# 2 SITE CHARACTERISTICS

# 2.1 GEOGRAPHY AND DEMOGRAPHY

## *2.1.1 SITE LOCATION AND DESCRIPTION*

The site is in the township of Ontario, in the northwest corner of Wayne County, New York, on the south shore of Lake Ontario about 16 miles east of the center of the city of Rochester and 40 miles west-southwest of Oswego, at longitude 77°18.7'W and latitude 43° 16.7'N. The general location is shown in Figure 2.1-1.

The site comprises approximately 426 acres owned by Ginna LLC. Figure 2.1-2 shows the site and its relationships to topographic features.

The surface of the land on the southern shore of Lake Ontario, at the site and east and west of it, is either flat or gently rolling. It slopes upward to the south from an elevation of about 255 ft above mean sea level (msl) near the edge of the lake; to 440 ft at Ridge Road (New York State Highway 104), 3.5 miles south of the lake; and then to about 1600 ft at the northern edge of the Appalachian Plateau, 30 to 40 miles to the south. Southward from Ridge Road the terrain progressively roughens, with a series of small abrupt hills, commencing about 10 miles south of the site.

Wayne County, in which the site is located, is primarily of an agrarian nature and sparsely populated. The location is shown in Figure 2.1-1. There are no substantial population centers, industrial complexes, transportation arteries, parks or other recreational facilities within a 3-mile radius of the Ginna site (*Reference 1*). Roughly 70% of the county's 600 square miles are utilized for approximately 2500 farms, which primarily produce apples, grapes, cherries, dairy products, field crops, and vegetables. About 34% of Wayne County's workers are employed in manufacturing operations, 18% in service industries, 16% in retail trade, 14% in agriculture, and 18% in other occupations. Typical industries are listed in Table 2.2-1.

Monroe County, located adjacent to and west of Wayne County, has many manufacturing activities centered in and around Rochester. Approximately 22% of the county's 673 square miles is in urban development, about 28% is vacant, wooded, or water surface, and 50% is farm land upon which dairy products, field crops, poultry, livestock, fruits, and horticultural specialties are produced. Of Monroe County's workers, about 45% are employed in manufacturing, 20% in service industries, 16% in retail trade, 1.4% in agriculture, and the rest in other activities. Typical industries are listed in Table 2.2-2.

The land within a radius of 5 miles of the site is used for agricultural purposes, principally for growing apples, cherries, grapes, and field crops. There are only a few dairy farms in a 5-mile radius of the plant. They average between 50 to 75 milk cows per farm. Part of the site is under lease for fruit farming.

## *2.1.2 EXCLUSION AREA AUTHORITY AND CONTROL*

The site boundary is the line beyond which the land is neither owned, nor leased, nor otherwise controlled by Ginna Station (see Figure 2.1-2). The exclusion area is completely within the site boundary (see Figure 2.1-2). The distance from the containment to the nearest exclusion area boundary (EAB) (excluding the boundary on the lakefront) is 1550 ft but the minimum exclusion distance is assumed to be 450 meters or 1476 ft. No public highways or railroads traverse the exclusion area.

The Constellation Energy Nuclear Group, LLC (CENG) owns and controls all of the land, including mineral rights, within the exclusion area. Technical Specification Amendment 115 was issued on April 1, 2014, which approved the transfer of the license for R.E. Ginna Nuclear Power Plant (Ginna) held by R.E. Ginna Nuclear Power Plant, LLC, (Ginna LLC) to Exelon Generation Company, LLC, as approved by Order dated March 24, 2014. The joint venture held between Constellation Energy Nuclear Group, LLC, (CENG) and Electricite de France, S.A., was not modified as part of Amendment 115. The joint venture consists of a 50.01% ownership interest of an ultimate domestic parent Exelon Generation Company, LLC, and a 49.99% ownership interest of an ultimate foreign parent, Electricite de France, S.A., a French Corporation (*Reference 8*). Regarding the lakeshore frontage within the exclusion area, CENG, by New York State procedures (*Reference 2*), owns the land above 243.8 ft msl. This is well below the average lake stage of 246 ft msl, but is above the extreme low water level of 242.23 ft msl and the lowest regulated level of 243 ft msl (see Section 2.4); however, since the low period is generally in the winter and the high period in the summer, it is not expected that there would be any beach use of this area. The exclusion area is not defined over the waters of Lake Ontario adjacent to the Ginna site. While CENG has not specifically defined an exclusion area over the water, arrangements have been made with the U.S. Coast Guard, as documented in the Ginna Nuclear Emergency Response Plan, for emergency response in the event of a plant emergency.

CENG has established a security zone on the waters of Lake Ontario for the purpose of excluding watercraft in the vicinity of the waters that surround the plant. The boundaries of the security zone have been established by the U.S. Coast Guard and the boundaries are marked by a system of buoys. The buoys are removed during winter months to prevent them from becoming a boating hazard if they were to break free as a result of ice or winter snow. The establishment of this security zone complies with the requirements of an NRC Order (*Reference 7*), and 33 CFR 165.911 (a)(2).

### *2.1.3 POPULATION DISTRIBUTION*

#### 2.1.3.1 Population Within Five Miles

The population distribution by 1-mile increments within 5 miles of the plant, projected for the years 1970, 1980, 1990, and 2010, is shown in Figure 2.1-4. The 1970 estimates were based on a 1967 count of houses and electric meters and includes summer residents. The estimates for 1980, 1990, and 2010 were made by the Rochester Gas and Electric Rate and Economic Research Department and were derived from a study of past trends and probable future industrial, commercial, residential, and recreational development.

Updated population data based on preliminary estimates from the 1980 Census (*Reference 3*) are shown on Figure 2.1-5. Rochester Gas and Electric Corporation estimated that 10,864 persons resided within 5 miles of the plant in 1980, a density of 138 persons per square mile averaged over the entire area. It should be noted that this figure compares favorably with the 1980 population projection of 10,934 persons shown in Figure 2.1-4.

Updated 1992 population estimates based on data obtained from the Center for Government Research and 1990 Census data are shown in Figure 2.1-5a. Rochester Gas and Electric Corporation estimated that 11,277 persons resided within 5 miles of the plant in 1992. It should be noted that this figure is significantly lower than the 1990 population projection of 14,491 persons shown in Figure 2.1-4.

Based on the original FSAR for Ginna Station published in 1968, four schools were located approximately 3.5 miles south of the plant, and had a total enrollment of 2272 pupils and a teaching staff of 180. The nearest offsite residence is about 2000 ft southwest of the plant, and there are two occupied farmhouses on the site. The farms are owned by RG&E and the occupants have leases renewable annually at the option of RG&E. One farmhouse is about 2200 ft southeast of the plant and the other is about 1500 ft south. Both farmhouses are outside the exclusion area. Other buildings (horse barns) are located about 800 ft east and 1400 ft south of the plant.

#### 2.1.3.2 Population Within Forty Miles

The population distribution projections by 10-mile increments within 40 miles of the plant, for the years 1970, 1980, 1990, and 2010, are shown in Figure 2.1-6. The 1970 estimates were based on extrapolations of the 1960 Census and a special census of Monroe County (Rochester area) dated April 1, 1964. The estimates for 1980, 1990, and 2010 were made by the RG&E Rate and Economic Research Department and were derived from a study of past trends and probable future industrial, commercial, residential, and recreational development.

#### 2.1.3.3 Transient Population

Based on the original FSAR, there is a summertime increase of about 500 people in the lakeside population within a 5-mile radius of the plant, and a summer-time increase of 4000 to 5000 people in the lakeside population within a 20-mile radius of the plant. The nearest group of houses are summer cottages, 0.8 miles west. Other groups are located at Bear Creek, 1.5 miles east, and at Ontario-on-the-Lake, 2 miles west.

Other than the summertime residents of the area, there are no large groups of transients within 5 miles of the site. The only parks near the site are Webster Beach Park in Monroe County, approximately 6 miles west of the plant site, and B. Forman Park in Wayne County, approximately 8 miles east of the plant site. There are no federal recreational facilities in the area. There are no state parks, public campsites, or special use areas within 10 miles of the plant (*Reference 3*). Wayne County does have a migrant labor population during the June-October season, primarily for apple picking. Approximately 115 farm-worker camps of five or more persons are scattered throughout Wayne County, with a total population of about 4400 migrants. Information from Rural New York Farmworker Opportunities shows that there are only 12 camps, with about 130 migrants, located in the vicinity of the Ginna site (*Reference 4*).

#### 2.1.3.4 Low-Population Zone

The low-population zone specified for the Ginna site is the area within a 3-mile (4827 m) radius of the plant (*Reference 5*). A review in 1981 of population estimates and projected

growth estimates indicates that the population growth in the area since the plant received an operating license in 1969 has been modest, and this trend is expected to continue. No population center of 25,000 residents has developed, or appears likely to develop, closer than the eastern boundary of the Rochester urbanized area.

### 2.1.3.5 Population Center

Figure 2.1-7 shows the locations of population centers (over 25,000 people) within a radius of 100 miles of the plant site. Figure 2.1-8 shows the locations and sizes of population centers of over 2000 people within a radius of 50 miles. These figures are based on the 1960 census, except the Rochester urbanized area, which is based on the 1980 census. There has been no significant change in population since that time.

The nearest population center to the Ginna site containing more than 25,000 residents is the Rochester urbanized area, whose eastern boundary is about 10 miles from the site (*Reference 1*). The only other population center of more than 25,000 persons is the city of Auburn (population 32,442) (*Reference 3*), located more than 40 miles southeast of the site.

### 2.1.3.6 1989 Updated Population Data

RG&E reviewed Ginna Station projected population changes through the year 2009 in support of the October 5, 1989, application for an extension of expiration of the Ginna Operating License from April 25, 2006, to September 18, 2009 (*Reference 6*). RG&E obtained 1984 population data for the thirteen county area included within a 50-mile radius of the plant. The population in this area had increased by only 3% overall since 1970, which was substantially below the RG&E 1970 estimates for 1984. The 1980 population within 2 miles of the plant was 1078 people. This population was estimated to increase to 1390 by the year 2015 based on the 1980-1985 population growth rate for Wayne County. The population centers with populations greater than 25,000 people, within the 50-mile radius of the plant, continued to be Monroe County, which includes the city of Rochester (Rochester 1984 population equaled 243,000), and the city of Auburn, New York. Population projections for the year 2015, based on the 1970-1980 growth rates, were as follows:

| | | Population | |
|---|---|---|---|
| **Population Center** | **Location** | **1984** | **2015** |
| Monroe County | 20 miles WSW | 711,200 | 742,100 |
| Auburn, New York | 45 miles ESE | 32,000 | 35,000 |

## REFERENCES FOR SECTION 2.1

1. Rochester Gas and Electric Corporation, R. E. Ginna Nuclear Power Plant Unit No. 1, Environmental Report, Volume 1, Sections 2.1 and 2.2.

2. New York State Policy as established by the Land Utilization Department within the New York State Office of General Services.

3. U.S. Census Bureau, "General, Social, and Economic Characteristics," Characteristics of Population, TC80-1-C34, U.S. Government Printing Office, November 1983.

4. Letter from Thomas J. Harris, Rural New York Farmworker Opportunities, to George Wrobel, RG&E, April 10, 1981.

5. Safety Evaluation by the Division of Reactor Licensing, U.S. Atomic Energy Commission in the Matter of Rochester Gas and Electric Corporation Robert Emmett Ginna Nuclear Power Plant Unit No. 1, Docket No. 50-244 (SER), Section 2.1, June 19, 1969.

