2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

The Salem site is located in a rural area consisting of marshes, abandoned meadowland, and some farmland. There are no major manufacturing or chemical plants within 5 miles of the site. All such facilities are beyond 8 miles and would not interfere with the normal operation of the Salem Generating Station (SGS).

Due to the lack of plants within 5 miles, our study was extended to 10 miles in order to present an accurate description of the site vicinity.

The Delaware River, a major transportation route, represents the only possible hazard to the Salem Station due to the Intracoastal Waterway which passes through the River 1.5 miles west of the site. The freight traffic on the river is described in Section 2.2.3. All features described in this section are shown on Figure 2.1-16.

2.2.1 Location and Routes

The location of manufacturing plants, chemical plants, storage facilities, and transportation routes (land and water) and pipe lines are provided on Figure 2.2-1 and listed in Table 2.2-1.

2.2.2 Descriptions

2.2.2.1 Missile Bases or Missile Sites

There are no military bases or missile sites within 10 miles of the site. The nearest such facility is the Dover Air Force Base, 20 miles south-southwest, which is capable of handling the C-5A jumbo jet transport plane. The base has a population of 8,200, which is expected to increase to 10,000 persons when in full operation (1). Greater Wilmington Airport, 21 miles north-northwest, serves as a station for a combat helicopter squadron and for a C-130 heavy transport wing (2).

2.2.2.2 Manufacturing Plants

There are no manufacturing plants within 5 miles of the site. There are 11 manufacturing plants within 10 miles of the site producing a variety of goods from canned corn to felt base floor coverings (3,4). The nearest company, Gioia Speciality Foods, Inc., employs less than 25 people and produces canned beans. It is located 6.5 miles west (5). For detailed information about manufacturing plants see Table 2.2-1 and Figure 2.2-1.

2.2.2.3 Chemical Plants and Storage Facilities

There are eight chemical companies in a cluster located 10.0 to 10.5 miles north-northwest. The nearest large operation is the Getty Oil Company Refinery. For more details see Table 2.2-1 and Figure 2.2-1.

2.2.2.4 Oil and Gas Pipelines and Tank Farms

There are two pipelines within 10.5 miles of the site, the nearest of which is the Getty Oil Company pipeline which runs within 9 miles of the site. The pipeline serves a large tank farm of approximately 50 tanks. The tank farm is located 10 miles north-northwest of the site. A second pipeline runs from the Pioneer Chloromane plant 2000 feet into the Delaware River at a point 10.4 miles from the site. These pipelines are shown on Figure 2.2-1.

2.2.2.5 Transportation Complexes (Harbors, Railway Yards, Airports)

There are no major harbors, railway yards, or airports within 10 miles of the site. The only "harbor facility" of any significance is the Getty Oil Company pipeline terminal in Delaware City, 9 miles north-northwest, used by moderate-size tankers (15 to 30,000 tons).

Although there are no harbors located within 10 miles of the site, small craft fishing and pleasure boating is popular in the area. There are two boating access areas within 10 miles, the nearest being Augustine Beach access area, 3.7 miles northwest. Woodland Beach is located 10 miles south-southeast. Although no boating figures are readily available, it was observed that both areas are used heavily for fishing and pleasure boating during the warmer months and probably for hunting during fall.

A list of the Marinas is included in the list of Recreational Facilities in Table 2.1-10.

There are no railroads within 5 miles of the site. However, there is a single track serving the chemical complex 10 miles north-northwest. Forty railroad cars were counted within the complex using aerial photos taken in 1968.

There are three turf airstrips within 10.5 miles of the site, the nearest of which is Salem Airport, 8 miles north-northeast.

2.2.2.6 Transportation Routes (Highways, Railway, and Waterways)

All transportation routes within 10 miles of the site are shown on Figure 2.2-1. The only major route within 5 miles of the site is the Intracoastal Waterway, 1.5 miles west of the island.

