HABITABILITY OF THE LASALLE COUNTY STATION CONTROL ROOM FOLLOWING POSTULATED ACCIDENT INVOLVING SHIPMENTS OF ANHYDROUS AMMONIA IN THE VICINITY OF LASALLE COUNTY STATION

COMMONWEALTH EDISON COMPANY
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EXECUTIVE SUMMARY

Anhydrous ammonia is identified in Regulatory Guide 1.78 as a toxic substance which should be considered when evaluating the habitability of a nuclear power plant control room during a postulated hazardous chemical release. The hazard of the control room habitability posed by a particular toxic chemical depends upon the distance the material is stored from the control room, the quantity of the material transported near the site. In addition, the prevailing wind direction affects the likelihood that an accidental release will reach the control room ventilation air intakes.

Regulatory Guide 1.78 requires that mobile or stationary sources of anhydrous ammonia within a five mile radius of the plant be included in the habitability analysis. Regulatory Guide 1.70 in Section 2.2, requires that all facilities and activities within five miles of the nuclear plant be considered in the analysis, and in addition it requires that facilities and activities at greater distances be considered as appropriate to their significance.

Section 2.2.3 of the Standard Review Plan (NUREG-0800) provides a probability criteria for determining if a toxic release need be considered a design basis event.

In 1975, a survey of industries and transportation routes which may use, store and/or transport hazardous chemicals in the vicinity of the LaSalle County Station was completed to meet the requirements of Regulatory Guide 1.78. The survey indicated that anhydrous ammonia was transported in the area of the LaSalle Station and that several industries stored and/or utilized this chemical at their facilities. At that time, no further analysis was performed to determine whether uninhabitable conditions could be caused in the control room during an accidental release of anhydrous ammonia. Instead, to expedite the licensing of the plant, redundant ammonia detectors were provided on each outside air intake of the control room.

In 1986 and 1987, a second set of surveys was conducted to supplement the 1975 data and to provide additional information needed to perform quantitative analysis of the station control room habitability and exposure risk due to accidental release of anhydrous ammonia. The 1986-1987 survey yielded the following results:

1. State Highway 170 and County Road 6, the nearest roadways to the plant can be used by local farmers and tank trucks to transport ammonia. Shipment of ammonia on other highways and railroads need not be considered as these are more than 5 miles away from the plant.

2. A section of the Illinois River passes within the 5 miles of the station control room air intake, and the survey indicated that shipments totaling 310,500 tons by 121 barges on the Illinois River is representative of the annual barge shipments of anhydrous ammonia in the vicinity of the plant.

3. Two stationary storage facilities are located near the Illinois River. The Kaiser Agricultural Chemical company stores anhydrous ammonia in two refrigerated tanks (20,000 and 22,500 tons) which are located just inside the 5 mile radius of the plant. The Seneca Port Authority also stores

30,000 tons of ammonia in a refrigerated tank which is approximately 5.75 miles from the plant:

4. Commonwealth Edison is currently leasing approximately 300 acres of land near the plant to local farmers. At the present time, the farmers are using 28% granular nitrogen to fertilize the leased property, however, the possibility of using anhydrous ammonia in the future does exist. The analysis assumed that as many as 10 farm fertilizer containers, each carrying approximately 1,450 gallons of ammonia, could be used on the leased property each year. This ammonia would be transported on the station service road.

Two types of quantitative analyses were conducted: Dispersion and Probability analysis. A dispersion analysis was done in accordance with Regulatory Guide 1.78 to determine whether an accidental release of ammonia on waterways and roadways resulted in concentrations exceeding the toxicity limit in the control room two minutes after odor detection. Accidental releases which did not exceed the toxicity limit were not included in the probability analysis.

The probability analysis considered the meteorological data, length of transportation route within 5 miles of station, probability of accidents resulting in spills, and frequency of shipments for the transportation mode under consideration.

The results of the dispersion analysis showed that the accidental releases of ammonia due to transportation of the farm fertilizer containers and tank trucks on County Road 6 and IL. 170, respectively, did not result in concentrations exceeding toxicity limits and that a probability analysis was not warranted for these accidents. The probability analysis considered the accidental releases due to transportation of ammonia on the river, tank trucks on County Road 6, farm fertilizer contains on station service road and on the leased land, and storage in offsite tanks.

The aggregate probability of causing uninhabitable conditions in the control room was determined by summing the individual probabilities due to accidents involving ammonia barges, ammonia storage tanks, ammonia tank trucks, on-site transportation and storage of ammonia. The aggregate probability was calculated to be 2.85×10^{-6} per year. This probability assessment is conservative, and when it is combined with reasonable qualitative arguments, a more realistic exposure risk assessment of 1.5×10^{-7} per year is obtained.

The probabilities are shown to be of the same order of magnitude as specified by Section 2.2.3 of the Standard Review Plan, NUREG-0800. Therefore, the toxic hazard created by the accidental release of ammonia in the vicinity of LaSalle County Station is not considered a significant risk to the safe operation of the station.

1.0 INTRODUCTION

In 1975, Commonwealth Edison Company commissioned a survey of industries and transportation routes which may use, store, and/or transport hazardous chemicals in the vicinity of the LaSalle County Station. This survey was conducted to meet the requirements of Regulatory Guide 1.78 (Reference 1). The 1975 survey indicated that anhydrous ammonia was transported in the area of the LaSalle Station and that several industries stored and/or utilized this chemical at their facilities. At that time, no further analysis was performed to determine whether uninhabitable conditions could be caused in the control room during an accidental release of anhydrous ammonia. Instead, to expedite the licensing of the plant, redundant ammonia detectors were provided on each outside air intake of the control room.

During January, and May of 1986 another survey was conducted to supplement the 1975 data. The purpose of the second survey was to gather additional data needed to perform quantitative analyses of the LaSalle Station control room habitability and exposure risk due to accidental release of anhydrous ammonia. Two distinct types of analyses were performed. The first analysis evaluated the dispersion of the vapor released from a postulated accident and its subsequent infiltration into the control room. The second analysis determined the probability that uninhabitable conditions in the control room could be caused by accidents involving the transportation of anhydrous ammonia and ammonia stored at nearby locations. The probability analysis considered the statistical data pertaining to accidents for a given mode of transportation, pertinent storage conditions, and the meteorological parameters that would be required to cause the development of toxic concentrations in the control room.

In January of 1987 another survey was conducted to determine the potential usage of anhydrous ammonia on the leased farm lands within the station property boundaries.

Finally, during June through September of 1987, a survey was conducted to determine the potential shipments of ammonia through routes along the immediate vicinity of the station.

The following sections describe the Regulatory Guides which form the basis of the control room habitability evaluation, the survey of ammonia shipments around and within the LaSalle Station, the analysis of the habitability of the control room, and the conclusion reached regarding ammonia as a hazard. It is concluded that the toxic hazard created by the accidental release of ammonia in the vicinity of the LaSalle County Station is not a significant risk to the safe operation of the station.

2.0 REGULATORY GUIDES

Regulatory Guide 1.78 identifies anhydrous ammonia as a hazardous chemical and requires a control room habitability analysis in case there is an accidental ammonia release from stationary or mobile sources near the plant. It also provides a methodology for analyzing the effects of an ammonia release.

Regulatory Position 1 of Regulatory Guide 1.78 states that ammonia stored or situated at distances greater than five miles from the control room need not be considered in evaluating habitability of the nuclear power plant control room during a postulated ammonia release. Regulatory Guide 1.78 also specifies the frequency, distance, and quantity of chemicals transported or stored with respect to the control room that require a control room habitability analysis.

In order to establish the design basis events for a plant, Section 2.2.2.2 of Regulatory Guide 1.70 (Reference 2) requires identification of hazardous and toxic chemicals processed, stored or transported in the vicinity of the site. It further requires consideration of all facilities and activities within five miles of the plant and inclusion of facilities and activities at greater distances as appropriate to their significance. For evaluation of potential accidents, Section 2.2.3.1 of Regulatory Guide 1.70 defines the design basis events external to the nuclear plant as those accidents that have a probability of occurrence on the order of about 10^{-7} per year or greater and have potential consequences serious enough to affect the safety of the plant to the extent that 10CFR Part 100 of the guidelines could be exceeded. For toxic chemicals, the Regulatory Guide requires consideration of accidental releases of these chemicals from onsite storage facilities and nearby mobile and stationary sources. These toxic chemical concentrations determined for a spectrum of meteorological conditions then should be used in evaluating control room habitability according to Regulatory Guide 1.78.