6. Letter from A. R. Johnson, NRC, to R. C. Mecredy, RG&E, Subject: Environmental Assessment - Ginna Nuclear Power Plant, dated April 17, 1991.

7. NRC Order from S. J. Collins, NRC, to P. S. Wilkens, RG&E, Subject: Issuance of Order for Interim Safeguards and Security Compensatory Measures for - R. E. Ginna Nuclear Power Plant, dated February 25, 2002.

8. Letter from Nadiyah S. Morgen, NRC, to Mary G. Korsnick and Bryan P. Wright, Constellation Energy Group: R.E. Ginna Nuclear Power Plant – Issuance of Amendment to Conform the Renewed Facility Operating License to Reflect the Direct Transfer of Operating Authority (TAC No. MF2588), dated April 1, 2014.

# 2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

## *2.2.1 LOCATIONS AND ROUTES*

There is little industrial activity in the vicinity of the R. E. Ginna Nuclear Power Plant. Wayne County, where Ginna Station is located, is primarily a rural area. Typical industries in Wayne County and Monroe County are listed in Tables 2.2-1 and 2.2-2, respectively. Industrial activity is most heavily concentrated in the town of Webster, about 6 miles from the site, and consists primarily of light manufacturing (Xerox copiers). No industrial development is expected to occur in the vicinity of the Ginna site.

The nearest transportation routes to the plant are Lake Road and U.S. Route 104, which pass about 1700 ft and 3.5 miles, respectively, from the plant at their closest points of approach. The highway separation distances at Ginna Station exceed the minimum distance criteria given in Regulatory Guide 1.91, Revision 1, and, therefore, provide reasonable assurance that transportation accidents resulting in explosions of truck-size shipments of hazardous materials will not have an adverse effect on the safe operation of the plant. Any large quantities of hazardous material would be shipped via U.S. Route 104 which is sufficiently distant (3.5 miles from the plant site) not to be of concern.

## *2.2.2 DESCRIPTION*

The effects of nearby railroads, pipelines, waterways, and airports, and the effects of stored chemicals onsite and offsite are discussed in the following sections.

### 2.2.2.1 Railroads

The railroad nearest to the plant is the Ontario Midland Railroad about 3.5 miles to the south. Comparing this distance with the guidance provided in Regulatory Guide 1.91, potential railroad accidents involving hazardous materials are not considered to be a credible risk to the safe operation of the plant.

### 2.2.2.2 Pipelines

The nearest large pipelines to the plant are a 12-in. gas line located about 6 miles southwest of the plant and a 16-in. gas line located about 10 miles south of the plant. These pipelines are far enough away to ensure that pipeline accidents will not affect the safety of the plant. The gas line service to the Ginna house heating boiler and the boiler controls were reviewed and compared with National Fire Protection Association (NFPA) 85 and were found acceptable (*Reference 1*). On the basis of the resolution of all gas line items during the fire protection review, the gas line on the plant site does not present a safety hazard. Fire protection is discussed in Section 9.5.1.

### 2.2.2.3 Waterways

There are no large commercial harbors along the southern shore of Lake Ontario near the plant. Some freight is shipped through Rochester harbor about 20 miles to the west. Major shipping lanes in the lake are located well offshore, at least 23 miles or more from the plant.

As discussed in the NRC Safety Evaluation Report for SEP Topic II-1.C, shipping on Lake Ontario is not considered to be a hazard to the plant.

The possibility of shipping damage to the service water intake structure has also been considered (*Reference 2*). The intake system (Section 10.6.2) is completely submerged below the surface of the lake. A 10-ft reinforced-concrete-lined tunnel, driven through bedrock, extends 3100 ft north from the shoreline. The tunnel rises vertically and connects to a reinforced concrete inlet section. The occurrence of historical low water level will result in a depth of water of 30 ft at the inlet and with 15 ft of cover over the intake structure. This is sufficient to prevent damage from any boating which might pass in the vicinity of the structure. Furthermore, plugging of inlet water flow by a single large piece of material is prevented by the design of the intake structure, in that water enters on a full 360-degree circle (*Reference 2*). Another design feature at Ginna Station which ensures continued availability of essential service water is that service water intake can be directly drawn from the discharge canal, which is located on the plant site, protected from any potential lake boating. Thus, lake navigation is not considered to be a hazard to the plant.

### 2.2.2.4 Airports

The closest airport to the plant is the Williamson Flying Club Airport, a small, privately owned, general aviation facility located approximately 10 miles east-southeast of the plant. In 1981, the airport had one paved runway, designated 10-28 and oriented in an almost east-west direction, which was 3377 ft long and 40 ft wide. The runway is equipped with low-intensity runway lights. The airport has instrument approach capability to runway 10-28 from the Rochester VORTAC. There is no control tower at this airport. The airport is used for general aviation activities such as business and pleasure flying, and for agricultural spraying operations. As of 1981, there were 5000 operations per year at the facility and about 30 based aircraft, including part-time based crop dusters. The great majority of the aircraft are single-engine propeller airplanes, which typically weigh on the order of 1500 to 3600 lb. The small number of operations at this airport is substantially less than the criteria in Section III.3 of Section 3.5.1.5 of the Standard Review Plan (SRP) and is sufficiently small that in the SER for SEP Topic II-1.C the NRC staff determined that their operations are not a potential hazard.

Monroe County Airport, in Rochester, New York, about 25 miles southwest of the plant, is the nearest airport with scheduled commercial air service. The NRC has reviewed the probabilities for an airline crash from the low-altitude Federal airways in the vicinity of Ginna Station. The calculated probabilities are $5.1 \times 10^{-8}$ for airway V2 and $1.4 \times 10^{-8}$ for airway V2N. (The current FAA designation is airway V483, vice V2N.) Because both probabilities are less than the $1 \times 10^{-7}$ acceptance criteria, the NRC concluded in the Safety Evaluation Report for SEP Topic II-1.C, dated September 29, 1981, that the probability of a commercial air traffic crash at Ginna is acceptable.

### 2.2.2.5 Military Facilities

Air Force Restricted Area R-5203 is located about 8 miles north of the plant site. Whenever flight activity is conducted by the Air Force within R-5203, radar surveillance is maintained by the 174th Fighter Wing, the 108th Tactical Control Group, or possibly the Cleveland Air

Route Traffic Control Center. Pilots rely upon onboard navigational equipment to maintain their presence within the specified limits of the restricted area. Pilots can also be advised if their aircraft stray beyond their limits by the radar surveillance unit covering the area at the time. The restricted area is used for military flight training which includes high-speed interceptor training maneuvers, operational flight checks, and air-to-air refueling. The current altitude ranges in 1981 were from 2000 to 50,000 ft above the surface.

There is also an inactive slow-speed low altitude military training route (SR-826) which passes about 6 miles west of the plant. Route SR-826 is not currently a military controlled air space. Acceptance criterion II.2 of Standard Review Plan 3.5.1.6 states that, for military air space, a minimum distance of 5 miles is adequate for low-level training routes, except those associated with unusual activities such as practice bombing. Air Force Restricted Area R-5203 is about 8 miles away at its closest boundary, and no unusual activities, such as bombing practice, take place. The inactive slow-speed low altitude military training route SR-826 is about 6 miles from the plant. Therefore, this criterion is met.

### 2.2.2.6 Toxic Chemicals

An onsite and offsite toxic chemical evaluation was performed by RG&E in response to the requirements of NUREG 0737, Item III.D.3.4 (*Reference 3*). Sources of chemicals identified during and following the chemical survey and the associated chemical hazards evaluation are discussed below and in *Reference 5*.

#### 2.2.2.6.1 Onsite Toxic Chemicals

A. A 500-gal anhydrous ammonia tank was located next to the all-volatile-treatment building about 40 m from the control room intake. The tank would have posed a problem with respect to control room concentrations following a postulated tank or line rupture. This tank has been removed.

B. Two 6000-gal tanks (one containing 98% $H_2SO_4$, the other containing 50% NaOH) are located in the all-volatile-treatment building, about 40 m from the control room. Two similar tanks were located in the primary water treatment facility about 100 m from the control room intake. These tanks were permanently removed per PCR-2006-0017.

   The all-volatile-treatment tanks are contained in separate areas of large enough volume to contain the entire contents of both tanks. Each area is drained to a common sump through separate lines. Valves in the lines are maintained in the closed position so that no mixing of the $H_2SO_4$ and the NaOH is likely to occur. $H_2SO_4$ is not considered a hazard to the control room operator unless heated as a result of dilution or mixture with the caustic. Neither is likely to occur.

C. Several 55-gal drums of 30% $NH_4OH$, 50-gal drums of 15% $NH_4OH$ and 5% $N_2H_4$, and a 35-gal drum of 35% $N_2H_4$ are located in the turbine building about 75 m from the control room intake. Also, a variety of gas bottles are maintained throughout the plant. The drums of $NH_4OH$ and $N_2H_4$ are dilute and stored in small quantities and thus are not considered a hazard. The individual bottles do not pose a threat to the control room operators and

there is no potential identified for damage to a large number of bottles as the result of a single event.

D. There are two Halon 1301 systems for fire protection. The fire control agent is Bromotrifluoromethane which is stored in tanks outside the relay room. This agent is not considered a toxic hazard except as an asphyxiant. The gas is much heavier than air and unless it is stirred up, it will settle to the floor. The control room is above the relay room. The system should not be activated unless a fire has been detected isolating the control room from the relay room. However, if it is assumed that half the gas (640 lb) is injected into an unisolated relay room and that the gas is well mixed, concentrations as high as $2 \times 10^5$ mg/m$^3$ may be attained. This is less than the generally accepted limit for protective action (requiring use of self-contained breathing apparatus) of $5.9 \times 10^5$ mg/m$^3$. The Halon 1301 system does not pose a threat to control room habitability.

E. A plastic tank containing a maximum of 3000 gal of sodium hypochlorite (NaOCl) at a concentration of up to 17% by weight is located east of the screen house. The tank is situated on a foundation slab approximately 3 ft below grade and is surrounded by a reinforced concrete containment dike. Postulated rupture of the tank yields a negligible concentration outside of the control room, primarily because of the low volatility of the chemical. Sodium hypochlorite is not considered a threat to control room habitability (*Reference 3 and 5*).

   The original underground sodium hypochlorite tank (*Reference 3*) has been abandoned and closed in place, in compliance with the requirements of 6 NYCRR Part 598.10(c) (*Reference 4*).

F. Two 350-gal ethanolamine (ETA) tanks are located in the turbine building basement outside of the turbine pump room. The ETA is stored and injected at a concentration not to exceed 80% solution strength. The storage and processing system is contained such that any spill will not come into contact with any plant materials that are not compatible with 80% ETA and any spill will not come within 50 feet of a control room air intake.

### 2.2.2.6.2 Offsite Toxic Chemicals

A. The town of Ontario water plant, about 1.1 miles from the site, stores chlorine in two 2000-lb tanks. One tank is refilled each month from a truck containing 2750 lb of chlorine housed in a 2000 lb cylinder and five 150-lb cylinders.

   The chlorine tanks may pose a hazard to control room habitability following a postulated catastrophic rupture with stable meteorology. This hazard is discussed in Section 6.4.3.2.1 and in *Reference 5*. The truck which refills the chlorine tanks transports the chlorine via Route 104 and poses no hazard more severe than that discussed in Section 6.4.3.2.1 and in *Reference 5*.

B. Chemicals used by local fruit growers are transported to local distribution firms about 50 times per year. These chemicals are generally solids stored in small containers. They are not stored in large quantities anywhere in the Ginna Station area.

