PUGET
POWER

July 2, 1982
PLN-259

Mr. Harold R. Denton, Director
Office Of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Puget Sound Power & Light Company
Skagit/Hanford Nuclear Project, Units 1 & 2
Docket Nos. 50-522 and 50-523
Anhydrous Ammonia Hazard Analysis

Gentlemen:

The preliminary investigation of potential spills of chemicals transported near the Site indicated that anhydrous ammonia being transported by truck to the 200-East Area of the Hanford Reservation could pose a hazard to the Skagit/Hanford Nuclear Project (S/HNP) control room operators. This was documented in Preliminary Safety Analysis Report (PSAR) Amendment 23 and the commitment made to install redundant anhydrous ammonia detectors in the control room air intake. Subsequently, however, a detailed analysis was performed of the probability of an accident involving a truck shipment of anhydrous ammonia. The results of the analysis indicated that the probability of occurrence of an accidental spill of anhydrous ammonia, simultaneously with an event producing a radiological release in excess of 10 CFR Part 100 guidelines, is of such low magnitude that anhydrous ammonia detectors in the control room air intakes are not justified. Amendment 25 to the S/HNP PSAR will reflect the results of the study and the removal of the detectors.

A copy of the analysis is enclosed for your review.

Very truly yours,

Robert V. Myers

Robert V. Myers
Vice President
Generation Resources

Encl.

8207130122 820702
PDR ADOCK 05000522
A PDR

B001

PROBABILITY OF A PART 100 RELEASE FOLLOWING A SPILL OF ANHYDROUS AMMONIA NEAR SKAGIT/HANFORD NUCLEAR PROJECT

The consequences of potential accidents involving truck shipments of anhydrous ammonia near the Skagit/Hanford Nuclear Project (S/HNP) Site have been analyzed to ensure that the requirements of 10 CFR Part 100, Section 100.10, are met. An accidental spill of anhydrous ammonia during shipment is an offsite hazard which has the potential for occurring simultaneously with onsite accidents leading to a Part 100 radiological release. Specific guidance with respect to offsite hazards is provided in Chapter 2, Section 2.2.3 of Reg. Guide 1.70, Rev. 3. As indicated therein, the identification of design basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant is acceptable if the expected rate of occurrence of potential exposure in excess of the 10 CFR Part 100 guidelines is estimated to exceed approximately 10^{-7} per year using assumptions that are as representative of the specific site as practicable (a realistic analysis). The expected rate of potential exposures in excess of 10 CFR Part 100 guidelines of approximately 10^{-6} per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower (a conservative analysis).

The following is a conservative analysis of the potential hazard caused by an accident involving truck shipments of anhydrous ammonia near the Plant Site. It indicates clearly that the probability of occurrence of the initiating event, an accidental spill of anhydrous ammonia which results in the exposure of control room personnel to toxic levels (toxicity limit = 100 ppm, from Reg. Guide 1.78) is of such low magnitude that the Part 100 exposure criterion is met.

The probability of exposure of control room personnel to toxic levels of anhydrous ammonia is product of:

(a) The number of shipments per year passing the Plant Site

(b) The number of spills per truck mile

(c) The number of miles of road near the Plant on which anhydrous ammonia is transported, and

(d) The probability that meteorological conditions are such that toxic gas plume will reach the Plant.

These factors are discussed below.

A. Number of Shipments Per Year

A survey was performed to determine anhydrous ammonia shipment quantities and frequencies near the Plant Site. According to information supplied by the U.S. Department of Energy (DOE), anhydrous ammonia will be shipped by truck to the 200-East Area in quantities of 2,000-3,000 gallons per container 8-10 times annually (Ref. 1). Shipments may be by tank truck and trailer, utilizing two containers. For this analysis, 10 tank truck shipments were conservatively assumed with a spill of one container (3,000 gallons, approximately 8.5 tons). The rationale for the amount of anhydrous ammonia spilled for any accident is discussed under the meteorological analysis below.

B. Number of Spills Per Truck Mile

Data from various sources has been analyzed to arrive at a conservative accident probability. According to a study performed by Arthur D. Little, Inc. (ADL) the frequency of loaded tank truck accidents which results in a loss of lading is 2.7×10^{-8} accidents per tank truck mile (Ref. 2). This frequency is based on an average annual number of loaded tank truck accidents, 1,650; total annual average tank truck mileage, 1.24×10^{9} miles; and a conservative estimate that fewer than 2% of the reported accidents involving loaded tank trucks resulted in a spill. This information was compiled from annual accident reports filed with the Department of Transportation (DOT), mileage statistics compiled by the Interstate Commerce Commission, and tank truck census data developed by the Department of Commerce during the period 1968-1972. The data includes private and common carrier shipments over short, intermediate and long-haul distances in both urban and rural sectors of the country.