Sections 2.2.1 and 2.2.2 of the Standard Review Plan, NUREG-0800 (Reference 3) requires a review of identified hazardous material which are stored and/or transported in accordance with Regulatory Guide 1.78. The review procedures require identification of facilities and activities within eight kilometers (5 miles) of the plant. Facilities and activities at greater distances should be considered if they otherwise have the potential for affecting the plant safety-related features.

As part of its acceptance criteria, Section 2.2.3 of the Standard Review Plan (SRP) provides a probability criteria for determining if a toxic release need be considered a design basis event. Specifically, it states:

> The probability of occurrence of the 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 is practicable. In addition, because of the low probabilities of the events under consideration, data are often not available to permit accurate calculation of probabilities. Accordingly, the expected rate of occurrence of potential exposures in excess of the 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.

As part of its review procedures, Section 2.2.3 of the SRP states:

> Similarly, special attention should be given to the review of a site where several man made hazards are identified, but none of which, individually, has a probability exceeding the acceptance criteria stated herein. The objective of this special review should be to assure that the aggregate probability of an outcome that may lead to unacceptable plant damage meets the acceptance criteria of Subsection II of this SRP section.

3.0 SUMMARY OF AMMONIA SHIPMENTS AROUND LASALLE

3.1 1975 Survey of Ammonia Shipment

The LaSalle County Station Updated Final Safety Analysis Report (UFSAR), Section 2.2.1, describes the location of the plant site and the transportation routes near the site. The UFSAR Sections 2.2.1 and 2.2.2 describe the nearby industrial, transportation, and military facilities. All industrial facilities are located outside of a five mile radius of the plant; therefore, ammonia used or stored at these facilities need not be considered in evaluating the control room habitability. A survey was conducted in 1975 to determine the shipment of ammonia to these industries by the three modes of transportation, namely highways, railroads and waterways. The U.S. Highway 6 and State Highway 47, are the nearest highways to the station and the Chicago Rock Island and Pacific, the nearest railroad, are all located farther than five miles from the station. Therefore, transportation of ammonia by these two modes of transportation was not considered in the control room habitability analysis.

The UFSAR Section 2.2.2.4 describes the river traffic on the Illinois River. Section 2.2.3.1.C of the UFSAR concluded that the only transportation route carrying ammonia within five miles of the station is the Illinois River, which is located approximately 4.7 miles north of the station. A review of the 1974 data on commodities transported on the Illinois River (UFSAR Table 2.2-4) did not differentiate barge shipments of ammonia from other chemicals.

3.2 1986-1987 Surveys of Ammonia Shipment

These surveys were conducted between January 1986 and September 1987. The purpose of these surveys was to gather additional data needed to perform quantitative analyses of the control room habitability and exposure risk due to accidental release of anhydrous ammonia. Each mode of transportation was evaluated with regard to the frequency and volume of ammonia shipments within 5 miles of the plant. These surveys included carriers, river terminals, and end-users as a means of accounting for all ammonia movement in the area. Agricultural and industrial storage and utilization of ammonia within and beyond 5 miles of the plant were also incorporated in the data base.

The following government agencies were contacted for information concerning the shipment of ammonia:

1. U.S. Coast Guard, (Hazardous Chemical Branch), Chicago, Illinois and Washington, D.C.
2. U.S. Army Corps of Engineers, Rock Island, Illinois.
3. Illinois Department of Transportation, Water Resources Division.
4. LaSalle County Chamber of Commerce.
5. Lockmasters at Marseilles, Illinois.
6. Lockmasters at Dresden Island, Illinois.
7. Illinois Department of Agriculture, Division of Plant Industries and Consumer Services.

In addition, the following companies and organizations including users and distributors of anhydrous ammonia were contacted for information:

1. The Illinois Fertilizer and Chemical Association
2. University of Illinois Agriculture Cooperative Extension
3. Seneca Port Operating Authority
4. Kendall-Grundy Fertilizer Supply
5. Walter Seed and Fertilizer, Inc.
6. LaSalle Fertilizer Supply
7. DuPont Industries
8. CF Industries
9. Kaiser Agricultural Chemicals
10. Beker Industries
11. Olin Chemical Company
12. Borg-Warner Corporation
13. Agri Company
14. Conti-Carriers and Terminals
15. Brent Towing Company
16. Southern Towing Company

17. Port Arthur Towing Company

18. Grow Mark Cooperative

19. Mazon Farm Elevator Co.

20. Crop Production Service

21. Ransom Fertilizer Service

Since the nearest railroad (Chicago Rock Island & Pacific) is more than 5 miles from the LaSalle County Station, it was not surveyed for this analysis.

3.2.1 Transportation of Ammonia on Roadways

Regarding the shipment of ammonia on highways, the survey revealed that U.S. Highway 6 and 51, and Interstate 80 and Illinois State Highways 17, 18, 23, 47 and 170 may be used to transport ammonia in tank trucks. These highways except for State Highway 170 are more than 5 miles away from the LaSalle County station and need not be further evaluated. State Highway 170 is 3.2 miles east of the nearest control room air intake and transportation of ammonia on this highway had to be further evaluated.

The other road traffic of anhydrous ammonia within 5 miles is due to the transportation of farm fertilizer containers by local farmers. These containers, each having a capacity of approximately 6,350 pounds, are taken from distribution centers located outside the 5 mile radius of concern and driven over local roads to area farms. The containers have a capacity of either 1,000 gallons or 1,450 gallons and it is possible to pull two in tandem. The nearest location of such a tank, on a local road or farm, was determined to be approximately one half mile from the control room (Reference 4). Also, approximately 300 acres of land within the station property boundary are leased to farmers. Currently, these farmers use 28% granular nitrogen to fertilize the leased lands. However, the possibility of using anhydrous ammonia does exist. In the event anhydrous ammonia were to be used, a maximum of 10 containers would be transported on County Road 6 to the fields via the station service road. It is expected that the entire contents of each tank would be utilized within 24 hours of delivery and that application of anhydrous ammonia would probably occur sometime during April and/or mid October (Reference 5).

In order to determine what other type of traffic exists on County Road 6, the LaSalle County Highway Department was contacted. County Road 6 has been posted for load limitations of 12 tons during spring and 27 tons during summer (Reference 6). Tank trucks hauling ammonia to dispatch centers carry 18-20 tons of ammonia and weigh approximately 36-48 tons gross. Therefore transportation of ammonia on County Road 6 was prohibited

(Reference 6). However, in May of 1987, based on a decision of the LaSalle County Board, the weight restrictions on County Road 6 were lifted for a year (May 15, 1987 - January 15, 1988) on an experimental basis. It is possible that the weight restrictions may be permanently lifted if no deterioration of the road occurs (Reference 7).

A list of distribution centers (retailers of anhydrous ammonia) within a 25-mile area of the station covered by several counties: LaSalle, Grundy, Livingston, Marshall, Kankakee, Putnam and Will, was obtained from the Illinois Department of Agriculture. These were identified on the Illinois Highway map. The primary wholesale suppliers of ammonia were also identified. These are Grow Mark, Kaiser Agricultural, CF Industries, and W. R. Grace Company. A description of Kaiser Agricultural and CF Industries operation is presented in Sections 3.2.2 and 3.2.3. Grow Mark, a farm cooperative receives its ammonia supply from the CF Industries which in turn leases ammonia storage tanks from the Seneca Port Authority. Kaiser Agricultural supplies ammonia to distribution centers within 100-miles of its storage facility covering Illinois and Wisconsin. Tank trucks fill up at the terminal storage facilities (CF Industries/Seneca Port, and Kaiser Agricultural) and service storage tanks located at the distribution centers. The storage tank sizes at the local distribution centers range between 18,000 to 30,000 gallons. None are located within a 5 mile radius of the LaSalle Station.

Based on the location of the distribution centers, conversations with the wholesale and retail suppliers (References 8, 9, 10, 11, 12, 13, 14 and 15), it was determined that anhydrous ammonia is primarily shipped on Interstate 80, U.S. Highways 6, and 51 and Illinois Highways 17, 18, 23, 47 and 170. Walter Seed and Fertilizer, Inc stores ammonia in a 30,000 gallon tank at Grand Ridge, and is located 8.2 miles west of the station on the County 6 Road. The principal sources of its yearly 50 shipment (15 tons each) of ammonia supply are W.. R. Grace Company, located in Henry, Illinois on Illinois Highway 18, approximately 35 miles southwest of the station and Kaiser Agricultural approximately 5 miles north east of the station. Of the 50 yearly shipments, 16-17 shipments of ammonia are provided by Kaiser Agricultural. Ammonia to Walter Seed and Fertilizer site is hauled on via U.S. 6 and Illinois 23 from Kaiser Agricultural. However, since County Road 6 is not posted anymore, ammonia could be transported on County Road 6 (Reference 15). No other potential path could be determined which would use County road 6 to transport ammonia.