C. The Monroe County Water Authority operates a pumping station that is approximately 4.1 miles from the site. The pumping station contains a tank of Sodium Permanganate with 6,000 gallons working capacity and a tank of Sodium Hypochlorite with a working capacity of 6,000 gallons.

   The Sodium Permanganate tank poses no hazard to control room habitability. The Sodium Hypochlorite volume is below the level of concern for control room habitability.

## REFERENCES FOR SECTION 2.2

1. U.S. Nuclear Regulatory Commission, Fire Protection Safety Evaluation Report, Supplement 2, February 6, 1981.

2. Rochester Gas and Electric Corporation, Technical Supplement Accompanying Application for a Full-Term Operating License, August 1972.

3. Letter from J. E. Maier, RG&E, to D. M. Crutchfield, NRC, Subject: NUREG 0737 Requirements, dated September 4, 1981.

4. Letter from K. Sahler, RG&E, to New York State Department of Environmental Conservation (NYDEC), Hazardous Substance Bulk Storage Registration Number 8-000170 Rochester Gas and Electric Corporation's Ginna Station, dated March 11, 1997.

5. Constellation Energy Corporation, Design Analysis, DA-NS-2000-053, Revision 1, Control Room Toxic Hazards Analysis, dated December 14, 2004.

**Table 2.2-1**

**TYPICAL INDUSTRIES IN WAYNE COUNTY (CIRCA 1969)**

| **Company and Product** | **Distance From Site (miles)** | **Direction From Site** |
|---|---|---|
| National Distillers & Chemical Corporation (Kordite Division) | 14.5 | South |
| Macedon | | |
| Polyethelene products | | |
| | | |
| Duffy-Mott Company, Incorporated | 8.5 | Southeast |
| Williamson | | |
| Baby foods | | |
| | | |
| Garlock, Incorporated | 15.0 | Southeast |
| Palmyra | | |
| Mechanical packings | | |
| | | |
| Bloomer Bros. Company | 19.0 | Southeast |
| Newark | | |
| Folding paper boxes | | |
| | | |
| Jackson Perkins Company | 19.0 | Southeast |
| Newark | | |
| Nurserymen | | |
| | | |
| Sarah Coventry, Incorporated | 19.0 | Southeast |
| Newark | | |
| Direct-mail sales of costume jewelry | | |
| | | |
| National Biscuit Company (Dromedary Company Division) | 19.0 | Southeast |
| Lyons | | |
| Cake mixes, dates, and peels | | |

| Company and Product | Distance From Site (miles) | Direction From Site |
|---|---|---|
| | | |
| General Electric Company | 27.5 | Southeast |
| Clyde | | |
| Electronic equipment | | |
| | | |
| Comstock Foods, Incorporated | 31.0 | East |
| Red Creek | | |
| Canned foods | | |
| | | |
| Kenmore Machine Products, Incorporated | 22.0 | Southeast |
| Lyons | | |
| Refrigerant products | | |
| | | |
| Olney & Carpenter, Incorporated | 27.5 | East |
| Wolcott | | |
| Canned foods | | |
| | | |
| C. W. Stuart & Company | 19.0 | Southeast |
| Newark | | |
| Nurserymen | | |
| | | |
| Francis Leggett Company | 12.5 | East |
| Sodus | | |
| Canned foods | | |
| | | |
| The Waterman Food Products Company | 3-4 | South |
| Food processing | | |
| | | |
| Ontario Kraut Corporation | 3-4 | South-south-west |

| **Company and Product** | **Distance From Site (miles)** | **Direction From Site** |
|---|---|---|
| Food processing | | |
| | | |
| Victor Preserving Company | 3-4 | South |
| Food processing | | |
| | | |
| Ontario Cold Storage | 3-4 | South-south-west |
| Food processing | | |
| | | |
| Waterman Fruit Products Company | 3-4 | South-south-west |
| Food processing | | |
| | | |
| Ontario Food Products | 3-4 | South-south-west |
| Food processing | | |
| | | |
| Lyndan Products Company | 3-4 | South-south-west |
| Food processing | | |

## Table 2.2-2

## TYPICAL INDUSTRIES IN THE ROCHESTER AREA OF MONROE COUNTY (CIRCA 1969) (LOCATED 18 MILES WEST OF THE SITE)

| | |
|---|---|
| Associated Dry Goods Corporation (Sibley, Lindsay & Curr Company subsidiary) | department store |
| Bausch & Lomb, Incorporated | optical instruments and lenses |
| Bond Stores, Incorporated | men's and boys' apparel |
| Burroughs Corporation (Todd Company Division) | business forms |
| Eastman Kodak Company | photographic equipment |
| Fashion Park Incorporated | men's and boys' apparel |
| Friden, Incorporated (Commercial Controls Corporation subsidiary) | special business machines |
| Gannett Company, Incorporated | newspaper publishing |
| General Dynamics Corporation (General Dynamics-Electronics Division) | communication equipment |
| General Motors Corporation (Delco Appliance - Division) | electric motors |
| General Motors Corporation (Rochester Products Division) | motor vehicle parts |
| General Railway Signal Company | signaling equipment |
| Gleason Works | machine tools |
| Hart's Food Stores Incorporated | |
| Lehigh Valley Railroad Company | |
| Lincoln Rochester Trust Company | |
| McCurdy & Company | department store |
| Michaels, Stern & Company, Incorporated | men's and boys' apparel |
| New York Central System | |
| Pfaudler Permutit, Incorporated (Pfaudler Company Division) | food products and machinery |
| Rochester Gas and Electric Corporation | |
| Rochester Telephone Corporation | |
| Taylor Instrument Companies | thermometers and instruments |
| Xerox Corporation | photographic copying equipment |

# 2.3 METEOROLOGY

## *2.3.1 REGIONAL CLIMATOLOGY*

Atmospheric characteristics of the site region have been evaluated to provide a basis for regulated radioactive gas release limits (Section 2.3.4.1), accident analysis (Section 2.3.4.2), and storm protection (Section 2.3.2).

General climatic conditions at the site are influenced by its location in open rolling terrain on the lakeshore and by strong winter weather systems which move across the Great Lakes, usually from the northwest. Winters are rigorous with abundant snowfall (averaging about 75 inches of snow per year) and with a high percentage of cloud cover. Summers are moderately warm with an average of 2.5 to 3 inches of rainfall per month.

The site is well-ventilated. Calms (wind speeds less than approximately 1 mile/hr at about 50 ft above grade) occur about 1% of the time. Prevailing winds are from west-southwest (away from Rochester).

## *2.3.2 LOCAL METEOROLOGY*

### 2.3.2.1 Meteorological Parameters

The climate in the site region, as typified by more than 30 years of records at Rochester airport, 20 miles west-southwest of the site, is shown in Figure 2.3-1. Average wind direction distribution measured at the site, at the Rochester airport, and at the Rochester Coast Guard station, 15 miles west of the site, is shown in Figure 2.3-2. Direction distribution during precipitation is also shown for the site and the airport in Figure 2.3-2. Average wind velocity distribution for these places is shown in Tables 2.3-1 through 2.3-6.

The normal wind speed to be used in the design and structural upgrade of Ginna Station safety-related structures, in conjunction with a normal ground snow load of 40 $lb/ft^2$, is 75 mph at 30 ft.

### 2.3.2.2 Severe Weather

The NRC evaluated severe weather phenomena for the Ginna site as part of the Systematic Evaluation Program (SEP) Topic II-2.A and concluded in *Reference 1* that the following phenomena applied to the Ginna site.

Through 1981, normal daily temperatures have ranged from a minimum of 18°F in January to a maximum of 82°F in July (*References 2 & 4*). Measured extreme temperatures for the site region are 100°F, which occurred in June 1953, and -16°F, which occurred in February 1961 (*Reference 5*). The extreme minimum and maximum temperatures appropriate to the Ginna site are 2°F (equaled or exceeded 99% of the time) and 91°F (equaled or exceeded 1% of the time) (*Reference 6*).

Mean annual snowfall in the site region is approximately 86 inches. In the site area, a maximum monthly snowfall occurred in February 1958 and totaled 72.6 inches (*Reference 7*). The maximum measured snow depth on the ground for the site region is 48 inches (*Reference 8*).

Highly localized effects operate to produce snowfalls in the Lake Ontario "snow belt" along the southern and eastern shores of the lake. A study of the area (*Reference 9*) has shown that snow loads for these sections of the lakeshore are about 40 to 50 lb/ft$^2$. If the 48-hr probable maximum winter precipitation (*Reference 8*) is added to the load, a total load of 100 lb/ft$^2$ results (*Reference 10*).

Thunderstorms occur an average of 29 days per year in the site area. Based on the annual number of thunderstorm days, the calculated annual flash density of ground lightning strikes is four flashes per km$^2$ (*Reference 11*). A structure with the approximate dimensions of the Ginna reactor building can expect, on the average, one strike every 10 years.

As a result of the SEP program (Topic III-7.B) (*Reference 12*), RG&E initiated the Ginna Structural Upgrade Program (Section 3.3.2) with acceptance criteria corresponding to event with a probability of $10^{-5}$ per reactor year. These criteria included the design tornado for the Ginna site with a wind velocity of 132 mph (*Reference 13*). The design criteria for steel structures are as follows:

A. No significant yielding at wind speeds up to 132 mph

B. No instability or collapse that might affect components or systems needed for safe shutdown at wind speeds up to about 200 mph.

### *2.3.3 ONSITE METEOROLOGICAL MEASUREMENTS PROGRAM*

A 250-ft primary meteorological tower is located on the Ginna site. A backup tower is located at substation 13A, approximately 0.5 miles south of the Ginna site. Lightning protection is provided on the primary tower to protect the weather instrumentation.

The primary tower measures wind speed, wind direction, and temperatures (Dewpoint was removed in 1998 because it is not currently used in monitoring post-accident releases, see *Note 1*) as shown on Figure 2.3-3. The backup tower measures wind speed and wind direction as shown on Figure 2.3-4. Precipitation is measured on a separate pad near the primary tower.

The operational meteorological measurements program for Ginna consists of the primary 250-ft guyed tower located near the Lake Ontario shoreline approximately 850 ft northwest of the containment building. Listed below are the instrumentation and the heights of measurement on the tower.

| Measured Parameter | Elevation Above Ground (ft) |
|---|---|
| Wind direction and speed | 33, 150, 250 |
| Dry bulb temperature | 33, 150, 250 |
| Vertical temperature gradient | 33 to 150, 33 to 250 |
| Dewpoint | 33 |

Examination of the measurements system indicates that it conforms to the position stated in Regulatory Guide 1.23 (*Note 1*) for system accuracies, except for one of the wind direction and speed sensors at the 150 ft level and those at the 250 ft level. These wind sensors are not low-threshold instruments (i.e., starting speed of less than 1 mph) due to the short lifetime expected from the more sensitive sensors at a relatively windy site near a large lake, such as Ginna. The use of less sensitive, more sturdy wind instrumentation at the upper levels of the meteorological tower at Ginna is acceptable.

Strip-chart recorders for wind speed, wind direction, and temperature, measurements from the primary tower are located in an environmentally controlled equipment shelter located approximately 70 ft southwest of the tower. Precipitation, measured by means of a rainfall bucket mounted at about the 3-ft level on a separate concrete pad located approximately 30 ft northwest of the equipment shelter is also recorded on a strip chart in the shelter. A stripchart recorder for wind speed and wind direction measurements from the backup tower is located in an enclosure shed adjacent to the tower.