The Waterway is the main route for barge and freighter traffic from the Atlantic to the Philadelphia Area ports. In 1970, at least 4,700 vessel trips were made past Artificial Island.*

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*Total traffic (9,858 trips) on the Chesapeake and Delaware Canal, 8 miles north-northwest was subtracted from the total traffic on the Delaware River (14,565 trips) to determine how many vessels passed Artificial Island (6).

According to U.S. Corps of Engineer Statistics (6) over 4.5 million passengers traveled from Philadelphia to the sea in 1970. This does not include the 25,000 who traversed the Chesapeake and Delaware Canal. The 4.5 million seems unrealistic and may result from double counting passengers on vessels that made several stops above Salem. The method used in compiling the statistics does not allow for double counting errors.

The Delaware River Hydrographic Chart delineates an anchorage zone northwest of Artificial Island. This zone is only for anchorage of vessels carrying explosives. According to Mr. Charles Ide and Lt. Edward Kangeter of the Safety Division, Coast Guard Station at Gloucester City, New Jersey, only one vessel since 1970 has carried explosives up-river past the site. The port of Philadelphia does not accept explosive cargo; all such cargoes, in limited quantities only, must be unloaded at Wilmington, Delaware. It was Lt. Kangeter's opinion that very few vessels with explosive cargoes have passed, or will pass, Artificial Island. He added that, with construction of the Salem Station, the Coast Guard is petitioning for a relocation of the anchorage area. This might increase anchorage by non-hazardous vessels, but Mr. Ide believes this is unlikely due to the distance to port.

U.S. Highway 13, 6.5 miles west, is traveled by an average total of 14,560 vehicles daily (7). Trailways Bus Service runs nine routes daily on this road, and one bus daily through Middletown, 10 miles west on Route 896. Six buses per day run to Salem, New Jersey, 8 miles north-northeast along Route 49 (8).

There are no figures for rail traffic within 10 miles of the site, but rail lines in both Delaware and New Jersey handle mainly freight traffic. No commuter train traffic exists in the site vicinity.

An in depth analysis of the highway network including local roads is provided in Attachment II-1 of the Salem Generating Station

Emergency Plan. Included in this attachment is the analysis of evacuation times as required by NUREG-0654, FEMA-REP-1: Rev. 1.

2.2.2.7 Petroleum Wells, Mines, or Quarries

There are no petroleum wells, mines, or hardrock quarries within 10 miles of the site. The nearest quarrying of any kind is sand and gravel pit activity along Route 49 in Quinton, New Jersey, 9 miles northeast to 10 miles east of the site.

2.2.3 Evaluations

2.2.3.1 Barge Transportation

There is no known movement of high explosives in the vicinity of Artificial Island*, the site of SGS. There is barge movement of flammable materials, such as jet fuel and gasoline, but these movements are not likely to pose much of a hazard to the station, since the probability of a runaway barge carrying flammable material striking the intake structure is very remote (i.e., around 1.0^{-7} per year).

A quantitative probabilistic analysis indicates that the risk of a runaway barge containing flammable material hitting the intake at Salem and igniting is 5.0×10^{-9} occurrences per year. Details of the analysis are given below.

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*This fact has been verified by searching the records kept by the U.S. Army Corps of Engineers and the Bureau of Customs. In addition, the U.S. Coast Guard Offices in Philadelphia and New York also confirmed this fact. Finally, there are no known industrial or military activities in that region which would warrant shipment of high explosives.

According to the U.S. Corps of Engineers (9), compilation of traffic between Philadelphia and the sea, there are approximately 550 barge movements of loaded barges past the Salem site per year (1972 data). In addition, some 850 non-seagoing barge movements are needed for lightering purposes (10) and also move past Salem each year. Of this grand total of 1,400 loaded barge movements per year, 850 carry crude oil (essentially non-flammable), 160 carry sulfuric acid, 180 carry jet fuel, and the rest carry "clean" petroleum products such as fuel oil and gasoline (9). Since sulfuric acid and crude oil are not flammable, only 390 barges (1400-850-160) move by Salem each year carrying a flammable cargo. Therefore, the total traffic of concern to this analysis is 390 barge movements per year. Note that these 390 barges all have drafts of less than 16 feet and all can potentially approach the intake and hit it.