3.2.2 Transportation of Ammonia on Water Ways

In order to determine the frequency and quantity of anhydrous ammonia transported by barge on the Illinois River in the vicinity of the LaSalle Station, all major industries and barge transportation companies were contacted to gather pertinent

information. Furthermore, information regarding terminals located along the river between the locks and dams at Marseilles and Dresden Island was reviewed to account for those ammonia shipments passing by the site destined for delivery outside the 5 mile radius.

Anhydrous ammonia is generally shipped by barge in specially constructed refrigerated cylinders (Reference 16). The normal cargo size of these barges ranges between 2400 and 2800 tons with two cylinders per barge (Reference 17). DuPont and CF Industries each receive ammonia in special 3600-ton barges which unload at the Seneca Port Authority terminal (Reference 18).

Exhibit 1 is a presentation of anhydrous ammonia users and distributors and annual barge shipments in the vicinity of the LaSalle County Station. The Marseilles Lock and Dresden Lock statistics for 1984 are also shown on this exhibit. It can be seen that the normal annual tonnage of ammonia shipped by the surveyed transportation companies (310,500 tons) compares very well with the Marseilles lock annual tonnage for 1984 (308,800 tons). The calculated average cargo weight of 2566 tons (310,500/121) carried by barges on the Illinois River also compares very well with the normal cargo weight ranging between 2400 and 3600 tons carried by the ammonia barges.

3.2.3 Storage of Ammonia Near LaSalle Station

A survey of terminals along the Illinois river within 5 miles of the station indicated that there were very few major storage sites for anhydrous ammonia. Exhibit 2 lists the docks and anchorage facilities on the Illinois River near the station. This exhibit updates Table 2.2-2 of the UFSAR. The exhibit lists dock and anchorage facilities between river miles 244 and 254. Only those terminals located between river miles 248 and 253 are within 5 miles of the control room. Kaiser Agricultural Chemical Company, which stores or utilizes anhydrous ammonia, is located outside the five mile radius of the control room. However, according to Kaiser (Reference 19), it maintains two refrigerated storage tanks containing anhydrous ammonia within the 5 mile radius of the LaSalle control room. One of these tanks is 20,000 tons capacity and the other is 22,500 tons capacity. The Seneca Port Authority (located at river mile 253.8, outside the 5 mile radius of the control room) maintains a 30,000 ton refrigerated tank and meters out ammonia to DuPont and CF industries.

3.2.4 Summary of 1986-1987 Survey Results

The results of the 1986-1987 surveys indicate the following:

1. Shipment of anhydrous ammonia on highways (U.S. Highways 6 and 51, Interstate 80, and State Highways 17, 18, 23 and 47) and the nearest railroad Chicago Rock Island & Pacific need not be considered in the LaSalle County Station control room

habitability analysis. These highways and railroad are more than 5 miles away from the control room.

2. Shipment of ammonia on State Highway 170 should be considered as it is 3.2 miles east of the LaSalle Station and does have ammonia shipping on it.

3. The nearest public road, County Road 6, is approximately 2560 feet away from the nearest air intake of the control room. Shipments of ammonia in farm fertilizer containers (6350 lbs) and tank trucks (18-20 tons) on County Road 6 need to be considered in the analysis.

4. The nearest station service road that could be used to transport the farm fertilizer containers is approximately 550 feet away from the nearest air intake of the control room; ammonia containers carrying approximately 6350 lbs of ammonia need to be considered in the analysis.

5. A total of 10 farm fertilizer containers may be used in a year on the leased lands with one container remaining at the site for one day. This should be considered.

6. A shipment of approximately 310,500 tons by 121 barges on the Illinois River is representative of an annual barge shipment of anhydrous ammonia in the vicinity of the LaSalle County Station. The ammonia is shipped in specially constructed refrigerated cylinders and the maximum carrying capacity of one cylinder is 1800 tons. This should be considered.

7. Storage of ammonia in two tanks maintained by Kaiser should be considered as these are located within 5 miles of the LaSalle Station.

8. A tank maintained by the Seneca Port Authority is located more than 5 miles away from the plant. However, it should be considered due to the quantity to ammonia stored in the tank.

4.0 DISPERSION ANALYSIS AND CONTROL ROOM INFILTRATION IN ACCORDANCE WITH REGULATORY GUIDE 1.78

Regulatory guide 1.78 states in C.2 that "If hazardous chemicals such as those indicated in Table C-1 are known or projected to be frequently shipped by rail, water, or road routes within a five-mile radius of a nuclear power plant, estimates of these shipments should be considered in the evaluation of control room habitability...Shipment are defined as being frequent if there are 10 per year for truck traffic, 30 per year for rail traffic, or 50 per year for barge traffic." Based on this, barge traffic on the Illinois River and truck traffic on state highway 170 and County Road 6 need be considered.

In paragraph C.4 the regulatory guide states; The toxicity limits should be taken from appropriate authoritative sources such as those listed in the References section. For each chemical considered, the values of importance are the human detection threshold and the maximum concentration that can be tolerated for two minutes without physical incapacitation of an average human (i.e., severe coughing, eye burn, or severe skin irritation). The latter concentration is considered the "toxicity limit." Based on this the human detection threshold for ammonia is 10 ppm and the toxicity limit is 100 ppm.

In paragraph C.5 regulatory guide 1.78 states; Two types of industrial accidents should be considered for each source of hazardous chemicals: maximum concentration chemical accidents and maximum concentration-duration chemical accidents.

For a maximum concentration accident, the quantity of the hazardous chemical to be considered is the instanteous release of the total contents of one of the following: (1) the largest storage container falling within the guidelines of Table C-2 and located at a nearby stationary facility, (2) the largest shipping container (or for multiple containers of equal size, the failure of only one container unless the failure of that container could lead to successive failures) falling within the guidelines of Table C-2 and frequently transported near the site, or (3) the largest container stored onsite. Maximum concentration accidents were analyzed for items 1 and 2. No ammonia is stored onsite.

Maximum concentration-duration accidents were not analyzed as they were judged to fall easily within the bounds of a maximum concentration accident and pose no additional threat to the LaSalle control room.

In paragraph C.7 it is stated that "The detection mechanism for each hazardous chemical should be considered. Human detection may be appropriate if the buildup of the hazardous chemical in the control room is at a slow rate due to slow air turnover." And that "The time required for buildup of a hazardous chemical from the detection concentration to the toxicity limit should be considered."

4.1 Barge Transportation

Based on the requirements of Regulatory Guide 1.78, an analysis was performed considering a complete rupture of a non-refrigerated 1800-ton ammonia carrier barge which instantly releases its contents. Upon release, aproximately 21% flashes immediately to vapor. The remainder is a liquid at -25°F, which gradually boils off by transfer of heat from the environment.

The flashed vapor constitutes the principal hazard to the station. The dispersion and propagation to the LaSalle site is predicted in accordance with methods described in Regulatory Guide 1.78. The stability class considered is Pasquill, Type F, which results in control room concentrations which would be exceeded in less than 5% of all occurrences.

Exhibit 3 describes the basis of the analysis and the results from the release from a barge on the Illinois River. The control room air exchange rate used in the analysis is that of a control room in the non-isolated mode. According to Regulatory Guide 1.78, this control room is classified as a Type C control room. Exhibit 4 shows the results of the dispersion analysis as the rise in concentration with respect to time. According to this analysis, a response time that is rapid enough to avoid exposure to toxicity limitation is less than 48 seconds. According to Regulatory Guide 1.78 Table C-1, the concentration level for anhydrous ammonia is 100 ppm. Exhibit 3 shows that the concentration would reach 480 ppm two minutes after the presence of the chemical in the control room becomes noticeable by its odor to personnel. Based on this determination that maximum concentrations would be exceeded if an accident occurred, it was determined necesary to perform a probability analysis to show that accidental releases of ammonia are not a design basis event (see Section 5.0).

4.2 Highway Transportation

As noted in the 1987 survey, tank trucks transport ammonia on State Highway 170 and a potential to transport ammonia on County Road 6 exists.