NOTE: The meteorological dewpoint monitor was originally installed to gather information used for making a determination if the property location had acceptable meteorological characteristics for siting a power reactor. The unit was part of a collection of instrumentation whose purpose was to provide data used to estimate the atmospheric diffusion of potential radionuclide releases (Regulatory Guide 1.23). Rochester Gas and Electric gathered and submitted the required meteorological data as part of the application for a full term operating license. NRC review of the onsite meteorological measurement program was planned as part of the Systematic Evaluation Program (SEP) topic II-2.B. This topic review was subsequently deleted based on the requirement to comply with the TMI action plan task II-F.3, "Instrumentation for Monitoring Accident Conditions" (NUREG-0660). (Regulatory Guide 1.97 contains the required meteorological instrumentation to quantify offsite exposures.) The information gathered by the dewpoint system is not required to satisfy our Regulatory Guide 1.97 commitments nor is it used as an input to other dose calculations.

A wind speed and direction recorder (33 ft) and three temperature displays (33, 150, and 250 ft) are located in the control room. Additional recording and display of meteorological data is provided by the plant process computer system (PPCS). Data from the backup tower can be reviewed in the technical support center (TSC) or the emergency operations facility (EOF) by means of modem connection. A minicomputer at the main tower can be accessed by telephone to get average and instantaneous values of wind speed, wind direction, temperature, and rainfall as well as the meander range for wind direction.

In 1981, RG&E committed to performing semi-annual primary and backup tower instrumentation calibrations (*Reference 20*). In 1992, the meteorological tower system was replaced with state of the art measurement equipment. In 1995, a review of 1994 instrumentation calibration data resulted in a determination that the as-found values were within tolerances and that no instrumentation adjustments were required. Based on the demonstrated reliability of the upgraded instrumentation, the calibration frequency was modified in 1996 to include annual instrumentation calibrations.

## *2.3.4 DIFFUSION ESTIMATES*

### 2.3.4.1 Long-Term Diffusion Characteristics

The long-term diffusion characteristics for the Ginna site were reevaluated in June 1976 pursuant to the requirements of Appendix I to 10 CFR 50 (*References 14* and *15*). The atmospheric diffusion models used are those described in Regulatory Guide 1.111. The meteorological data used for the calculations were data from 1975. Wind roses for 4 years (1966, 1967, 1973-74, and 1975) were used to demonstrate that the 1975 data used in the analysis were consistent with longer term conditions at the site. The diffusion factors are given in Section 2.3.4.1.8.

#### 2.3.4.1.1 Meteorological Data

Table 2.3-7 summarizes data bases available from the site monitoring program. The data periods used for the Regulatory Guide 1.111 calculations are indicated in the right hand column of the table. Data used for the analyses are presented as joint frequency tables. These tables were compiled for the 33 ft level for the 1975 period of record. Table 2.3-8 is a joint frequency table of wind speed, wind direction, and stability group for the 33-ft level using deltaT between 150 ft and 33 ft. These data are used for evaluation of all plant vent locations.
Joint frequency tables similar to Table 2.3-8 for the years 1966, 1967, and 1973-74 are shown in Table 2.3-9. *Figures 2.3-5 through 2.3-8* represent wind roses for each year of data collected up to 1975 from the lower level of the meteorological tower. The lower sensor array was moved from 50 ft to 33 ft in 1974.

Hourly data on meteorological conditions occurring during intermittent release periods have not been included since data for 1973-1975 show that release times were well distributed over the 24-hours period. Because of the intermittent release distribution with regard to time of day, annual average meteorology is considered applicable to such releases.

Inspection of the available records showed that the 1975 data were similar to longer term records previously collected at the site and therefore were appropriate for analyses at the site. For example, diffusion calculations using the wake-split model were made for the plant vent using 3-year composite joint frequency data for comparison with the calculation using 1975 joint frequency data. Results were not significantly different. Thus, from a diffusion standpoint the 1975 data are considered representative of longer term conditions. Another check of long-term representativeness was made by comparing wind roses from the four 1-year site data periods. Figures 2.3-5 through 2.3-8 were compared. They showed close similarity for most years, which further supports the conclusion that the 1975 data were representative of longer term conditions.

#### 2.3.4.1.2 Airflow Trajectory and Terrain Influences

The general flow pattern in the Ginna site region, as indicated by the four wind roses, is from the northwest to the south. During the fall and winter, the eastern two-thirds of the U.S. and the northeastern U.S. in particular is dominated by high pressure centers generally passing to the south of the Ginna region. With their clockwise flow of air, these high pressure centers produce west or southwest winds when to the west of Ginna and south or southeast winds when to the east of Ginna. In the spring and summer there is a general west to east flow

across the U.S., which produces northwest to southwest winds in the Ginna site region depending on the position of the high pressure center. Also, mostly in the summer and scattered through the year, there are some Canadian high pressure centers that pass to the north of Ginna, producing clockwise circulation that accounts for most of the northerly and easterly winds in the area. Low pressure centers are rather frequent in the Ginna area particularly because of its close proximity to the St. Lawrence Valley cyclone storm track. However, these low pressure centers generally move rapidly and affect the area usually with east or northeast winds for only short periods of time.

During periods of light winds, local terrain features and the presence of the lake have some effect on flow patterns in the area. Balloon soundings were made at Ginna and at Oswego about 60 miles east of Ginna in support of a fossil plant application to the state of New York (*Reference 16*). Over 100 soundings were made at various times during a 1 year period. A lake effect circulation pattern was only identified in one of the soundings. Since winds are generally strong in the site region, it is expected that lake effect circulations will occur infrequently. Land breezes during periods when the lake is warmer than the land may also occur; however, these are not apparent from the sounding program results or from the meteorological tower records.

Since the terrain is gently rolling in the site region, it should not have a strong influence on wind patterns or cause flow channeling in any particular direction at the site. This is also confirmed by measurements at the meteorological tower. Since it is not considered practical at the present time to compute estimates using particle-in-cell or puff trajectory diffusion models, correction factors suggested in Regulatory Guide 1.111 for open terrain were used in this analysis. This is considered to result in estimates at distances near the plant which are very unlikely to be exceeded.

#### 2.3.4.1.3 Atmospheric Diffusion Model

Average atmospheric dispersion evaluations were made using the straight line airflow model shown below:

$$\overline{(X/Q^{1})}_D = 2.032 \sum_{ij} n_{ij} \left[N x \bar{u}_i \Sigma_{zj}(x)\right]^{-1} \exp\left[-h_e^2 / 2\sigma_{zj}^2(x)\right]$$

(Equation 2.3-1)

where:

$h_e$ = the effective release height.

$n_{ij}$ = the length of time (hours of valid data) weather conditions are observed to be at a given wind direction, windspeed class, i, and atmospheric stability class, j.

N = the total hours of valid data.

$u_i$ = the geometrical mean of all speeds in the windspeed class, i, at a height representative of release, calms are one-half the threshold anemometer speed or less; extrapolation to higher levels, if necessary, is done by raising the ratio of the two heights to the n

power where n = 0.25, 0.33, and 0.5 for unstable, neutral, and stable conditions, respectively.

$_{z\,j}(x)$ = the vertical plume spread without volumetric correction at distance, x, for stability class, j (see Figure 1 of Regulatory Guide 1.111) based on vertical temperature difference (delta T) and Regulatory Guide 1.23 categorization of Pasquill Groups by delta T.

$\Sigma_{z\,j}(x)$ = the vertical plume spread with a volumetric correction for a release within the building wake cavity, at a distance, x, for stability class, j; otherwise $\Sigma_{z\,j}(x) = \sigma_{z\,j}(x)$.

$\overline{(X/Q')_D}$ = the average effluent concentration, X, normalized by source strength, Q′, at distance, x, in a given downwind direction, D.

2.032 = $(2/\pi)^{1/2}$ divided by the width in radians of a 22.5° sector.

In some cases hourly data were used and the summation over i and j in the above equation was deleted and the summation was accomplished for all hours at all distances for each direction. Dilution was decreased according to terrain correction factors in Figure 2 of Regulatory Guide 1.111. These factors were multiplied by the results from *Equation 2.3-1* and varied in accordance with the direction and distance being evaluated.

### 2.3.4.1.1 Source Configuration Considerations

#### *2.3.4.1.1.1 Unobstructed Release Point*

If a release point is elevated and there are no buildings which would obstruct the plume in its normal trajectory, *Equation 2.3-1* is used with the height of release defined as follows:

$$h_e = h_s + h_{pr} - h_t - c$$

where:

| | | |
|---|---|---|
| $c$ = | correction for low relative exit velocity. |
| $h_e$ = | effective release height. |
| $h_{pr}$ = | rise of the plume above the release point based on Briggs (see below). |
| $h_s$ = | physical height of the release point (the elevation of the stack base should be assumed to be zero). |
| $h_t$ = | maximum terrain height between the release point and the point for which the calculation is made. |

Values of $h_{pr}$ are computed follows for a "jet" since nuclear plant vents have an insignificant amount of buoyancy due to heated discharges

$$h_{pr} = 1.44 D \left(\frac{W_o}{u}\right)^{2/3} \left(\frac{X}{D}\right)^{1/3}$$

(Equation 2.3-2)

up to the point where $h_{pr}$ is the minimum of the following two equations:

$$h_{pr\ max} = 3\left(\frac{W_o}{u}\right)D$$

(Equation 2.3-3)

or

$$h_{pr\ max} = 1.5\left(\frac{F_m}{u}\right)^{1/3} s^{-1/6}$$

(Equation 2.3-4)

where symbols are as before, and

$D$ = stack or vent effective inside diameter (m)

$W_o$ = stack or vent exit velocity (m/sec)

$u$ = wind speed at discharge level (m/sec)

$F_m$ = momentum flux ($m^4/sec^2$)

$s$ = stability parameter ($sec^{-2}$)

#### *2.3.4.1.1.2 Obstructed Release Point*

If the plume trajectory from a release point (vent) does not remain outside of building wake influences near large structures, all or portions of the plume are considered to be entrapped and brought to ground level in the turbulent wake of the building. The criteria for determining the portion of the plume treated as an elevated or ground release follow from Equations 6, 7, and 8 of Regulatory Guide 1.111 and are repeated here for completeness.

If $W_o/\bar{u} > 5.0$ use $h_e$ as calculated above

If $W_o/\bar{u} \leq 1.0$ use $h_e = 0$

$$\text{If } 1 < \frac{W_o}{\bar{u}} \leq 1.5 \qquad E_t = 2.58 - 1.58\left(\frac{W_o}{\bar{u}}\right)$$

(Equation 2.3-5)

$$\text{If } 1.5 < \frac{W_o}{\bar{u}} \leq 5.0 \qquad E_t = 0.3 - 0.06\left(\frac{W_o}{\bar{u}}\right)$$

(Equation 2.3-6)

The appropriate diffusion estimate is then computed by assuming an elevated release 100 (1 - $E_t$) percent of the time and by assuming ground release 100 $E_t$ percent of the time. Calculations utilizing this mixed model are referred to as wake-split calculations.

A building wake correction is computed for all ground releases near structures in accordance with the following general equation:

$$\Sigma = \sqrt{\sigma_z^2 + cH^2 / \pi} \leq 1.73\sigma_z$$

(Equation 2.3-7)

| | | |
|---|---|---|
| where: | *Σ* = | effective dispersion coefficient for use in *Equation 2.3-1* ($m_p$) |
| | *c* = | building wake coefficient (c = 0.5). |
| | *H* = | height of the tallest structure in the nuclear plant power block (m) |

#### 2.3.4.1.5 Removal Mechanisms

As radioactive effluent in a plume travels downwind, it is subject to several removal mechanisms including radioactive decay, dry deposition, and wet deposition (during rain). Corrections for radioactive decay are not made in the estimates reported in this section.