Based on accident statistics for the years 1968 to 1973 collected by the U. S. Coast Guard (11), the national average accident frequency involving all barges where damage was in excess of $1,500 has been found to be 0.42 accidents per million miles (12). The frequency of all types of barge accidents is therefore 0.42×10^{-6} per mile. Runaway barge accidents form a small subset of all accidents since most barge accidents are caused by impact with bridges, weirs, spillways, piers, other barges, etc., but not due to runaways. A very conservative estimate of number of runaways per total number of accidents is estimated at 0.1 (13).

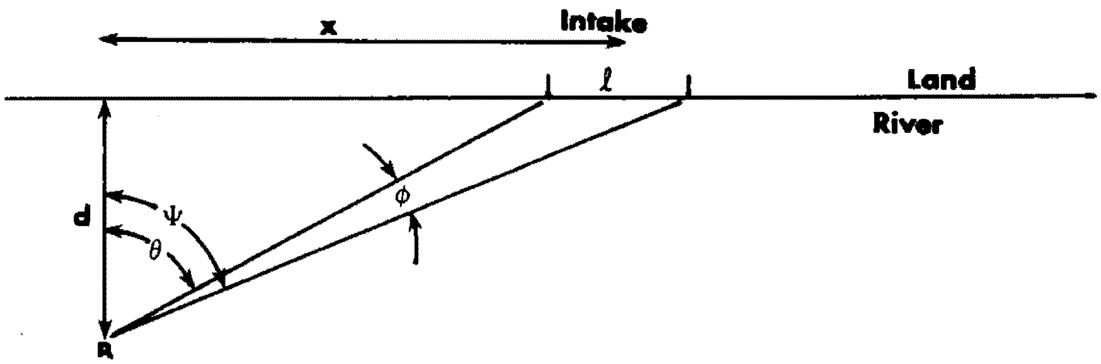
We calculate the frequency of runaway barge occurrences per year per mile of the Delaware River in the vicinity of Salem, designated by f as:

$$f = \frac{\text{number of barge runaways}}{\text{year-mile}} \quad \text{Delaware} = 390 \times 0.42 \times 10^{-6} \times 0.1 = 1.6 \times 10^{-5}/\text{year-mile}$$

We now address the question of how many of these runaways will strike the Salem intake. As shown below, if a barge can run away in any direction with equal probability and does not change direction once it has run away, the probability of it striking a target (water intake) of length ℓ is given by f

$$\frac{\ell}{2}$$

Consider the collision geometry shown below:



A barge (assumed a point) B runs away in a random direction at a projected distance x from the center of target (water intakes) of length ℓ. Once the barge has run away, it is assumed that it does not change directions. In order to hit ℓ, the barge must be within the section given by angle $\emptyset$.

Since all angles of a runaway are equally likely, the probability of runaway within an angle $\emptyset$ is $\emptyset/2\pi$.

The total probability of a barge runaway at any distance x causing a strike at ℓ is

$$\int_a^b f \frac{\emptyset \quad (x)}{2\pi} dx$$

where a and b represent the two end-points of the barge movements. Since the integrand decreases rapidly with distance away from the intake, the limits can be replaced with $\pm \infty$.

$$\int_{-\infty}^{\infty} f \frac{\emptyset(x)}{2\pi} dx = \frac{f}{\pi} \int_{0}^{\infty} [\tan^{-1} \frac{x+\ell/2}{d} - \tan^{-1} \frac{x-\ell/2}{d}] \quad dx$$

$$= \frac{f}{\pi} \int_{0}^{\infty} \tan^{-1} \frac{\ell/d}{1 + \frac{x^2 - (\ell/2)^2}{d^2}} \quad dx$$

$= \frac{f}{2}$ for the case when $d >> \ell/2$

This is true for the Delaware where d = 5000', ℓ = 100'

The above expression represents the probability of a runaway barge (originating anywhere in the river) striking the target ℓ.

