail was deterministically screened out from the probabilistic evaluation since toxic concentrations were not predicted to occur in the control room.
6. Includes adjustment factor of 0.39 accounting for the appropriate highway type. This factor was derived and utilized in the 1984 offsite hazards analysis update. The values provided in this table equal the frequencies from the 1981 report times 0.39. For those materials that represented less than 0.1% of the cumulative risk in 1981, a hazard frequency of 2.3E-9/yr was assigned.
7. This column represents the number of shipments observed during the 1996 I-5 truck survey with the exception of the butane and ethanol AT&SF shipment values which were obtained directly from the AT&SF.

Table 3
Updated Explosive Hazard Frequency

Chemical	Route	P_{base}	$N_{ship,obs}$ Observed 96 [Note 5]	$N_{ship,base}$ Annual 77	"Constant" [Note 3]	P_{curr}
Acetylene	I-5	2.0E-10	4	241	13.7	5.5E-11
Hydrogen, Comp.	I-5	[Note 1]	6	n/a	n/a	1.2E-9
Hydrogen, Liq.	I-5	[Note 1]	7	n/a	n/a	1.4E-9
LPG [Note 4]	I-5	[Note 1]	112	n/a	n/a	2.8E-8
LPG [Note 4]	AT&SF	1.6E-7 [Note 2]	2,027 [Annual]	2,329 [Note 2]	n/a	1.4E-7
					Total	1.7E-7

Notes:

1. Increased Shipment Size. New baseline developed for 1996 OHA Update.

2. Baseline value used in table corresponds to NSG/PRA Report PRA-23-920-007. 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 per Section 6.1.1. The current updated risk values for compressed hydrogen, liquid hydrogen, and LPG (I-5) were evaluated explicitly and did not involve the use of the constant. Updating of the LPG (AT&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 ethanol.

5. Number of shipments observed during two week truck survey except for the LPG - AT&SF number, which is an annualized figure.

Table 4
Updated Flammable Vapor Cloud Hazard Frequency

Chemical	Route	P_{base}	$N_{ship,obs}$ Observed 96 [Note 5]	$N_{ship,base}$ Annual 77	"Constant" [Note 3]	P_{curr}
Acetylene	I-5	3.0E-9	4	241	13.7	8.2E-10
Hydrogen, Comp.	I-5	[Note 1]	6	n/a	n/a	8.8E-9
Hydrogen, Liq.	I-5	[Note 1]	7	n/a	n/a	9.0E-9
LNG	I-5	1.6E-8	0	420	16.[illegible]	n/a
LPG [Note 4]	I-5	[Note 1]	112	n/a	n/a	1.7E-7
LPG [Note 4]	AT&SF	1.3E-8 [Note 2]	2,027 [Annual]	124 [Note 2]	n/a	2.1E-7
					Total	4.0E-7

Notes:

1. Increased Shipment Size. New baseline developed for 1996 OHA Update.

2. Baseline value used in table has been adjusted here to account for a difference in accident rates used between the 1992 explosive hazards evaluation and baseline flammable hazards evaluation for LPG rail shipments.

3. Constant to account for updated accident and truck survey shipment data using the "ratioing" method per Section 6.1.1. The current updated risk values for compressed hydrogen, liquid hydrogen, and LPG (I-5) were evaluated explicitly and did not involve the use of the constant. Updating of the LPG (AT&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 ethanol.

5. Number of shipments observed during two week truck survey except for the LPG - AT&SF number, which is an annualized figure.