Dry deposition which results in depletion of halogen and particulate isotopes from the plume is considered only to the extent suggested in Regulatory Guide 1.111. Depletion factors in these curves are a function of height and distance; therefore, for sites where elevated releases occur the terrain must be subtracted from the plume height before entering the curves at the appropriate distance. Each elevated or ground level X/Q is multiplied by the depletion and the terrain correction factors before combining to give the final depleted X/Q value.

To determine relative deposition rate as a function of distance and stability the curves given in Figures 7 through 10 of Regulatory Guide 1.111 are used. Again, terrain heights are subtracted before the table look-up is made. Terrain correction factors, if any, multiply each D/Q value. Values from the curves are divided by the sector cross width (arc) at the point of calculation.

Dry deposition is believed to adequately represent overall deposition rates, since seasonal rainfall is fairly uniform; therefore, wet deposition has not been considered.

#### 2.3.4.1.6 Summary of Plant Discharges

A summary of plant vent information for each discharge point is given in Tables 2.3-10 and 2.3-11. Only vents used during routine operation are considered in this evaluation.

#### 2.3.4.1.7 Input Assumptions

Table 2.3-12 tabulates all pertinent input information utilized in making the model calculations. Table 2.3-13 gives terrain elevations for all distances out to 10 miles. Terrain height is

conservatively not allowed to decrease with increasing distance or to decrease below plant grade in accordance with Regulatory Guide 1.111.

#### 2.3.4.1.8 Results

Resulting X/Q, depleted X/Q, and D/Q values are listed in *Reference 14*, (pages 89-94) for each direction sector for ten distances. These results are used as input for the dose calculations described in Section 11.3.

Tables 2.3-14 through 2.3-19 are reproduced from *Reference 14* (pages 96-102). These tables summarize the resulting diffusion factors for each of the receptor locations. Each table represents model results for one vent location for each season being evaluated. One set of calculations was made for the plant vents located on the intermediate building roof through which most effluents are discharged and a second set of calculations was made for vents which are assumed to release into the building wake in all wind conditions.

### 2.3.4.2 Accident Analysis Diffusion Characteristics

The atmospheric transport and diffusion characteristics for accident analysis at the Ginna site were reevaluated during the review of Systematic Evaluation Program (SEP) Topic II-2.C. Specifically, the NRC calculated the X/Q values for the Ginna site, with the results appearing in *Reference 17*. The results of the RG&E evaluation appear in *Reference 18*. The two evaluations are discussed below, but have been superseded and are included here for historical purposes.

As part of the Control Room Emergency Air Treatment System (CREATS) Modification, new accident dose analyses were required for the control room because of the characteristics of the new system. For consistency, it was decided to calculate new dose values for the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ), and to update the analysis using the alternate source term per *Reference 21*. New atmospheric dispersion coefficients (X/Q) were calculated as part of this effort and are detailed in *Reference 22*. The NRC approved these new X/Q values and dose analyses in *Reference 23*, as supplemented by *Reference 24*.

#### 2.3.4.2.1 Nuclear Regulatory Commission Evaluation (Historical)

The atmospheric dispersion factors were calculated using the direction dependent method described in Regulatory Guide 1.145. The model considers the directionally dependent atmospheric dispersion conditions. Specifically, the model considers the following effects:

A. Lateral plume meander, as a function of atmospheric stability, wind speed, and distance from the source, during periods of low wind speeds (less than 6 m/sec) and neutral and stable atmospheric conditions.
B. Exclusion area boundary distance as a function of direction from the plant.
C. Atmospheric dispersion conditions when the wind is blowing in a specific direction.
D. The fraction of time that the wind can be expected to blow into each of the 16 compass directions.

For the purpose of this evaluation available onsite meteorological data for the periods 1966-1967 and 1973-1974 were used (see Table 2.3-9). For the composite data set, wind speed and wind direction were measured at the 50-ft level with the wind speeds reduced by means of a power law to represent conditions at the 33-ft level. Atmospheric stability was defined by the vertical temperature gradient measured between the 33-ft and 150-ft levels. The maximum X/Q value was calculated for the southeast direction, 503 m from the plant.

Using the composite of onsite meteorological data, the following X/Q values for an assumed ground-level release with a building wake factor, cA, of 440 $m^2$ were determined at distances corresponding to the exclusion area boundary (EAB) and the outer boundary of the low-population zone (LPZ) in an onshore direction.

| **Time Period** | **Distance** | **X/Q (sec/m 3)** |
|---|---|---|
| 0 to 2 hours | EAB (503 m SE) | $4.8 \times 10^{-4}$ |
| 0 to 8 hours | LPZ (4827 m) | $3.0 \times 10^{-5}$ |
| 8 to 24 hours | LPZ (4827 m) | $2.1 \times 10^{-5}$ |
| 1 to 4 days | LPZ (4827 m) | $8.6 \times 10^{-6}$ |
| 4 to 30 days | LPZ (4827 m) | $2.5 \times 10^{-6}$ |

### 2.3.4.2.1 Rochester Gas and Electric Corporation Evaluation (Historical)

The atmospheric dispersion factors were calculated using the direction dependent method described in Regulatory Guide 1.145 (0.5% probability). Considerations used in the analysis include the following:

A. Lateral plume meander, as a function of atmospheric stability, wind speed and distance from the source, during periods of low wind speeds (less than 6 m/sec) and neutral and stable atmospheric conditions.

B. Atmospheric dispersion conditions when the wind is blowing in each specific onshore direction using hourly meteorological data in the WINDOW program (*Reference 19*).

C. The release was assumed to be at ground level.

D. A building wake factor has been applied (cA = 440 $m^2$).

E. Three years of meteorological data (1966, 1967, and 1973-1974) were used (see Table 2.3-9).

F. The exclusion area boundary in each of 16 directions is as shown in Table 2.3-20. The distance to the low-population zone is 4827 m.

| Time Period | Location | X/Q (sec/m 3) |
|---|---|---|
| 0 to 2 hours | EAB | $2.2 \times 10^{-4}$ |
| 0 to 8 hours | LPZ (4827 m) | $2.3 \times 10^{-5}$ |
| 8 to 24 hours | LPZ (4827 m) | $7.0 \times 10^{-6}$ |
| 1 to 4 days | LPZ (4827 m) | $2.7 \times 10^{-6}$ |
| 4 to 30 days | LPZ (4827 m) | $1.1 \times 10^{-6}$ |

### 2.3.4.2.2 Current Approved Evaluation

The current approved evaluation was performed using the KRPavan computer code, and is detailed in *Reference 22*. Assumptions and results are below:

- Meteorological data for the years 1999 through 2003 was used in this analysis. Unlike ARCON96 (used in the control room $\chi$/Q determinations), KRPavan does not consider missing or invalid data. As such, missing and invalid hours are deleted from the SQRT files.
- There are a total of 43,824 available hours. Of these, 556 are missing (not recorded) and 835 hours are determined to be invalid. The net hours of available data is 42,433. A sample KRPavan output file shows that only 42,430 hours of data were read, i.e., 3 hours were omitted from the joint frequency distribution. No effort was made to recover the 3 hours of missing data. The data recovery fraction is:

  42,430/43,824 = 0.968, or about 97 percent.

This exceeds the 90% minimum data recovery suggested in Regulatory Guide 1.23.

- Activity releases are assumed to be at ground level
- The height of the lower and upper level wind speed measurement instruments are 10 meters (33 ft) and 45.7 meters (150 ft), respectively. The upper level height is provided for information.
- Calm hours are distributed in the first wind speed category of the joint frequency distribution.
- The assumed building wake area is normal to a line drawn from the source to the receptor. Incident air flow, striking a simple block building, may move upward or sideways, depending on the position of the edges of the roof or sides. Clusters of buildings, like the Ginna site, that have a greater vertical area (and more roofs and edges) than a single structure, e.g. the facade, are effective wake producers.
- The vertical cross-section area, conservatively assumed for the building-wake correction, is $1850m^2$. This is the area of the Containment Building Facade assumed for containment leakage. Other values are also used ($1071m^2$ and $1800m^2$) to investigate sensitivity to changing wake area.
- The direction dependant Exclusion Area Boundary (EAB) χ/Q values for licensing basis case are shown on Table 2.3-21. The direction dependant Low Population Zone (LPZ) χ/Q values for the licensing basis case are shown on Table 2.3-22.
- Figure 2.3-9 shows the plant layout, including activity release points and elevations of the major structural high-points. All activity releases are not assumed into the containment wake, rather, all releases are assumed into the wake produced by the overall facility. A conservatively small wake area is assumed.
- Fourteen wind speed categories are assumed.
- Wind speed is input in meters/sec.

The off-site χ/Q values are summarized below:

| **Boundary** | **0-2 hours** | **0-8 hours** | **8-24 hours** | **24-96 hours** | **96-720 hours** |
|---|---|---|---|---|---|
| EAB | 2.17E-4 | - | - | - | - |
| LPZ | 4.97E-5 | 2.51E-5 | 1.78E-5 | 8.5E-6 | 2.93E-5 |

#### 2.3.4.2.1 Conclusions

The atmospheric dispersion values described in Section 2.3.4.2.3 are the values that Ginna LLC will use in the future in estimating offsite radiological exposures from hypothetical accidents.

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# Table 2.3-1

## WIND VELOCITY SUMMARY GINNA SITE TOWER, 50 FT. TOWER (FEBRUARY 1965 - JANUARY 1967, INCLUSIVE)

| wind speed | calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Tot | Avg | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | |
| 0 | 157 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 157 | 0 | 0.97 |
| 1-3 | 0 | 82 | 86 | 52 | 83 | 119 | 74 | 75 | 74 | 89 | 124 | 156 | 115 | 74 | 55 | 85 | 123 | 1466 | 2 | 9.18 |
| 4-7 | 0 | 128 | 100 | 87 | 154 | 266 | 191 | 186 | 229 | 386 | 611 | 787 | 537 | 265 | 244 | 278 | 161 | 4610 | 5 | 28.8 |
| 8-12 | 0 | 134 | 83 | 102 | 154 | 259 | 140 | 123 | 276 | 482 | 421 | 602 | 672 | 565 | 559 | 299 | 192 | 5063 | 9 | 31.6 |
| 13-18 | 0 | 68 | 63 | 97 | 105 | 91 | 57 | 40 | 159 | 287 | 75 | 129 | 355 | 598 | 469 | 283 | 145 | 3021 | 14 | 18.8 |
| 19-25 | 0 | 8 | 23 | 44 | 46 | 34 | 6 | 5 | 41 | 70 | 4 | 5 | 100 | 311 | 251 | 212 | 58 | 1218 | 21 | 7.6 |
| 26-32 | 0 | 0 | 13 | 12 | 10 | 5 | 0 | 0 | 5 | 10 | 0 | 1 | 23 | 76 | 94 | 118 | 21 | 388 | 28 | 2.5 |
| 33-40 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 18 | 19 | 36 | 0 | 79 | 34 | 0.5 |
| 40+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 0 | 7 | 48 | 0.05 |
| | | | | | | | | | | | | | | | | | | | | |
| TOT | 157 | 420 | 371 | 396 | 552 | 774 | 468 | 429 | 784 | 1324 | 1235 | 1680 | 1803 | 1908 | 1694 | 1314 | 700 | 16009 | 10 | --- |
| | | | | | | | | | | | | | | | | | | | | |
| AVG | 0 | 8 | 9 | 11 | 9 | 8 | 7 | 7 | 9 | 9 | 7 | 7 | 9 | 13 | 13 | 14 | 10 | 10 | --- | --- |
| | | | | | | | | | | | | | | | | | | | | |
| % | 0.97 | 2.65 | 2.35 | 2.50 | 3.50 | 4.86 | 2.94 | 2.69 | 4.92 | 8.32 | 7.74 | 10.3 | 11.2 | 11.8 | 10.6 | 8.22 | 4.39 | --- | --- | --- |