Note that the presence of a stream current in real rivers will prevent straight trajectories for runaway barges. However, the effect of slightly curved trajectories is expected to have little effect on the end result.

Since the length of the water intake is 110 feet, or 0.02 mile, the probability of a runaway barge striking the intake is:

$$1.6 \times 10^{-5} \times \frac{0.02}{2} = 1.6 \times 10^{-7} \frac{\text{strikes}}{\text{year}}$$

Not every strike will involve spillage of chemical. On a national average basis, only 45 percent of the barge accidents result in the involvement or release of contents (12) and about 7 percent of the releases result in fire (14). Carrying these frequencies to runaways, the probability of a barge running away, hitting the intake, releasing some of the flammable content and igniting is:

$$1.6 \text{x} 10^{-7} \times 0.45 \times 0.07 = 5.0 \text{x} 10^{-9} \text{ occurrences/year}$$

This represents an extremely remote event.

2.2.3.2 Hazardous Chemicals - Onsite

Regulatory Guide 1.78, Paragraph C.2 states that hazardous chemicals such as those indicated in Table C-1 of the Guide, must be included in the analysis if they are frequently shipped within a 5 mile radius of the plant. The Guide also defines frequent shipments as being 50 or more trips per year for barge traffic, 10 or more trips per year for truck traffic, and specifies in Paragraph C.1, that chemicals stored or situated at distances greater than 5 miles from the facility need not be considered.

Following is the analysis of control room habitability during a postulated hazardous chemical release occurring either on the site or within a 5 mile radius of the plant. As indicated in Section 2.2, the Salem site is located in a rural area with no major manufacturing or chemical plants located within 5 miles of the site. The only major transportation route within 5 miles of the plant is the Delaware River, with the Intracoastal Waterway passing 1 mile west of the site.

The SGS uses a sodium hypochlorite biocide system, thus eliminating an onsite chlorine hazard. The control room is equipped with smoke and combustible detectors located in the air conditioning unit ducts. These detectors provide alarms in the control room in the event of smoke or combustible hazards present. The control room is equipped with radiation detectors which provide annunciation, automatically isolate the control room, and initiate emergency ventilation in the pressurized mode. The site was reviewed to identify potentially hazardous chemicals which may impact control room habitability during a postulated release. The site includes the SGS, HCGS, and deliveries to and near the site. Hazardous chemicals which may impact control room habitability are identified as sulfuric acid, nitrogen, ammonium hydroxide, hydrazine, ethanolamine, sodium hydroxide, and helium. Fire fighting agents such as carbon dioxide and halon are discussed later in this section. The basis for identification was the chemical's physical properties, toxicity and/or asphyxiant threshold levels, and storage quantities and locations.

Table 2.2-2 presents the chemicals stored onsite or shipped by the site on the Delaware River which are identified in Regulatory Guide 1.78, Table C-1. Table 6.4-3 in Section 6.4 provides information on the control room ventilation system, as required by Regulatory Guide 1.78, Paragraph C.7. As can be seen from Table 2.2-2, the hazardous chemicals stored onsite are sulfuric acid, nitrogen, ammonium hydroxide, hydrazine, ethanolamine, sodium hydroxide, and helium.

As previously mentioned, several chemicals are stored onsite that are considered hazardous. Sulfuric acid is stored in 4,000 and 2,250 gallon tanks in the SGS Turbine Buildings and it is stored in 16,000 gallon tanks at the HCGS. Calculations indicated that the toxicity limit found in Regulatory Guide 1.78 will not be exceeded in the control rooms during a postulated release at any of the sources.