State Highway 170 is located 3.2 miles east of the nearest LaSalle County station control room air intake. Using interpolation method provided in Appendix A and Table C-2 of Regulatory Guide 1.78, it was determined that tank trucks carrying less than 34.7 tons of ammonia on Highway 170 would not require a control room habitability evaluation for the LaSalle County Station. The maximum weight of ammonia carried by tank trucks on Highway 170 is 20 tons. Therefore, transportation of ammonia on Highway 170 does not impact LaSalle County Station control room habitability.

As noted in the 1987 survey, tank trucks carrying approximately 18 to 20 tons of anhydrous ammonia could use County Road 6 in transporting ammonia from Kaiser Agricultrual to Grand Ridge distribution center. Dispersion analysis shows that the 2-minute toxicity limitation level of 100 ppm would be exceeded due to an accidental release of tank truck contents on County Road 6. Therefore, a probability analysis was undertaken to show that accidental releases of ammonia from tank trucks are not a design basis event based on probability (see Section 5.0).

Exhibit 5 shows the control room concentration that could be caused by an accidental release of anhydrous ammonia from a 1450 gallon farm fertilizer container on County Road 6. The nearest location of the fertilizer container on this road, is considered in this analysis. The container size assumed is the largest size identified for this application. The concentration in the control room is found to be less than the toxicity limit.

Exhibit 6 shows the control room concentration that could be caused by an accidental release of anhydrous ammonia from a 1450 gallon farm fertilizer container on the station service road. Exhibit 7 shows the results of the dispersion analysis as the rise in concentration with respect to time. The maximum concentration shown in Exhibit 7 exceeds the 2-minute toxicity limit

100 ppm. Therefore, a probability analysis was undertaken to show that accidental releases of ammonia on the station service road and the leased farm lands are not a design basis event (see Section 6.0).

5.0 PROBABILITY OF CAUSING UNINHABITABLE CONDITIONS IN THE CONTROL ROOM BY ACCIDENT INVOLVING BARGE TRANSPORTATION

The dispersion analysis shows that the calculated ammonia concentration in the unisolated control room is 480 ppm at 2 minutes after the odor is detected. The dispersion analysis is based on a complete rupture of a 1800-ton ammonia container and the consequent release of the entire content. The toxic level specified in Regulatory Guide 1.78 is 100 ppm. However, the Standard Review Plan and Regulatory Guide 1.70 provide criteria for acceptance based on probability calculation. An exposure risk of 10^{-7} applies when the calculation is performed with realistic assumptions. With conservative assumptions, the risk of 10^{-6} applies.

A probability analysis was performed by the following method. Statistical meteorological data for the LaSalle site (33-foot level) were used which consisted of occurrence probabilities of stability class, wind direction and wind magnitude (Reference 26). Exhibit 8 shows the orientation of the wind direction sectors of the meteorological data with respect to the Illinois River and the LaSalle County Station. The probability that the control room could be made uninhabitable is calculated from the probability of an accident within each sector, the probability that the wind had a direction which would carry released vapor to the control room and that the stability classes were E, F, or G. Under these stability classes, the control room was found to be uninhabitable based on the diffusion analysis described in Regulatory Guide 1.78. Only the portion of the river within a distance of 5 miles from the station was considered it this analysis according to Regulatory Guide 1.78.

Exhibit 9 shows the computations performed and the exposure risk per barge shipment. In Exhibit 9, numerical values are given for the occurrence probabilities of wind direction and stability class for each sector and the length of the river in each sector. The probability of control room uninhabitability per shipment is calculated by the summation of the contribution made by each sector and stability class. For a total of 121 shipments per year a risk exposure level of 3.15×10^{-7} per year is estimated (Exhibit 9). The barge accident statistic was obtained from Reference 33 and the meteorological data was obtained from Reference 26.

The results of the probability calculation show that the LaSalle County Station control room will remain habitable for up to 121 barge shipments of ammonia on the Illinois River for an acceptable exposure risk of 3.15×10^{-7} per year.

6.0 PROBABILITY OF CAUSING UNINHABITABLE CONDITIONS IN THE CONTROL ROOM BY ACCIDENT INVOLVING COUNTY ROAD 6, STATION SERVICE ROAD AND LEASED FARM LANDS

Three probability analyses were performed. These involved accidents on County Road 6, station service road and those involving farm fertilizer containers on the leased lands.

6.1 Accidents on County Road 6

It was conservatively assumed that all the 50 annual tank truck shipment of ammonia to the Grand Ridge distribution center from Kaiser Agricultural located at Seneca occur on County Road 6. The probability that the control could be made uninhabitable was calculated from the probability of an accident on County Road 6 under all stability classes and within the wind sectors covered by a five mile radius. Exhibit 10 shows computation performed. The results of the probability calculation show that at an exposure risk of 8.435×10^{-7} per year the control room will remain habitable if there were any releases from these tanks.

6.2 Accidents on Station Service Road

It was conservatively assumed that all the 10 farm fertilizer containers either pulled by tractors or pickup trucks are transported on the service road and these containers travel the entire length of service road. Although these can be pulled in tandem, it was assumed that 10 trips are made on this road every year. Wind direction sectors and the meteorological data with respect to this road and the control room were ignored in this probability analysis to conservatively estimate the accident probability. Exhibit 11 shows the computations performed and the exposure risk per truck shipment. For a total of 10 shipments per year a risk exposure level of 2.7×10^{-7} per year is estimated.

These results show that the LaSalle County Station control room will remain habitable for up to 10 shipments of ammonia on the station service road for an acceptable exposure risk of 2.7×10^{-7} per year.

6.3 Accidents on Leased Land

The probability that the control room could be made uninhabitable was calculated from the probability of an accident on leased land under all stability classes and within all wind sectors. It was assumed that a total of 10 farm fertilizer containers are utilized in a year and that each container remains on leased lands for one day. Exhibit 11 shows such computations performed. The results of the probability calculation show that at an exposure risk of 2.74×10^{-7} per year, the control room will remain habitable if there were any releases from these containers.

7.0 PROBABILITY OF CAUSING UNINHABITABLE CONDITIONS IN THE CONTROL ROOM BY ACCIDENT INVOLVING OFFSITE AMMONIA STORAGE TANKS

The Regulatory Guide 1.70 and the SRP require a review of facilities and activities at distances greater than 5 miles if they otherwise have the potential of affecting the control room habitability. As indicated above, the Kaiser Agricultural Chemical Company stores anhydrous ammonia in two refrigerated tanks (20,000 and 22,500 tons). These tanks are located on the fringes of the 5 mile radius. The Seneca Port Authority also stores 30,000 tons of ammonia in a refrigerated tank at river mile 253.8 mile, is approximately 5.75 miles from the plant.

A probability risk analysis was performed for these tanks. As before, the analysis is based on a complete rupture of the tanks and consequent release of the entire content. Statistical meteorological data for the LaSalle site (33-foot level) were used which consist of occurrence probabilities of stability class, wind direction and wind magnitude (Reference 26). The Kaiser tanks and Seneca tank are located North and NE of the plant, respectively. The probability that the control room could be made uninhabitable was calculated from the probability of an accident within each sector and the probability that the wind had a direction which would carry released vapor to the control room under all stability classes (A, B, C, D, E, F & G).

Exhibit 12 shows such computations performed. The results of the probability calculation show that at an exposure risk of 1.1×10^{-6} per year, the control room will remain habitable if there were any releases from these tanks.

8.0 AGGREGATE PROBABILITY OF CAUSING UNINHABITABLE CONDITIONS IN THE CONTROL ROOM BY ACCIDENT INVOLVING AMMONIA RELEASES

The aggregate acceptable exposure risk to maintain habitable conditions in the control room is the sum of the probability of ammonia releases due to barge accidents, tank truck accidents on County Road 6, offsite storage tank and onsite farm fertilizer container rupture. Exhibit 13 shows that this aggregate probability is 2.85×10^{-6}/year.

9.0 DISCUSSION OF RESULTS

The maximum individual probability of offsite and onsite sources of anhydrous ammonia that could result in uninhabitable conditions in the control room is 8.44×10^{-7} per year (Exhibit 10). Similar aggregate probabilities of these sources are 2.85×10^{-6} per year.