An alternate method of deriving the probability that a tank truck carrying anhydrous ammonia would be involved in an accident which results in a spill was calculated using data provided by the DOT and based on a commodity transportation survey done by the Bureau of the Census (Ref 3). During 1977 there were 22 accidents involving truck shipments of anhydrous ammonia, not all of which involved a spill. Shipments during 1977 totaled 402×10^{6} ton-miles. Since DOT did not provide information regarding the number of accidents which resulted in spills, it was assumed that the 2% factor used in the ADL study is applicable. Then the accident rate for trucks carrying anhydrous ammonia resulting in a spill is:

$$\frac{22 \text{ accidents}}{402 \times 10^6 \text{ ton-miles}} \times .02 = 1.09 \times 10^{-9} \quad \frac{\text{accidents w/spill}}{\text{ton-mile}}$$

As a further check on these accident probabilities, data from a Sandia Laboratories report was analyzed (Ref 4). Sandia performed an analysis of accident data for five different types of highway segments. For that type of highway most similar to Route 4 on the Hanford Reservation, (flat, straight interstate), Sandia lists an accident probability of 1.1×10^{-6} truck accidents per truck mile. Multiplying by .02 for the number of accidents which result in a spill, the likelihood of a truck accident resulting in a spill on Route 4 is:

$$1.1 \times 10^{-6} \quad \frac{\text{accidents}}{\text{truck-mile}} \times .02 = 2.2 \times 10^{-8} \quad \frac{\text{accidents w/spill}}{\text{truck-mile}}$$

C. Number of Miles Near the Plant Site on Which Anhydrous Ammonia is Transported

Reg. Guide 1.78 requires that shipments of toxic chemicals within 5 miles of the Plant Site must be considered in the evaluation of control room habitability.

There are four roads which pass within 5 miles of the S/HNP Site: Route 4 South, Route 2 South, Route 10 and Highway 240. However, it is likely that anhydrous ammonia will be shipped on Route 4 only from the Tri-Cities area to the 200-East Area on the Hanford Reservation. Although the Tri-Cities area is a major supplier of anhydrous ammonia, shipments across the Hanford Reservation are unlikely except to the 200-East Area. Furthermore, any accidents involving shipments along Highway 240, which passes within 4 miles of S/HNP, would have insignificant impact on the Plant. Therefore, a portion of a shipment route consisting of approximately 10 miles of road within 5 miles of S/HNP on which an accident may be of concern was used in the accident analysis.

D. The Probability that Meteorological Conditions Exist Such that a Toxic Gas Plume Will Reach the Plant

The methodology of NUREG-0570 was used to model transport and dilution of the spilled anhydrous ammonia to the control room air intake. It was conservatively assumed that 3,000 gallons were instantaneously released, i.e. the entire contents of one container. Of the 3,000 gallons released, 18% instantaneously vaporizes upon depressurization. The remaining 82% spills into a pool and slowly vaporizes by drawing heat from the surroundings (see Table 1). If a tank truck and trailer should be involved in an accident, it is assumed that, at most, the contents of one vessel (3,000 gallons) will contribute to a vapor cloud. This assumption is consistent with accident statistics (Ref. 5) and the analysis of NUREG-0570 (the entire inventory of one container is released) and Reg. Guide 1.78 (for multiple containers of equal size, the failure of only one container is assumed unless the failure of that container could lead to successive failures).

The probability that meteorological conditions would occur such that the concentrations of ammonia in the control room from an accident on the road near S/HNP exceeds the toxicity limit has been calculated as follows:

$$P_m = \frac{1}{L_t} \Sigma_i \; P_{si} \; (\Sigma_j \; P_w{}^{ji} \times L_a{}^{ji})$$

Where: P_m is the meteorological probability

L_t is the total length of road with 5 miles of S/HNP (L_t = 10 mi)

P_{si} is the probability of stability class i occurring

$P_w{}^{ji}$ is the probability of wind speed j for stability class i occurring for the affected meteorological sector

$L_a{}^{ji}$ is the affected length of road for stability class i and wind speed j.

Values of P_{si} and $P_w{}^{ji}$ were obtained from Table 2.3-1 of the S/HNP Preliminary Safety Analysis Report. To determine $L_a{}^{ji}$, concentrations of anhydrous ammonia in the control room were calculated for different stability classes, radial distances and wind speeds using the conservative X/Q vapor dispersion factors from NUREG-0570. Table 2 shows the meteorological condition under which control room concentrations would exceed the toxicity limits. Using the $L_a{}^{ji}$ values of Table 2 and the P_{si} and $P_w{}^{ji}$ values from Table 2.3-1, the meteorological probability P_m has been calculated to be 0.06.

The methodology used to calculate this probability is conservative in all respects except that the conservative X/Q values are applied realistically. However, it is believed that the calculation remains sufficiently conservative such that the overall probability is conservative.

Risk

The resulting risk to the control room operators is the product of the above factors.