Liquid nitrogen and nitrogen stored as a compressed gas is stored at various locations onsite. According to the criteria contained in Regulatory Guide 1.78, the largest single source should be evaluated for its impact on control room habitability. The sources evaluated at the SGS are the portable nitrogen tube trailers located in various areas throughout the SGS yard area and the (2) liquid nitrogen tanks located behind Unit No. 1 & 2 Auxiliary Buildings which can contain up to 7500 gallons of liquid nitrogen. In addition to these sources, liquid nitrogen is also stored in 9,000 gallon tanks at the HCGS. Calculations indicated that the oxygen depletion is negligible in the control rooms during a postulated release at any of the significant sources.

Chemicals used as fire-fighting agents were evaluated. Carbon dioxide is stored on the 84 foot elevation of each of the Auxiliary Buildings. It is also stored at the HCGS. Calculations indicated that the toxicity limit established in Regulatory Guide 1.78 as well as asphyxiation levels would not be exceeded during postulated releases at the significant sources. The Halon storage vessels are relatively small and do not contain the volume of Halon required to cause asphyxiation in the control rooms; therefore, a postulated release will not pose a danger to the control rooms.

Ammonium hydroxide is stored in two 350 gallon vessel totes that are connected in series in the SGS Unit No. 1 and SGS Unit No. 2 Turbine Buildings. Evaluations concluded that the control rooms would remain habitable during a postulated release at either of the storage tank locations. The shipments to the site are considered "frequent" and are discussed in Section 2.2.3.3.

Hydrazine is stored in a 300 gallon vessel also in the Unit No. 1 side of the SGS Turbine Building. The calculations indicated that the control room concentrations will not exceed toxicity limits established in 29CFR Part 1910.1000, Subpart Z during a postulated release.

Ethanolamine is stored in two 350 gallon totes that are connected in series in the SGS Unit 2. The effective volume is 700 gallons. Evaluations concluded that the control rooms would remain habitable during a postulated release at the storage totes. The shipments to the site are considered "frequent" and are discussed in Section 2.2.3.3.

Aqueous sodium hydroxide is stored in various quantities and vessels at both the SGS and HCGS. Upon a release, sodium hydroxide vapors may form locally at the spill, but the physical properties of this chemical preclude the formation of a plume that will travel to the control room air intakes. The vapor pressure of aqueous sodium hydroxide is very low, especially as the concentration is increased. During a postulated release, mostly water will evaporate from the liquid pool, leaving the solid sodium hydroxide behind. The solid form of sodium hydroxide poses no danger to the control room due to its physical properties.

Helium is stored in 150 lb cylinders at both the SGS and HCGS. It is much lighter than air and upon a postulated failure of one of the cylinders, the helium would disperse rapidly into the atmosphere and not form a continuing plume.

Our analysis of the control room habitability requirements demonstrates that the control room personnel are adequately protected against the effects of accidental release of onsite hazardous chemicals and radioactive gases, and shows that the plant can be safely operated or shut down under design basis accident conditions. Due to the use of sodium hypochlorite, there is no chlorine hazard.

2.2.3.3 Hazardous Chemicals - Offsite

Table 2.2-4 provides a tabulation of estimated frequencies of hazardous chemicals shipped past Artificial Island, some of which are listed in Table C-1 of Regulatory Guide 1.78. Regulatory Guide 1.78 requires a control room habitability evaluation for shipments of hazardous chemicals that are considered "frequent" shipments. The frequent criterion for river barges is 50 per year. As seen from Table 2.2-4, none of the hazardous chemicals shipped past the site exceed this criteria, therefore, a control room habitability evaluation is not required.

Hazardous chemicals are also delivered to the SGS and the HCGS. Table 2.2-4 lists the deliveries of hazardous chemicals to the Generating Stations. A review of the shipment deliveries were compared to the "frequent" shipment criteria as stated in Regulatory Guide 1.78. Aqueous sodium hydroxide, sodium hypochlorite, ammonium bisulfite, and ethanolamine shipments are considered "frequent". As mentioned previously, a release of either sodium hydroxide or sodium hypochlorite will not impact the control rooms due to the physical properties of these chemicals. Ammonium bisulfite is also characterized a a chemical that will not readily evaporate and form a plume during a release due to its very low volatility. Therefore, a catastrophic failure of the tankers delivering these hazardous chemicals onsite will not impact control room habitability.