These probabilities are acceptable, if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The use of this probability assessment is conservative and the realistic probability can be shown to be lower because of the following conservatisms:

1. Ammonia when spilled on water produces a buoyant plume of ammonia vapor. On the basis of spill studies of liquid ammonia on water and

corresponding numerical models developed (Reference 27), the height of rise of ammonia plume can be predicted. The height of rise of an ammonia plume due to a 1800-ton spill at a distance where the plant is located is estimated to range between 700 and 5000 feet depending upon atmospheric stability conditions. These heights of rise are based on the wind velocity which results in maximum control room concentration of ammonia. Therefore, any ammonia plume released due to barge accidents may not affect the control room air intake which is located approximately 370 feet above the normal river elevation.

2. The probability of causing uninhabitable conditions due to release of ammonia from the refrigerated storage tank is shown in Exhibit 12. This is based on accidents involving complete rupture and subsequent release of the entire tank contents. This calculation also assumed that all stability classes would be sufficient to able to cause the control room to become uninhabitable. (See Section 7.0)

   Since ammonia is stored in refrigerated tanks at atmospheric pressure there is less likelihood that the entire contents of the tank will become airborne. Assuming a partial release of ammonia (10%) from the refrigerated Kaiser Agricultural Chemical tanks (20,000 and 25,000 tons) and Seneca Port Authority tanks (30,000 tons), the probability of causing uninhabitable conditions will be 2.0×10^{-7} per year and 1.62×10^{-7} per year, respectively (Exhibit 14). This new probability is based on stability Classes E, F and G only, rather than all stability classes considered in the analyses described in Section 7.0 and shown in Exhibit 12.

3. The assumption that tank trucks carry the full annual demand of anhydrous ammonia from Seneca to Grand Ridge on County Road 6 is conservative. Realistically, only the shipments from Kaiser Agricultural would be expected to occur (16-17 vs. 50). This would result in an accident probability of 2.81×10^{-7}/year. Additionally, according to wholesale suppliers of ammonia, the instructions to truck drivers have instructions not to transport ammonia on County roads because conditions on these roads are poor and that due to movement of farm equipment, and other traffic, transit time is quite longer on these roads than use of state highways (Reference 28).

4. The new aggregate probability considering accidents for barges, storage tanks, tank trucks on County Road 6, farm fertilizer containers on service road and the leased land is 1.50×10^{-6}/year (Exhibit 15).

5. No credit was taken for operator incapacitation events that would not result in exposures in excess of 10 CFR 100 guidelines. This analysis conservatively assumed that all such events resulted in an overexposure. There is precedent for assuming that only one out of ten operator incapacitation events would result in an overexposure and that a conservative factor of 10 could be applied to the calculated aggregate probability (Reference 29). The resultant new probability is 1.5×10^{-7}/year.

6. In a study conducted to evaluate spill hazards associated with the modal transport of hazardous materials, it was found that the expected annual exposure rate associated with the entire shipment of a substance by one mode was generally the lowest for barge and that the barge mode of transport is better inspected and regulated from a safety point of view (Reference 30). In a similar study, it was concluded that for 9 hazardous chemicals, that transport by barge is safest for 6 chemicals including anhydrous ammonia. (Reference 31).

7. The probability of causing uninhabitable conditions due to the release of ammonia from farm fertilizer containers on the station service road and from land on the station site which is leased for farming assumes that every release exceeds toxicity concentrations in the control room. If meteorological conditions of wind direction and atmosphere stability were considered in this part of the analysis, a smaller exposure risk to the control room would have been predicted.

10.0 CONCLUSIONS

An evaluation of transportation of ammonia and the impact of accidents on the LaSalle County Station per Regulatory Guide 1.78 indicates that ammonia toxicity limits can be exceeded in the control room in some instances. The aggregate probability of causing uninhabitable conditions at the LaSalle County Station control room has been calculated to be 2.85×10^{-6}/year as shown in Exhibit 13. It should be noted that a major portion of this probability is due to accident probabilities associated with offsite storage tanks owned by Kaiser Agricultural Chemical and Seneca Port Authority. This calculation is based on conservative assumptions. However, as discussed in Section 9.0, when the conservatism in the calculated probability is removed by reasonable assumptions, the exposure risk becomes 1.5×10^{-7}/year (Exhibit 14). The probabilities are shown to be of the same order of magnitude as the probability criteria specified by NUREG-0800. Therefore, the toxic hazard posed by the accidental releases of ammonia in the vicinity of the LaSalle County station is not considered a significant risk to the safe operation of the station.

11.0 REFERENCES

1. U.S. NRC Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," June 1974.

2. U.S. NRC Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 3, November 1978.

3. U.S. NRC Standard Review Plan NUREG-0800, Revision 2, July 1981.

4. Bill Woessner, County Agent, University of Illinois Agriculture Extension Service, in a telephone conversation with Sargent & Lundy Engineers, February 14, 1986.

5. John Schuh, Commonwealth Edison Company, Farm Leasing Manager, Real Estate Department, in conversations with Sargent & Lundy Engineers, December 18, 1986 and January 6, 1987.

6. William Stromwell, Supervisor, LaSalle County Highway Department, in telephone conversation with Sargent & Lundy Engineers, June 3, 1987.

7. Steven Schoff, Maintenance Foreman, LaSalle County Highway Department, in telephone conversation with Sargent & Lundy Engineers, June 22, 1987.

8. Larry Humble, Member Services Administrative Director, Grow Mark, Bloomington, Ill. in a letter dated August 14, 1987 to S. C. Mehta, Sargent & Lundy Engineers.

9. Glen McDonald, Plant Operations Manager, Seneca Port Authority, in telephone conversation with Sargent & Lundy Engineers, June 19, 1987.

10. Rick, Manager, LaSalle County Farm Supply, Streater, Ill., in telephone conversation with Sargent & Lundy Engineers, September 15, 1987.

11. Pat Mino, Manager, Mazon Farm Elevator Co., Mazon, Ill., in telephone conversation with Sargent & Lundy Engineers, September 15, 1987.

12. Mike Gernatz, Manager, Crop Production Service Blackstone, Ill, in telephone conversation with Sargent & Lundy Engineers, September 15, 1987.

13. Rich Fry, Manager, Ransom Fertilizer Service, Ransom, Ill., in telephone conversation with Sargent & Lundy Engineers, September 15, 1987.

14. Billy Joe Ryan, Plant Operations Manager, Kaiser Agricultural Chemical, in telephone conversation with Sargent & Lundy Engineers, September 16, 1987.

15. John Walters, Owner, Walter Seed and Fertilizer Inc., Grand Ridge, Ill., in telephone conversation with Sargent & Lundy Engineers, September 16, 1987.

16. William Pichocki, Traffic Manager, Olin Barge (Olin Chemical Company), in telephone conversations with Sargent & Lundy Engineers, February 21, 1986, May 5, 1986.

17. Howard Case, Southern Towing Company, in a telephone conversation with Sargent & Lundy Engineers, February 20, 1986.

18. William Stegbauer, Vice President, Operations, Southern Towing Company, in telephone conversations with Sargent & Lundy Engineers, February 20, 1986, May 5, 1986.

19. Billy Joe Ryan, Plant Operations Manager, Kaiser Agricultural Chemical, in a telephone conversation with Sargent & Lundy Engineers, April 23, 1986.

20. Christine Pershey, LaSalle Station Onsite Nuclear Safety Group, in a telephone conversation with Sargent & Lundy Engineers, February 21, 1986.

21. Jim Farley, Jesse Brent, Traffic Dept., Brent Towing Co., in telephone conversations with Sargent & Lundy Engineers, February 21, 1986, May 5, 1986.

22. Dennis Adson, AgriCo., in a telephone conversation with Sargent & Lundy Engineers, February 21, 1986.

23. Kevin Conway, Port Arthur Towing Co., in telephone conversations with Sargent & Lundy Engineers, February 21, 1986, May 5, 1986.

24. U.S. NRC NUREG-0170 (Vol. 1), Final Environmental Statement on the Transportation of Radioactive Material By Air and Other Modes, December 1977.

25. Robert H. Jones, Consultant, San Jose, Calif., in a telephone conversation with Sargent & Lundy Engineers, July 30, 1987.

26. LaSalle County Station Onsite Meteorological Monitoring Data (October 1, 1976 - September 30, 1978) collected by Murray & Trettel for Commonwealth Edison Company.

27. Arthur D. Little, Inc., "Prediction of Hazard of Spills of Anhydrous Ammonia on Water," NTIS AD-779-400, Report to U.S. Coast Guard, March 1974.

28. Larry Humble, Member Services Administrative Director, Grow Mark Bloomington, in telephone conversation with Sargent & Lundy Engineers, August 18, 1987.

29. Duquesne Light Company Report to the Nuclear Regulatory Commission, "Beaver Valley Power Station Control Room Habitability," December 28, 1981.