# Table 2.3-2

## WIND VELOCITY SUMMARY GINNA SITE TOWER, 150 FT. TOWER (FEBRUARY 1965 - JANUARY 1967, INCLUSIVE)

| wind speed | calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Tot | Avg | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | |
| 0 | 242 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 242 | 0 | 1.48 |
| 1-3 | 0 | 83 | 57 | 66 | 66 | 90 | 47 | 57 | 52 | 39 | 45 | 61 | 47 | 42 | 57 | 87 | 89 | 985 | 2 | 6.0 |
| 4-7 | 0 | 120 | 92 | 118 | 191 | 228 | 147 | 187 | 149 | 156 | 200 | 248 | 225 | 219 | 246 | 187 | 138 | 2851 | 5 | 17.5 |
| 8-12 | 0 | 88 | 67 | 106 | 183 | 234 | 242 | 231 | 335 | 465 | 391 | 651 | 741 | 611 | 516 | 267 | 122 | 5250 | 10 | 32.2 |
| 13-18 | 0 | 126 | 72 | 96 | 98 | 124 | 58 | 80 | 322 | 408 | 329 | 415 | 526 | 613 | 569 | 273 | 181 | 4290 | 15 | 26.3 |
| 19-25 | 0 | 65 | 31 | 57 | 45 | 35 | 6 | 18 | 143 | 169 | 31 | 68 | 206 | 342 | 334 | 214 | 158 | 1922 | 21 | 11.8 |
| 26-32 | 0 | 3 | 10 | 12 | 16 | 4 | 0 | 1 | 29 | 22 | 0 | 4 | 58 | 122 | 116 | 126 | 60 | 583 | 28 | 3.5 |
| 33-40 | 0 | 0 | 4 | 9 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 8 | 37 | 29 | 65 | 17 | 173 | 35 | 1.0 |
| 40+ | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 7 | 6 | 27 | 7 | 52 | 50 | 0.3 |
| | | | | | | | | | | | | | | | | | | | | |
| TOT | 242 | 485 | 334 | 464 | 601 | 715 | 501 | 575 | 1031 | 1259 | 997 | 1448 | 1812 | 1993 | 1873 | 1246 | 772 | 16348 | 12 | --- |
| | | | | | | | | | | | | | | | | | | | | |
| AVG | 0 | 10 | 10 | 11 | 9 | 9 | 8 | 8 | 12 | 12 | 10 | 10 | 12 | 14 | 14 | 16 | 14 | 12 | --- | --- |
| | | | | | | | | | | | | | | | | | | | | |
| % | 1.48 | 2.96 | 2.04 | 2.84 | 3.65 | 4.35 | 3.0 | 3.5 | 6.3 | 7.7 | 6.1 | 8.8 | 11.3 | 12.2 | 11.4 | 7.65 | 4.7 | --- | --- | --- |

## Table 2.3-3
## WIND VELOCITY SUMMARY GINNA SITE TOWER, 250 FT. TOWER (FEBRUARY 1965 - JANUARY 1967, INCLUSIVE)

| wind speed | calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Tot | Avg | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | |
| 0 | 129 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 129 | 0 | 0.78 |
| 1-3 | 0 | 56 | 54 | 55 | 51 | 70 | 34 | 26 | 35 | 25 | 22 | 50 | 44 | 36 | 54 | 70 | 64 | 746 | 2 | 4.52 |
| 4-7 | 0 | 98 | 94 | 125 | 155 | 152 | 100 | 88 | 85 | 87 | 101 | 131 | 115 | 117 | 163 | 150 | 113 | 1874 | 5 | 11.3 |
| 8-12 | 0 | 86 | 74 | 127 | 182 | 208 | 171 | 152 | 175 | 220 | 202 | 311 | 391 | 380 | 415 | 283 | 120 | 3497 | 10 | 21.1 |
| 13-18 | 0 | 100 | 87 | 110 | 120 | 156 | 142 | 178 | 290 | 404 | 314 | 542 | 759 | 817 | 615 | 316 | 174 | 5124 | 15 | 31.1 |
| 19-25 | 0 | 96 | 59 | 67 | 65 | 70 | 31 | 49 | 249 | 346 | 237 | 338 | 401 | 610 | 482 | 342 | 161 | 3603 | 21 | 21.7 |
| 26-32 | 0 | 22 | 12 | 18 | 13 | 20 | 2 | 3 | 73 | 102 | 14 | 30 | 89 | 213 | 230 | 211 | 69 | 1121 | 28 | 6.7 |
| 33-40 | 0 | 1 | 11 | 8 | 1 | 5 | 3 | 1 | 14 | 19 | 0 | 0 | 14 | 81 | 90 | 107 | 31 | 386 | 35 | 2.3 |
| 40+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 36 | 16 | 39 | 3 | 98 | 45 | 0.6 |
| | | | | | | | | | | | | | | | | | | | | |
| TOT | 129 | 459 | 391 | 510 | 587 | 681 | 483 | 497 | 922 | 1203 | 890 | 1402 | 1816 | 2290 | 2065 | 1518 | 735 | 16578 | 15 | --- |
| | | | | | | | | | | | | | | | | | | | | |
| AVG | 0 | 12 | 12 | 11 | 10 | 11 | 10 | 11 | 16 | 16 | 14 | 14 | 15 | 17 | 17 | 18 | 15 | 15 | --- | --- |
| | | | | | | | | | | | | | | | | | | | | |
| % | 0.78 | 2.75 | 2.32 | 3.05 | 3.5 | 4.1 | 2.9 | 3.0 | 5.55 | 7.30 | 5.35 | 8.5 | 11.0 | 13.8 | 12.5 | 9.2 | 4.4 | --- | --- | --- |

# Table 2.3-4

## WIND VELOCITY SUMMARY (HOURS) ROCHESTER AIRPORT FIVE YEARS

| wind-speed MPH | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| calm | 652 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 652 | 1.50 |
| 1-3 | 0 | 70 | 56 | 74 | 136 | 194 | 262 | 346 | 264 | 403 | 297 | 357 | 165 | 102 | 97 | 66 | 66 | 2955 | 6.7 |
| 4-7 | 0 | 216 | 156 | 185 | 503 | 624 | 653 | 716 | 606 | 1006 | 1248 | 1158 | 783 | 342 | 347 | 327 | 245 | 9115 | 20.8 |
| 8-14 | 0 | 548 | 627 | 662 | 793 | 862 | 632 | 456 | 771 | 1732 | 2879 | 2108 | 2813 | 1188 | 1363 | 938 | 777 | 19149 | 43.8 |
| 15-39 | 0 | 221 | 303 | 342 | 104 | 101 | 108 | 78 | 249 | 485 | 922 | 1081 | 4392 | 1233 | 1516 | 517 | 268 | 11920 | 27.2 |
| 40-49 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 22 | 0 | 0 | 0 | 0 | 26 | nil |
| 50+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 5 | nil |
| | | | | | | | | | | | | | | | | | | | |
| TOT | 652 | 1055 | 1144 | 1263 | 1536 | 1781 | 1655 | 1596 | 1890 | 3626 | 5346 | 4706 | 8180 | 2865 | 3323 | 1848 | 1356 | 43822 | --- |
| | | | | | | | | | | | | | | | | | | | |
| % | 1.5 | 2.4 | 2.6 | 2.9 | 3.5 | 4.1 | 3.8 | 3.6 | 4.3 | 8.3 | 12.2 | 10.8 | 18.7 | 6.5 | 7.6 | 4.2 | 3.1 | --- | --- |

## Table 2.3-5

## WIND VELOCITY SUMMARY (HOURS) DURING PRECIPITATION ROCHESTER AIRPORT

| wind-speed MPH | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| calm | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0.71 |
| 1-3 | --- | 6 | 4 | 17 | 23 | 26 | 29 | 35 | 21 | 27 | 30 | 32 | 17 | 17 | 16 | 8 | 13 | 321 | 3.80 |
| 4-7 | --- | 28 | 20 | 37 | 101 | 84 | 108 | 102 | 70 | 91 | 84 | 113 | 112 | 63 | 64 | 59 | 30 | 1166 | 13.8 |
| 8-14 | --- | 126 | 126 | 151 | 261 | 219 | 166 | 97 | 148 | 169 | 268 | 228 | 552 | 235 | 299 | 230 | 192 | 3467 | 41.1 |
| 15-39 | --- | 116 | 140 | 164 | 64 | 41 | 49 | 29 | 50 | 74 | 121 | 193 | 1111 | 393 | 537 | 178 | 150 | 3410 | 40.4 |
| 40-49 | --- | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 7 | --- |
| 50+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | --- |
| | | | | | | | | | | | | | | | | | | | |
| TOT | --- | 276 | 292 | 369 | 449 | 370 | 352 | 263 | 289 | 361 | 503 | 566 | 1797 | 708 | 916 | 475 | 385 | 8431 | --- |
| | | | | | | | | | | | | | | | | | | | |
| % | 60 | 3.28 | 3.48 | 4.38 | 5.33 | 4.4 | 4.18 | 3.1 | 3.44 | 4.28 | 6.0 | 6.7 | 21.2 | 8.41 | 10.8 | 5.64 | 4.57 | --- | --- |

## Table 2.3-6
## WIND VELOCITY SUMMARY (HOURS) ROCHESTER COAST GUARD STATION (1951 - 1955)

| Wind-Speed MPH | N | NE | E | SE | S | SW | W | NW | CALM | TOTAL | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| calm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 53 | 0.9 |
| 1-3 | 79 | 92 | 135 | 122 | 125 | 299 | 157 | 75 | --- | 1084 | 18.3 |
| 4-7 | 111 | 123 | 149 | 176 | 171 | 572 | 382 | 136 | --- | 1820 | 30.6 |
| 8-14 | 93 | 161 | 183 | 135 | 104 | 515 | 470 | 244 | --- | 1905 | 32.0 |
| 15-39 | 64 | 123 | 101 | 43 | 33 | 223 | 319 | 179 | --- | 1085 | 18.2 |
| 40-49 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | --- | 4 | --- |
| 50+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | --- | 0 | 0 |
| | | | | | | | | | | | |
| TOTAL | 348 | 502 | 568 | 476 | 433 | 1609 | 1328 | 634 | --- | 5951 | --- |
| | | | | | | | | | | | |
| % | 5.9 | 8.4 | 9.5 | 8.0 | 7.3 | 27.0 | 22.3 | 10.7 | 0.9 | --- | --- |
| | | | | | | | | | | | |

**Table 2.3-7**

**SUMMARY OF METEOROLOGICAL DATA GINNA SITE**

| Period of Record | Speed and Direction Level (ft.) | Temperature Difference Between (ft.) | Combined Percent Recovery | Comment |
|---|---|---|---|---|
| 12/65 - 12/66 | 50 | 150 - 10 | 91.0 | Used for 3-year composite for |
| 1/67 - 12/67 | 50 | 150 - 10 | 95.0 | Used for 3-year composite for |
| 1/68 - 4/73 | 50 | 150 - 10 | Not determined | Not used for analysis |
| 5/13/73 - 5/13/74 | 50 | 150 - 10 | 83.3 | Used for 3-year composite for |
| 1/75 - 12/75 | 33 | 150 - 33 | 84.1 | Used for diffusion calculations |
| Composite of 1/66 - 12/66 1/67 - 12/67 5/13/73 - 5/13/74 | 50 | 150 - 33 | 92.3 | Used for comparison with 1975 data |