Ethanolamine (ETA) is shipped frequently to the site in 350 gallon stainless steel totes. ETA is characterized as a chemical that will not readily evaporate and form a plume during a release. Therefore, a catastrophic failure of the truck delivering the totes onsite will not impact control room habitability.

Security Related Information
Figure Withheld Under 10 CFR 2.390

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Public Service Electric & Gas (PSE&G) has performed detailed studies of the potential hazards of ship transportation of the materials listed in Table 2.2-4, as well as liquified petroleum gas (LPG) and liquified natural gas (LNG). The report, entitled "Analysis of Potential Effects of Waterborne Traffic on the Safety of the Control Room and Water Intakes at Hope Creek Generating Station," was submitted on October 2, 1974, on the Hope Creek docket (Docket Nos. 50-354 and 50-355). The report provides analyses that support the conclusion that the probability of flammable vapor cloud reaching the nuclear facilities at Artificial Island is sufficiently low such that accidents occurring from the waterborne transportation of hazardous materials need not be considered in the design basis of the nuclear facilities at Artificial Island.

PSE&G is required as a condition of the Hope Creek Construction Permit to submit a yearly report updating factors that affect the probability of a flammable vapor cloud reaching Artificial Island. In addition, any significant changes that alter the probability calculations must be reported in a more prompt manner. A condition of the Salem Unit No. 2 Operating License requires that any significant information affecting probabilities reported on the Hope Creek docket must also be reported on the Salem docket.

The ability to isolate the ventilation system and recirculate the air, along with the protective breathing equipment, provides sufficient time to bring the plant to a safe shutdown condition from the control room in the event of hazardous chemical release from waterborne traffic.

2.2.4 References for Section 2.2

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3. Directory of Commerce and Industry, Delaware State Chamber of Commerce, Inc., Wilmington, Del., 1970.

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7. Communication, Dames and Moore and Rollin Neeman, Bureau of Planning, State of Delaware, Dover, Del.

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9. U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Delaware River, Philadelphia Harbor, 1972.

10. Personal Communications, Mr. Howard Lynch Interstate Oil Transport, Penn Central Plaza, Philadelphia, Pa.

11. U. S. Coast Guard Headquarters, Computer File on all Accidents Involving Damage in Excess of $1,500. Washington, D.C., 1974.

12. U. S. Department of Commerce, A Model Economic and Safety Analysis of the Transportation of Hazardous Materials in Bulk, Report to Office of Domestic Shipping by Arthur D. Little, Inc., Cambridge, Mass., July 1974.

13. U. S. Coast Guard, "Statistical Summary of Casualties to Commercial Vessels on Western Rivers, "November 1973. In this report, runaway barges are classified as being due to material failure (e.g., a broken tow line) and are found to represent 4 percent of all barge accidents. For the Delaware, a conservative estimate of 10 percent is used.

14. Atomic Energy Commission, "The Probability of Transportation Accidents, "by William A. Brobst. Presented at the 14th Annual Explosives Safety Seminar, New Orleans, Louisiana, November 1972.

15. Waterborne Commerce of the United States, U. S. Army Corps of Engineers.

16. Commodity traffic data for imports and exports collected by the Philadelphia Maritime Exchange.

17. Foreign trade cargo movements collected by the Delaware River Port Authority.

18. U. S. Department of Commerce, Census Bureau (handling foreign trade data for custom purposes.

19. Interstate Oil Transport, Inc. (which handles most of the barge operations on the Delaware River).

20. U. S. Coast Guard, Captain of the Port, Philadelphia (who is cognizant of all hazardous materials shipments in the Delaware River).

21. U.S. Coast Guard, Vessel Chemical Traffic Report, "Hazardous Traffic Passing Salem and Hope Creek Stations," Dated July 15, 1993.