30. G. R. Angell and A. S. Kalelkar, "The Cost and Relative Spill Hazards Associated with the Model Transport of Hazardous Materials," Proceedings of 1974 National Conference on Control of Hazardous Materials Spills, San Francisco (A.I. ChE. New York, 1976).

31. A. S. Kalelkar, L. J. Partridge, and R. E. Brooks, Jr., "Decision Analysis in Hazardous Material Transportation," Ibid.

32. J. A. Simmons, R. C. Erdmann, and B. N. Naft, "Risk Assessment of Large Spills of Toxic Materials," Ibid.

33. A Modal Economic and Safety Analysis of the Transportation of Hazardous Substances in Bulk. Arthur D. Little, prepared for Maritime Administration, 1974.

EXHIBIT 1

SURVEY OF USERS/DISTRIBUTORS OF ANHYDROUS AMMONIA IN THE VICINITY OF THE LASALLE COUNTY STATION

Anhydrous Ammonia Users	Yearly Tonnage
Seneca Port Authority (Reference 10)	150,000*
Kaiser Agricultural (Reference 19)	67,500**
Total	217,500

Transportation Companies	Frequency (barges/ year)	Tonnage (Tons/ year)
Southern Towing Companies (Reference 18)	68	172,000
Brent Towing (Reference 21)	24	67,500
Olin Barges (Reference 16) (Olin Chemical)	15	36,000
AgriCo (Reference 22)	4	10,000
Port Arthur Towing (Reference 23)	10	25,000
Total	121	310,500

Lock Statistics 1984 (Reference 20)	Nitrogeneous Chemical Fertilizers (Tons)
Marseilles Lock	308,800
Dresden Island Lock	65,300

*Anhydrous ammonia is delivered to Seneca Port Authority and then metered out to DuPont and CF Industries.

Of 150,000 tons received, 30,000 tons is stored in a refrigerated tank and 60,000 tons each is metered out to DuPont and CF Industries respectively (Reference 19).

**Of 67,500 tons received, 45,000 tons is stored in two refrigerated tanks.

EXHIBIT 2

DOCK AND ANCHORAGE FACILITIES ON THE ILLINOIS RIVER NEAR THE SITE

RIVER MILE FACILITY	
244.1	Borg Warner Chemical Co.
247.5	Snug Harbor Boat Club (1)
	small boat launching ramp (1)
247.9	Pittsburgh - Des Moines Steel Co.
248.7	Kaiser Agricultural Chemical (2)
249.8	Beker Industries (3)
252.0	Spring Brook Marina (1)
251.8	Commonwealth Edison
252.7 L	Peavey Grain Co.
252.7 R	Continental Grain Co.
252.8	Seneca Boat Club (1)
	Anchor-Inn Marina (4)
253.0	Anchor Marine, Inc.
253.4	Conti-Carriers & Terminals
253.8	Seneca Port District
253.9	Boat slip (1)

1. small boat launching and docks only

2. Kaiser Aluminum and Chemical replaced Illinois Nitrogen Corp. at this location in 1981. Kaiser Agricultural Chemical is a 1985 spin-off of Kaiser Aluminum and Chemical.

3. The UFSAR Table 2.2-3 indicates that Beker utilized anhydrous ammonia. The 1986-1987 surveys revealed that Beker no longer handles or stores anhydrous ammonia.

4. both small boats and barge facilities

L or R Left or Right River Bank

Source: U.S. Army Engineer District, Corps of Engineers, Chicago, Illinois, Clerk of the Illinois Waterways, From Mississippi River at Grafton, Illinois to Lake Michigan at Chicago & Calumet Harbors, April 1974.

Illinois Department of Transportation, Water Resources Division, Chicago, Illinois from Directory of Lake and River Terminals in Illinois, June 1982.

EXHIBIT 3

CONTROL ROOM HABITABILITY ANALYSIS (BARGE ON ILLINOIS RIVER)

Material spilled	anhydrous ammonia
Weight	1800 tons
Minimum distance from control room	22,700 ft.
Control room air exchange rate (not isolated)	0.8 per hour
Atmospheric Stability Class	F
Ambient air temperature	90°F
Concentration detectable by odor	10 ppm
Toxic concentration (2 minutes after detection)	100 ppm
Maximum calculated concentration at air intake	23300 ppm
Maximum calculated concentration in control room 2 minutes after detection	480 ppm
Wind speed causing maximum concentration in control room	5 m/sec

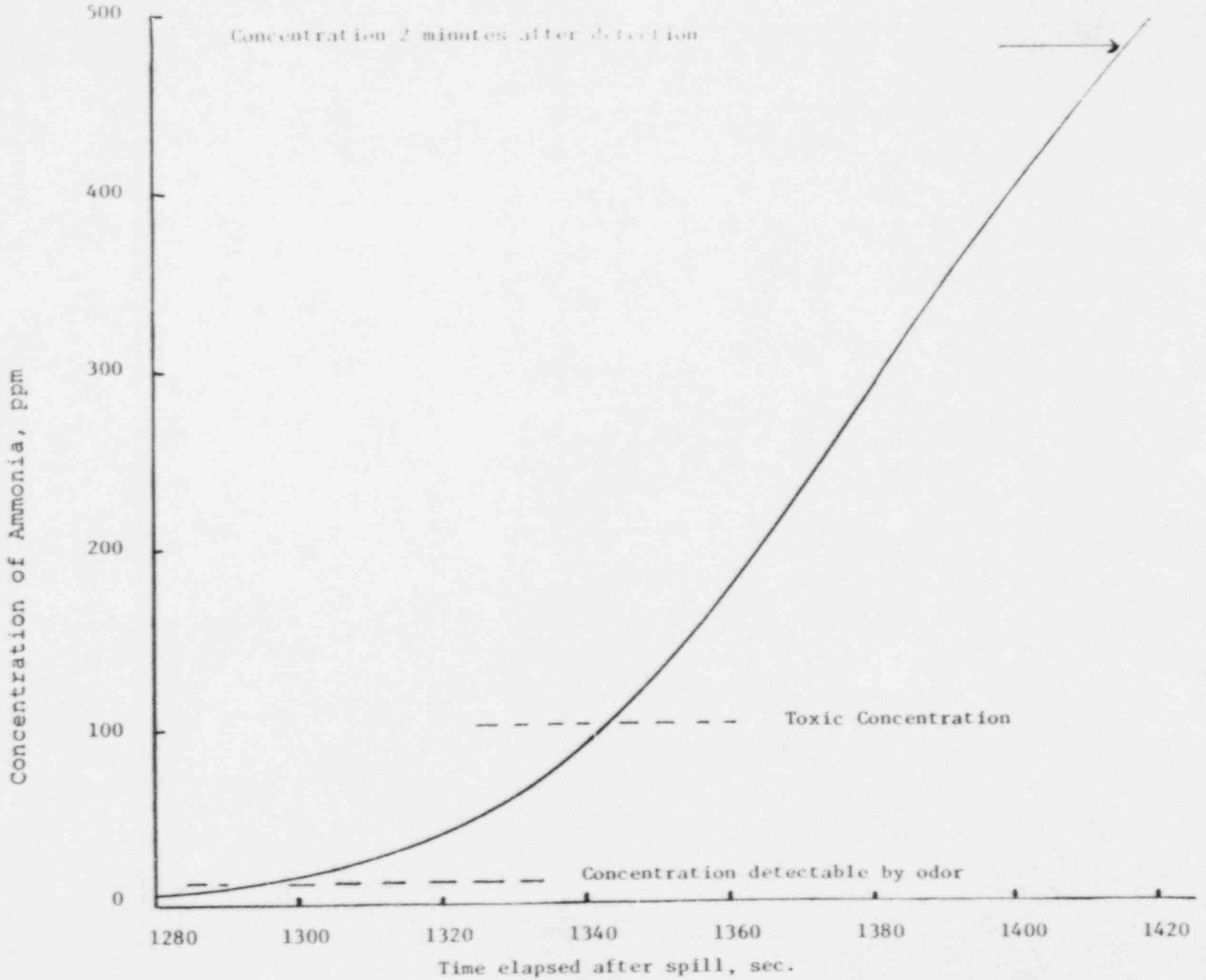

Exhibit 4 Concentration in Control Room after 1800 ton spill of anhydrous ammonia. 5 m/sec wind, F stability.