(a) Using the accident probability data presented in the ADL study,

$$2.7 \times 10^{-8} \ \frac{\text{accidents}}{\text{truck mile}} \times 10 \ \frac{\text{shipments}}{\text{year}} \times 10 \ \frac{\text{miles}}{\text{shipment}} \times .06$$

$= 1.6 \times 10^{-7}$ events/year

(b) Using the accident probability derived from DOT data in conjunction with the ADL study,

$$1.09 \times 10^{-9} \ \frac{\text{accidents}}{\text{ton-mile}} \times 853.5 \ \frac{\text{ton-miles}}{\text{year}} \times .06$$

$= 5.6 \times 10^{-8}$ events/year

(c) Using the accident probability derived from Sandia Laboratories data in conjunction with the ADL study,

$$2.2 \times 10^{-8} \ \frac{\text{accidents}}{\text{truck mile}} \times \frac{10 \text{ shipments}}{\text{Year}} \times \frac{10 \text{ miles}}{\text{shipments}} \times .06$$

$= 1.3 \times 10^{-7}$ events/year.

The conservative probability that a tank truck accident resulting in a spill of anhydrous ammonia will occur near S/HNP under the proper meteorological conditions is less than 1.0×10^{-6} per year. This analysis is considered very conservative even though part of the meteorological analysis used realistic methods. This probability is in accord with Standard Review Plan 2.2.3 for analyses based on conservative assumptions.

Other conservatisms, not included in the analysis, make the probability even less likely that a design basis event would result from an accidental spill of anhydrous ammonia. For example, the accident data relied on is generally based on "unrestricted" road conditions. Trucks carrying hazardous materials on the Hanford Reservation are subject to rigid US DOE control and are less likely than average to be involved in accidents. Furthermore, it was assumed that a truck accident which results in a loss of lading will spill the entire contents of a container. The actual probability of a complete spill or a spill severe enough to have an impact on S/HNP is likely to be less than 1.0 (Ref. 3,6).

It was further assumed for purposes of this analysis that concentrations of anhydrous ammonia in the control room, equal to the toxicity limits of Reg. Guide 1.78, would be sufficient to cause an evacuation of the control room simultaneously with an event resulting in a Part 100 radiological release. This assumption is very conservative in that a toxic chemical spill is an independent event. Operator corrective action which prevents the need to evacuate the control room is not considered. Further, evacuation of the control room is independent of accidents leading to a Part 100 release since Plant safety systems are available to automatically shut down the Plant and prevent a release.

TABLE 1

Vaporization of Anhydrous Ammonia Following a Spill From a Tanker Truck Near S/HNP

Amount of ammonia instantaneously flashing (1) - 18%

Amount of ammonia gradually evaporating - 82%

Extent of Spill (2) - 932 m^2

Vaporization Rate (3) - $918 + 3.00 \times 10^4/\sqrt{t}$ gm/sec

(1) The initial flashing fraction is calculated using eq. 2.1-3 of NUREG-0570.

(2) Spill area is calculated using eq. 2.1-1 of NUREG-0570.

(3) Vaporization rate is calculated using eq. 2.1-12 of NUREG-0570.

TABLE 2

Meteorological Conditions Resulting in Control Room Ammonia Concentrations Exceeding the Toxicity Limits

Stability Class	Wind Speed(1) (m/s)	Maximum Radial Distance From Control Room(2) (mi)	Affected Sectors(3)	Affected Road Length(4) (mi)
D	1	1	NE	<1
E	1	1	NE	<1
F	1	3	NNW to ESE	5.9
F	2.5	1	NE	<1
F	4.5	1	NE	<1
G	1	5	NW to ESE	10
G	2.5	2	N to E	3.3
G	4.5	1	NE	<1
G	7	1	NE	<1

(1) Wind speeds were chosen at the nominal mid-point of the wind speed categories of Table 2.3-1.

(2) Maximum distance from the control room for which the given stability class and wind speed will result in concentrations exceeding the toxicity limit.

(3) Sectors centered on the control room, from which wind could be blowing such that concentrations will exceed the toxicity limit.

(4) For length of less than 1 mile, 1 mile was conservatively used.

References

1. Personal Communication K. Bracken, DOE, to F. A. Spangenberg NESCO, November 16, 1981.

2. Arthur D. Little, Inc., A Modal Economic and Safety Analysis of the Transportation of Hazardous Substances in Bulk, report prepared for the U.S. Department of Commerce, Maritime Administration, Office of Domestic Shipping, Washington, D.C., Report No. COM-74-11271, 1974.

3. Personal Communication with data, David Jossi, Wilson Hill Associates - DOT, to Duane Mathiowetz, Bechtel Power Corporation, May 3, 1982.

4. W. F. Hartman, C. A. Davidson, and J. T. Foley, Statistical Description of Heavy Truck Accidents on Representative Segments of Interstate Highway, SAND-0409, January 1977.

5. San Onofre Nuclear Generating Station, Final Safety Analysis Report, Answer to NRC Question 312.46.

6. SAI Report to Bechtel Corporation, Analysis of the Probability of a Toxic Gas Hazard for the San Onofre Nuclear Generating Station as a Result of Truck Accidents Near the Plant, February 1981.