## Table 2.3-8a

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference ≤ -1.0 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 10 | 0.7 | 1.79 |
| 2.1 - 3.5 | 5 | 4 | 7 | 2 | 1 | 0 | 0 | 1 | 45 | 3.1 | 2.87 |
| 3.6 - 7.5 | 19 | 14 | 32 | 6 | 12 | 5 | 9 | 16 | 269 | 18.7 | 5.62 |
| 7.6 - 12.5 | 17 | 23 | 46 | 22 | 13 | 11 | 22 | 20 | 405 | 28.1 | 9.79 |
| 12.6 - 18.5 | 26 | 14 | 18 | 10 | 4 | 2 | 12 | 6 | 350 | 24.3 | 15.07 |
| 18.6 - 24.5 | 3 | 9 | 34 | 10 | 6 | 1 | 1 | 10 | 249 | 17.3 | 21.18 |
| 24.6+ | 0 | 0 | 1 | 9 | 7 | 0 | 0 | 3 | 113 | 7.8 | 30.06 |
| TOTAL | 70 | 65 | 140 | 59 | 43 | 19 | 44 | 56 | 1441 | 100.0 | 9.65 |
| PERCENT | 4.9 | 4.5 | 9.7 | 4.1 | 3.0 | 1.3 | 3.1 | 3.9 | 100.0 | --- | --- |
| AVG SPEED | 10.8 | 11.2 | 12.2 | 14.8 | 13.9 | 9.3 | 10.5 | 12.3 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 13.8 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 5 | | | | | | | | | | | |

## Table 2.3-8b

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference ≤ -1.0 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 10 | 0.7 | 1.79 |
| 2.1 - 3.5 | 2 | 1 | 0 | 2 | 1 | 4 | 8 | 7 | 45 | 3.1 | 2.87 |
| 3.6 - 7.5 | 14 | 12 | 10 | 7 | 22 | 46 | 25 | 20 | 269 | 18.7 | 5.62 |
| 7.6 - 12.5 | 18 | 23 | 14 | 23 | 65 | 23 | 34 | 31 | 405 | 28.1 | 9.79 |
| 12.6 - 18.5 | 13 | 18 | 18 | 27 | 54 | 37 | 36 | 55 | 350 | 24.3 | 15.07 |
| 18.6 - 24.5 | 4 | 3 | 10 | 18 | 22 | 38 | 70 | 10 | 249 | 17.3 | 21.18 |
| 24.6+ | 2 | 0 | 0 | 3 | 9 | 25 | 52 | 2 | 113 | 7.8 | 30.06 |
| TOTAL | 53 | 57 | 52 | 81 | 174 | 175 | 227 | 126 | 1441 | 100.0 | 9.65 |
| PERCENT | 3.7 | 4.0 | 3.6 | 5.6 | 12.1 | 12.1 | 15.8 | 8.7 | 100.0 | --- | --- |
| AVG SPEED | 11.3 | 11.0 | 13.1 | 14.4 | 13.6 | 15.5 | 18.7 | 12.1 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 13.8 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 5 | | | | | | | | | | | |

## Table 2.3-8c

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -1.0 BUT ≤ -0.9 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0.2 | 1.70 |
| 2.1 - 3.5 | 2 | 0 | 3 | 0 | 1 | 0 | 1 | 2 | 19 | 4.5 | 2.86 |
| 3.6 - 7.5 | 3 | 5 | 8 | 2 | 2 | 4 | 5 | 3 | 81 | 19.3 | 5.79 |
| 7.6 - 12.5 | 5 | 5 | 12 | 6 | 4 | 5 | 18 | 17 | 143 | 34.0 | 9.70 |
| 12.6 - 18.5 | 7 | 5 | 5 | 3 | 4 | 2 | 4 | 5 | 102 | 24.3 | 14.44 |
| 18.6 - 24.5 | 1 | 2 | 3 | 2 | 0 | 0 | 0 | 5 | 49 | 11.7 | 21.84 |
| 24.6+ | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 25 | 6.0 | 30.59 |
| TOTAL | 18 | 17 | 31 | 14 | 13 | 11 | 28 | 32 | 420 | 100.0 | 9.10 |
| PERCENT | 4.3 | 4.0 | 7.4 | 3.3 | 3.1 | 2.6 | 6.7 | 7.6 | 100.0 | --- | --- |
| AVG SPEED | 11.3 | 11.1 | 9.8 | 13.6 | 11.5 | 9.1 | 9.3 | 11.2 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 12.6 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 2 | | | | | | | | | | | |

## Table 2.3-8d

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -1.0 BUT ≤ -0.9 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.2 | 1.70 |
| 2.1 - 3.5 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 2 | 19 | 4.5 | 2.86 |
| 3.6 - 7.5 | 12 | 12 | 9 | 3 | 3 | 4 | 4 | 2 | 81 | 19.3 | 5.79 |
| 7.6 - 12.5 | 11 | 13 | 10 | 12 | 16 | 3 | 5 | 1 | 143 | 34.0 | 9.70 |
| 12.6 - 18.5 | 10 | 4 | 6 | 24 | 12 | 6 | 2 | 3 | 102 | 24.3 | 14.44 |
| 18.6 - 24.5 | 0 | 2 | 4 | 4 | 5 | 11 | 10 | 0 | 49 | 11.7 | 21.84 |
| 24.6+ | 1 | 0 | 1 | 3 | 4 | 8 | 6 | 0 | 25 | 6.0 | 30.59 |
| TOTAL | 35 | 31 | 30 | 46 | 41 | 34 | 31 | 8 | 420 | 100.0 | 9.10 |
| PERCENT | 8.3 | 7.4 | 7.1 | 11.0 | 9.8 | 8.1 | 7.4 | 1.9 | 100.0 | --- | --- |
| AVG SPEED | 9.9 | 9.6 | 11.8 | 14.5 | 14.3 | 19.1 | 17.7 | 9.3 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 12.6 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 2 | | | | | | | | | | | |

## Table 2.3-8e

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -0.9 but ≤ -0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0.7 | 1.46 |
| 2.1 - 3.5 | 0 | 5 | 4 | 3 | 1 | 1 | 2 | 0 | 35 | 5.8 | 2.89 |
| 3.6 - 7.5 | 6 | 7 | 8 | 6 | 16 | 3 | 6 | 13 | 139 | 23.2 | 5.61 |
| 7.6 - 12.5 | 3 | 5 | 4 | 10 | 9 | 8 | 25 | 34 | 206 | 34.3 | 9.71 |
| 12.6 - 18.5 | 5 | 2 | 4 | 4 | 4 | 1 | 9 | 16 | 148 | 24.7 | 15.01 |
| 18.6 - 24.5 | 0 | 1 | 2 | 3 | 0 | 0 | 1 | 2 | 47 | 7.8 | 20.57 |
| 24.6+ | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 21 | 3.5 | 28.69 |
| TOTAL | 14 | 20 | 22 | 26 | 32 | 13 | 44 | 67 | 600 | 100.0 | 8.14 |
| PERCENT | 2.3 | 3.3 | 3.7 | 4.3 | 5.3 | 2.2 | 7.3 | 11.2 | 100.0 | --- | --- |
| AVG SPEED | 10.1 | 8.2 | 9.0 | 10.1 | 9.5 | 8.5 | 10.1 | 11.3 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 11.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 0 | | | | | | | | | | | |

## Table 2.3-8f

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -0.9 but ≤ -0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 4 | 0.7 | 1.46 |
| 2.1 - 3.5 | 2 | 4 | 0 | 1 | 2 | 3 | 3 | 4 | 35 | 5.8 | 2.89 |
| 3.6 - 7.5 | 17 | 14 | 10 | 7 | 10 | 9 | 4 | 3 | 139 | 23.2 | 5.61 |
| 7.6 - 12.5 | 15 | 15 | 17 | 32 | 19 | 7 | 0 | 3 | 206 | 34.3 | 9.71 |
| 12.6 - 18.5 | 8 | 2 | 11 | 33 | 33 | 8 | 6 | 2 | 148 | 24.7 | 15.01 |
| 18.6 - 24.5 | 1 | 1 | 1 | 9 | 13 | 6 | 7 | 0 | 47 | 7.8 | 20.57 |
| 24.6+ | 1 | 0 | 0 | 5 | 4 | 4 | 3 | 0 | 21 | 3.5 | 28.69 |
| TOTAL | 44 | 37 | 39 | 88 | 82 | 37 | 23 | 12 | 600 | 100.0 | 8.14 |
| PERCENT | 7.3 | 6.2 | 6.5 | 14.7 | 13.7 | 6.2 | 3.8 | 2.0 | 100.0 | --- | --- |
| AVG SPEED | 9.5 | 7.4 | 11.1 | 13.6 | 13.7 | 13.5 | 16.8 | 7.0 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 11.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 0 | | | | | | | | | | | |

## Table 2.3-8g

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -0.8 but ≤ -0.3 (°F /100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 6 | 0.2 | 0.30 |
| CALM+ - 2.0 | 8 | 2 | 4 | 3 | 1 | 3 | 3 | 3 | 45 | 1.5 | 1.15 |
| 2.1 - 3.5 | 14 | 10 | 15 | 6 | 7 | 6 | 11 | 10 | 155 | 5.2 | 2.83 |
| 3.6 - 7.5 | 27 | 17 | 24 | 33 | 54 | 34 | 46 | 53 | 714 | 24.2 | 5.58 |
| 7.6 - 12.5 | 28 | 12 | 22 | 28 | 60 | 43 | 68 | 120 | 1011 | 34.2 | 9.71 |
| 12.6 - 18.5 | 20 | 7 | 9 | 34 | 19 | 6 | 22 | 69 | 669 | 22.6 | 14.94 |
| 18.6 - 24.5 | 17 | 3 | 10 | 12 | 4 | 0 | 3 | 24 | 235 | 7.9 | 21.00 |
| 24.6+ | 2 | 2 | 1 | 4 | 5 | 0 | 0 | 16 | 121 | 4.1 | 28.30 |
| TOTAL | 116 | 53 | 86 | 120 | 152 | 92 | 153 | 304 | 2956 | 100.0 | 7.28 |
| PERCENT | 3.9 | 1.8 | 2.9 | 4.1 | 5.1 | 3.1 | 5.2 | 10.3 | 100.0 | --- | --- |
| AVG SPEED | 10.2 | 8.8 | 8.9 | 11.3 | 9.8 | 8.0 | 9.1 | 12.0 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 11.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 16 | | | | | | | | | | | |

## Table 2.3-8h

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

Temperature Difference > -0.8 but ≤ -0.3 (°F /100 FT)

WIND DIRECTION

| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO-MEAN SPD (MPH) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 6 | 0.2 | 0.30 |
| CALM+ - 2.0 | 2 | 3 | 2 | 4 | 4 | 0 | 2 | 1 | 45 | 1.5 | 1.15 |
| 2.1 - 3.5 | 19 | 17 | 8 | 8 | 7 | 6 | 3 | 8 | 155 | 5.2 | 2.83 |
| 3.6 - 7.5 | 113 | 117 | 68 | 36 | 28 | 21 | 24 | 19 | 714 | 24.2 | 5.58 |
| 7.6 - 12.5 | 115 | 102 | 109 | 132 | 72 | 22 | 42 | 28 | 1011 | 34.2 | 9.71 |
| 12.6 - 18.5 | 40 | 25 | 44 | 134 | 99 | 62 | 54 | 25 | 669 | 22.6 | 14.94 |
| 18.6 - 24.5 | 13 | 4 | 5 | 29 | 59 | 27 | 23 | 2 | 235 | 7.9 | 21.00 |
| 24.6+ | 6 | 0 | 5 | 27 | 21 | 18 | 13 | 0 | 121 | 4.1 | 28.30 |
| TOTAL | 309 | 269 | 241 | 370 | 290 | 156 | 162 | 83 | 2956 | 100.0 | 7.28 |
| PERCENT | 10.5 | 9.1 | 8.2 | 12.5 | 9.8 | 5.3 | 5.5 | 2.8 | 100.0 | --- | --- |
| AVG SPEED | 9.3 | 8.0 | 9.9 | 13.4 | 14.9 | 15.3 | 14.1 | 10.1 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 11.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 16 | | | | | | | | | | | |