EXHIBIT 5

CONTROL ROOM HABITABILITY ANALYSIS (COUNTY ROAD 6)

Material spilled	anhydrous ammonia
Weight	6344 pounds
Minimum distance from control room	2560 ft.
Control room air exchange rate (not isolated)	0.8 per hour
Atmospheric Stability Class	F
Ambient air temperature	77.9°F
Concentration detectable by odor	10 ppm
Toxic concentration (2 minute exposure)	100 ppm
Maximum calculated concentration at air intake	4246 ppm
Maximum calculated concentration in control room 2 minutes after detection	99.7 ppm
Wind speed causing maximum concentration in control room	0.55 m/sec

EXHIBIT 6

CONTROL ROOM HABITABILITY ANALYSIS (STATION SERVICE ROAD)

Material spilled	anhydrous ammonia
Weight	6344 pounds
Minimum distance from control room	550 ft.
Control room air exchange rate (not isolated)	0.8 per hour
Atmospheric Stability Class	F
Ambient air temperature	77.9°F
Concentration detectable by odor	10 ppm
Toxic concentration (2 minute exposure)	100 ppm
Maximum calculated concentration at air intake	162,000 ppm
Maximum calculated concentration in control room 2 minutes after detection	2434 ppm
Wind speed causing maximum concentration in control room	0.255 m/sec

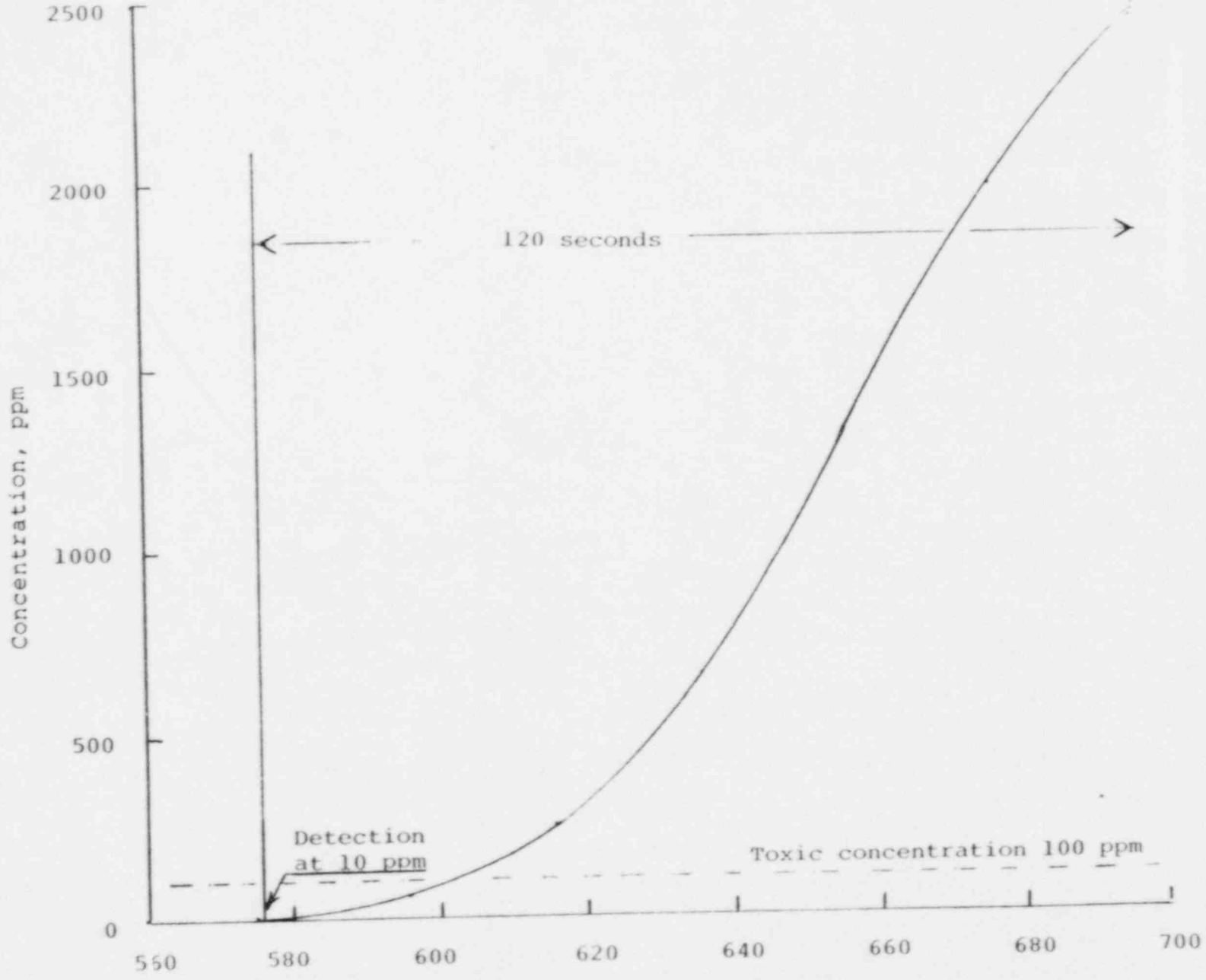

Exhibit 7 Time elapsed after accidental release, seconds
Concentration in control room after accidental release of 6350 lb of Anhydrous Ammonia at 550 ft.

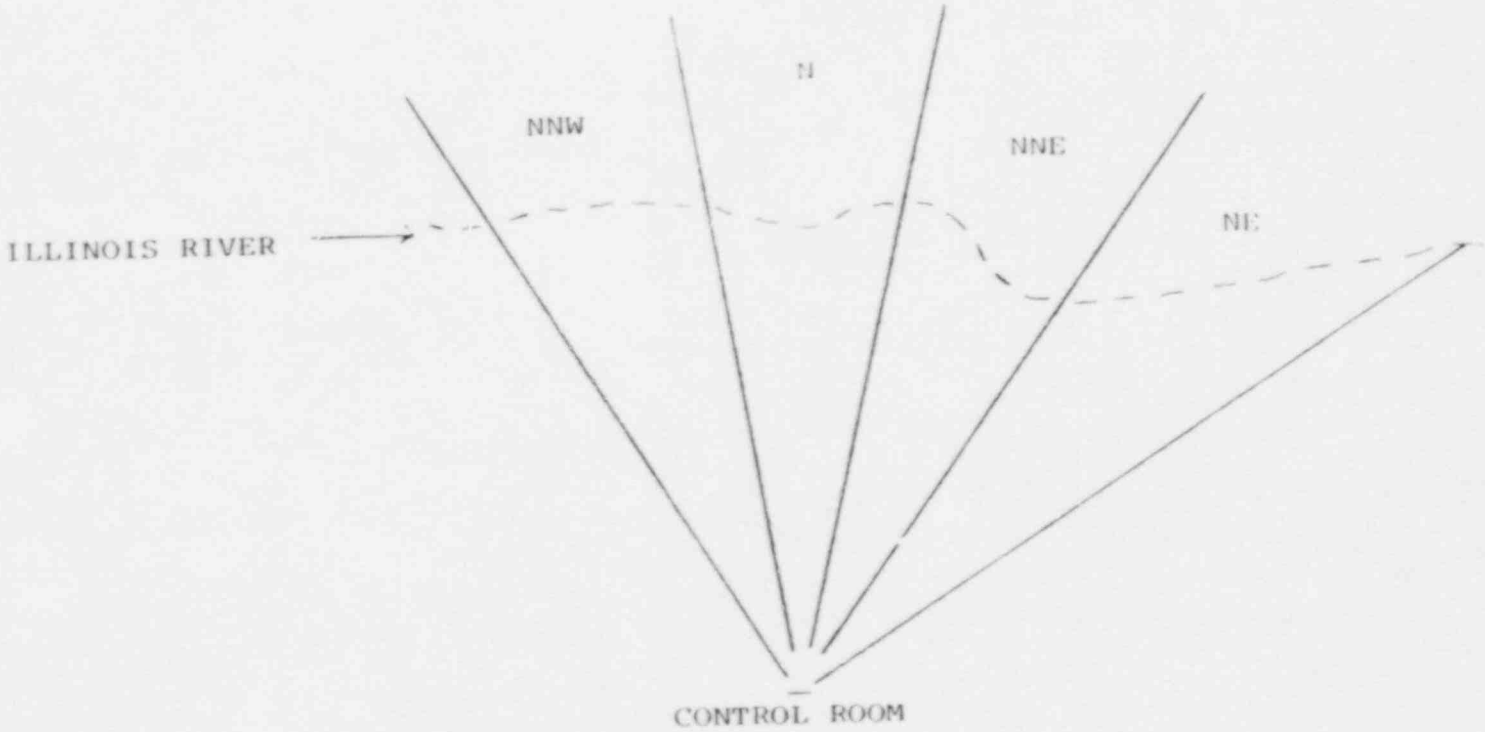

EXHIBIT 8

SCHEMATIC SHOWING RELATIONSHIP BETWEEN
THE ILLINOIS RIVER, WIND SECTORS AND THE CONTROL ROOM

EXHIBIT 9

CONTROL ROOM RISK ANALYSIS FOR BARGE SHIPMENTS OF ANHYDROUS AMMONIA ON THE ILLINOIS RIVER

Wind Sector	Length of river within sector and within 5 miles of site Li (miles)	Probability of occurrence of wind direction and stability class (include all wind speeds) Mi (stability class) E	F	G	Summation of river length and probability by class Σ LixMi (miles)
NNW	0.35	0.0173	0.0037	0.0064	0.00959
N	2.10	0.0072	0.0012	0.0016	0.0210
NNE	1.90	0.0045	0.0009	0.0012	0.01254
NE	0.095	0.0109	0.0030	0.0023	0.01539

(Summation of river length and probability by class and wind sector) Σ LixMi = 0.05852

Probability of control room uninhabitability per barge shipment = Pa x Σ LixMi = 2.6×10^{-9}/shipment where Pa = 4.46×10^{-8} releases/barge mile* (Reference 33)

PROBABILITY OF CONTROL ROOM UNINHABITABILITY DUE TO 121 BARGE SHIPMENTS PER YEAR = $121 \times 2.6 \times 10^{-9}$,
= 3.15×10^{-7}/year

*The accident rate of 5.13×10^{-8} provided in March 6, 1987 submittal (Attachment D) appears in a report "Barge Accident Statistics for Use in Radioactive Materials Transportation Risk Assessments" March 1983, prepared by R. H. Jones, Consultant for the Sandia National Laboratory, Transportation Technology Center. This accident rate was derived using an overall barge accident rate of 6.06×10^{-6}/barge Km (9.753×10^{-6}/barge mile) listed in Table 5-7 of Reference 24 (NUREG-0170).

Mr. Jones was contacted to verify the value of 5.13×10^{-8} listed in his report. Mr. Jones could not confirm this value. However, Mr. Jones calculated a barge accident rate of 2.65×10^{-9}/barge mile in a telephone conversation with Sargent & Lundy Engineers on July 30, 1987 (Reference 25). This was based on accident rate (9.753×10^{-6}/barge mile) and severity fraction (2.722×10^{-4}) listed in NUREG-0170 (Reference 24).

For conservatism, a higher barge accident rate of 4.46×10^{-8}/barge mile for ammonia spills provided in Reference 33 is used for probability calculation.

EXHIBIT 10

CONTROL ROOM RISK ANALYSIS FOR ROADWAY SHIPMENTS OF ANHYDROUS AMMONIA ON THE COUNTY ROAD 6

Wind Sector	Length of road within sector and within 5 miles of site Li (miles)	Probability of occurrence of wind direction and stability class (include all wind speeds) Mi (A B C D E F & G)	Summation of road length and probability by class Σ LixMi (miles)
E	2.20	0.038	0.0836
ESE	2.0	0.0418	0.0836
SE	0.5	0.0459	0.02295
SSE	0.23	0.0464	0.01067
S	0.23	0.0716	0.01646
SSW	0.20	0.0800	0.016
SW	0.50	0.0726	0.0363
WSW	2.10	0.0747	0.15687
W	2.0	0.101	0.202

(Summation of road length and probability by class and wind sector) Σ LixMi = 0.62845

Probability of control room uninhabitability for single tank truck shipment

$$= P_a^* \times \Sigma Li \times Mi = 27 \times 10^{-9} \times 0.62845$$

$$= 1.687 \times 10^{-8} \text{/shipment}$$

PROBABILITY OF CONTROL ROOM UNINHABITABILITY DUE TO 50 TANK TRUCK SHIPMENTS

$$= 50 \times 16.87 \times 10^{-9} \text{/year}$$
$$= 8.435 \times 10^{-7} \text{/year}$$

where $Pa^* = 27 \times 10^{-9}$ accidents/vehicle mile (Reference 33)

EXHIBIT 11

PROBABILITY OF CAUSING UNINHABITABLE CONTROL ROOM CONDITIONS AS A RESULT OF ACCIDENTAL RELEASE OF AMMONIA ON STATION SERVICE ROAD AND LEASED LAND FOR FARMING

Station Service Road

Approximate length of station service road, miles	= 1
No. of vehicles towing ammonia	= 10
Accident failure rate (accidents/vehicle mile) (Reference 33)	$= 27 \times 10^{-9}$
PROBABILITY OF CONTROL ROOM UNINHABITABILITY DUE TO ACCIDENTS ON THE SERVICE ROAD	$= 2.70 \times 10^{-7}$/year

Leased Land

No. of ammonia tanks stored/year	= 10
Length of time each tank remains on premises after delivery, days	= 1
Estimated accident frequency per year (Reference 32)	$= 10^{-5}$
PROBABILITY OF CONTROL ROOM UNINHABITABILITY DUE TO ACCIDENTS ON THE LEASED LAND	$= 2.74 \times 10^{-7}$/year

$(10 \times \frac{1}{365} \times 10^{-5})$

EXHIBIT 12

CONTROL ROOM RISK ANALYSIS FOR POTENTIAL ACCIDENTS INVOLVING STATIONARY SOURCES

Source	Kaiser Agricultural Chemical	Seneca Port Authority
Quantity	1 - 20,000 ton tank 1 - 25,000 ton tank	30,000 tons
Distance from LaSalle Station	5 miles	5.75 miles
Wind Sector	N	NE
Probability of wind blowing from sector (all stability classes & wind speeds)	0.0334	0.0487
Estimated accident frequency per year (Reference 32)	10^{-5}	10^{-5}
PROBABILITY OF CONTROL ROOM BECOMING UNINHABITABLE	6.60×10^{-7}/year	4.87×10^{-7}/year

EXHIBIT 13

CONSERVATIVE AGGREGATE PROBABILITY OF UNINHABITABLE CONDITIONS IN LASALLE COUNTY STATION CONTROL ROOM

Event	Probability/Year
Barge Traffic	3.15×10^{-7} (Exhibit 9)
Kaiser Agricultural Chemical Tanks	6.68×10^{-7} (Exhibit 12)
Seneca Port Authority Tanks	4.37×10^{-7} (Exhibit 12)
Tank Trucks on County Road 6	8.44×10^{-7} (Exhibit 10)
Fertilizer Tanks on Station Service Road	2.70×10^{-7} (Exhibit 11)
Fertilizer Tanks on Leased Land	2.74×10^{-7} (Exhibit 11)
AGGREGATE PROBABILITY	= 2.85×10^{-6}/year

EXHIBIT 14

REALISTIC PROBABILITY OF UNINHABITABLE CONDITIONS IN LASALLE COUNTY STATION CONTROL ROOM DUE TO OFFSITE STORAGE TANKS

Source	Kaiser Agricultural Chemical	Seneca Port Authority
Quantity	1 - 20,000 ton tank 1 - 25,000 ton tank	30,000 tons
Distance from LaSalle Station	5 miles	5.75 miles
Wind Sector	N	NE
Probability of wind blowing from sector (all stability classes & wind speeds)	0.01	0.0162
Estimated accident frequency per year (Reference 33)	10^{-5}	10^{-5}
PROBABILITY OF CONTROL ROOM BECOMING UNINHABITABLE	2.0×10^{-5}/year	1.62×10^{-7}/year

EXHIBIT 15

REALISTIC AGGREGATE PROBABILITY OF UNINHABITABLE CONDITIONS IN LASALLE COUNTY STATION CONTROL ROOM

Event	Probability/Year
Barge Traffic	3.15×10^{-7}
Kaiser Agricultural Chemical Tanks	2.0×10^{-7}
Seneca Port Authority Tanks	1.62×10^{-7}
Tank Trucks on County Road 6	2.81×10^{-7}
Fertilizer Tanks on Station Service Road	2.70×10^{-7}
Fertilizer Tanks on Leased Land	2.74×10^{-7}
	1.5×10^{-6}/year

A factor of 10 (operator incapacitation events leading to exposures in excess of 10CFR100 guidelines) can be applied to obtain the realistic aggregate probability (Reference 29)

$= 1.5 \times 10^{-7}$/year