**Table 2.3-8i**

**JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)**

| Temperature Difference > -0.3 but ≤ -0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO-MEAN SPD (MPH) |
| CALM | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0.2 | 0.30 |
| CALM+ - 2.0 | 0 | 2 | 3 | 2 | 2 | 2 | 7 | 5 | 37 | 2.7 | 1.25 |
| 2.1 - 3.5 | 6 | 7 | 10 | 8 | 2 | 3 | 6 | 11 | 126 | 9.0 | 2.13 |
| 3.6 - 7.5 | 3 | 3 | 12 | 12 | 28 | 20 | 25 | 51 | 541 | 38.8 | 5.36 |
| 7.6 - 12.5 | 2 | 3 | 2 | 10 | 14 | 22 | 26 | 90 | 429 | 30.8 | 9.55 |
| 12.6 - 18.5 | 1 | 2 | 0 | 4 | 2 | 3 | 4 | 38 | 210 | 15.1 | 14.72 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 10 | 32 | 2.3 | 21.53 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 15 | 1.1 | 27.61 |
| TOTAL | 12 | 17 | 30 | 36 | 49 | 50 | 71 | 206 | 1393 | 100.0 | 5.66 |
| PERCENT | 0.9 | 1.2 | 2.2 | 2.6 | 3.5 | 3.6 | 5.1 | 14.8 | 100.0 | --- | --- |
| AVG SPEED | 5.2 | 5.7 | 3.9 | 7.1 | 6.9 | 7.6 | 7.4 | 9.8 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 8.5 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 5 | | | | | | | | | | | |

## Table 2.3-8j

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -0.3 but ≤ -0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0.2 | 0.30 |
| CALM+ - 2.0 | 3 | 1 | 5 | 1 | 1 | 0 | 2 | 1 | 37 | 2.7 | 1.25 |
| 2.1 - 3.5 | 18 | 31 | 9 | 1 | 4 | 4 | 4 | 2 | 126 | 9.0 | 2.13 |
| 3.6 - 7.5 | 140 | 153 | 57 | 15 | 5 | 8 | 5 | 4 | 541 | 38.8 | 5.36 |
| 7.6 - 12.5 | 67 | 41 | 56 | 36 | 25 | 18 | 12 | 5 | 429 | 30.8 | 9.55 |
| 12.6 - 18.5 | 36 | 19 | 36 | 31 | 16 | 9 | 5 | 4 | 210 | 15.1 | 14.72 |
| 18.6 - 24.5 | 4 | 2 | 1 | 2 | 4 | 3 | 2 | 0 | 32 | 2.3 | 21.53 |
| 24.6+ | 2 | 0 | 1 | 5 | 4 | 1 | 1 | 0 | 15 | 1.1 | 27.61 |
| TOTAL | 270 | 247 | 165 | 91 | 59 | 43 | 31 | 16 | 1393 | 100.0 | 5.66 |
| PERCENT | 19.4 | 17.7 | 11.8 | 6.5 | 4.2 | 3.1 | 2.2 | 1.1 | 100.0 | --- | --- |
| AVG SPEED | 8.0 | 6.6 | 9.0 | 12.5 | 12.2 | 10.8 | 10.2 | 8.7 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 8.5 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 5 | | | | | | | | | | | |

## Table 2.3-8k

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -0.8 but ≤ 2.2 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | WIND DIRECTION | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 9 | 2.8 | 1.52 |
| 2.1 - 3.5 | 1 | 5 | 2 | 1 | 4 | 1 | 3 | 7 | 39 | 12.1 | 2.94 |
| 3.6 - 7.5 | 2 | 1 | 5 | 7 | 3 | 8 | 5 | 20 | 215 | 66.8 | 5.27 |
| 7.6 - 12.5 | 1 | 0 | 1 | 5 | 2 | 1 | 0 | 2 | 52 | 16.1 | 9.84 |
| 12.6 - 18.5 | 0 | 0 | 2 | 1 | 2 | 2 | 0 | 0 | 7 | 2.2 | 14.54 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 4 | 7 | 10 | 15 | 12 | 13 | 9 | 30 | 322 | 0.0 | 4.86 |
| PERCENT | 1.2 | 2.2 | 3.1 | 4.7 | 3.7 | 4.0 | 2.8 | 9.3 | 100.0 | --- | --- |
| AVG SPEED | 5.1 | 2.8 | 6.9 | 7.1 | 6.7 | 6.3 | 4.3 | 5.0 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 5.9 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 2 | | | | | | | | | | | |

## Table 2.3-8l

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > -0.8 but ≤ 2.2 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 9 | 2.8 | 1.52 |
| 2.1 - 3.5 | 9 | 3 | 0 | 0 | 0 | 0 | 1 | 2 | 39 | 12.1 | 2.94 |
| 3.6 - 7.5 | 81 | 55 | 11 | 9 | 0 | 2 | 2 | 4 | 215 | 66.8 | 5.27 |
| 7.6 - 12.5 | 9 | 4 | 4 | 8 | 6 | 0 | 6 | 3 | 52 | 16.1 | 9.84 |
| 12.6 - 18.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 2.2 | 14.54 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 100 | 62 | 15 | 17 | 6 | 3 | 9 | 10 | 322 | 0.0 | 4.86 |
| PERCENT | 31.1 | 19.3 | 4.7 | 5.3 | 1.9 | 0.9 | 2.8 | 3.1 | 100.0 | --- | --- |
| AVG SPEED | 5.4 | 5.4 | 6.9 | 7.5 | 8.7 | 4.4 | 8.6 | 6.5 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 5.9 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 2 | | | | | | | | | | | |

## Table 2.3-8m

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > 2.2 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2.6 | 1.89 |
| 2.1 - 3.5 | 1 | 1 | 1 | 1 | 4 | 0 | 0 | 0 | 14 | 12.1 | 2.84 |
| 3.6 - 7.5 | 3 | 3 | 0 | 3 | 6 | 8 | 4 | 1 | 69 | 59.5 | 5.46 |
| 7.6 - 12.5 | 0 | 0 | 0 | 1 | 3 | 3 | 2 | 0 | 29 | 25.0 | 8.85 |
| 12.6 - 18.5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.9 | 13.50 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 4 | 5 | 1 | 6 | 13 | 11 | 6 | 1 | 116 | 0.0 | 5.16 |
| PERCENT | 7.4 | 4.3 | 0.9 | 5.2 | 11.2 | 9.5 | 5.2 | 0.9 | 100.0 | --- | --- |
| AVG SPEED | 4.9 | 3.9 | 2.2 | 6.9 | 5.6 | 7.0 | 6.9 | 6.8 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 6.2 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 0 | | | | | | | | | | | |

# Table 2.3-8n

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 33-FT LEVEL FOR 1975 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 33 FT)

| Temperature Difference > 2.2 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| CALM+ - 2.0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2.6 | 1.89 |
| 2.1 - 3.5 | 1 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 14 | 12.1 | 2.84 |
| 3.6 - 7.5 | 8 | 3 | 11 | 6 | 4 | 3 | 0 | 6 | 69 | 59.5 | 5.46 |
| 7.6 - 12.5 | 0 | 7 | 6 | 4 | 0 | 0 | 1 | 2 | 29 | 25.0 | 8.85 |
| 12.6 - 18.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.9 | 13.50 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 9 | 12 | 20 | 10 | 5 | 4 | 1 | 8 | 116 | 0.0 | 5.16 |
| PERCENT | 7.8 | 10.3 | 17.2 | 8.6 | 4.3 | 3.4 | 0.9 | 6.9 | 100.0 | --- | --- |
| AVG SPEED | 4.7 | 7.0 | 6.4 | 7.0 | 4.6 | 4.6 | 12.2 | 6.9 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 6.2 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 0 | | | | | | | | | | | |

## Table 2.3-9a

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference ≤ -1.0 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 11 | 0.4 | 1.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 2.1 - 3.5 | 44 | 36 | 23 | 35 | 18 | 4 | 1 | 2 | 263 | 9.1 | 2.73 |
| 3.6 - 7.5 | 68 | 89 | 86 | 112 | 67 | 7 | 21 | 29 | 1012 | 35.1 | 5.20 |
| 7.6 - 12.5 | 13 | 16 | 57 | 106 | 60 | 6 | 11 | 41 | 887 | 30.8 | 9.46 |
| 12.6 - 18.5 | 2 | 13 | 40 | 55 | 26 | 0 | 1 | 5 | 501 | 17.4 | 14.82 |
| 18.6 - 24.5 | 0 | 3 | 38 | 44 | 9 | 0 | 0 | 1 | 192 | 6.7 | 20.31 |
| 24.6+ | 1 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 17 | 0.6 | 25.54 |
| TOTAL | 130 | 158 | 249 | 356 | 180 | 17 | 34 | 78 | 2883 | 100.0 | 6.56 |
| PERCENT | 4.5 | 5.5 | 8.6 | 12.3 | 6.2 | 0.6 | 1.2 | 2.7 | 100.0 | --- | --- |
| AVG SPEED | 4.8 | 6.1 | 10.2 | 9.9 | 8.6 | 5.8 | 7.1 | 8.5 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 9.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 2 | | | | | | | | | | | |

## Table 2.3-9b

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference ≤ -1.0 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 11 | 0.4 | 1.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 2.1 - 3.5 | 13 | 6 | 12 | 2 | 4 | 5 | 22 | 36 | 263 | 9.1 | 2.73 |
| 3.6 - 7.5 | 32 | 53 | 58 | 25 | 18 | 80 | 178 | 89 | 1012 | 35.1 | 5.20 |
| 7.6 - 12.5 | 42 | 24 | 45 | 49 | 35 | 199 | 155 | 28 | 887 | 30.8 | 9.46 |
| 12.6 - 18.5 | 35 | 1 | 5 | 18 | 28 | 108 | 153 | 11 | 501 | 17.4 | 14.82 |
| 18.6 - 24.5 | 8 | 1 | 0 | 4 | 2 | 31 | 43 | 8 | 192 | 6.7 | 20.31 |
| 24.6+ | 0 | 0 | 0 | 0 | 1 | 7 | 1 | 1 | 17 | 0.6 | 25.54 |
| TOTAL | 131 | 85 | 121 | 98 | 88 | 430 | 553 | 175 | 2883 | 100.0 | 6.56 |
| PERCENT | 4.5 | 2.9 | 4.2 | 3.4 | 3.1 | 14.9 | 19.2 | 6.1 | 100.0 | --- | --- |
| AVG SPEED | 9.9 | 6.7 | 6.9 | 9.9 | 10.6 | 11.4 | 10.5 | 6.7 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 9.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 2 | | | | | | | | | | | |

**Table 2.3-9c**

**JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)**

| Temperature Difference > -1.0 but ≤ -0.9 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 7 | 1.2 | 1.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 2.1 - 3.5 | 6 | 9 | 5 | 3 | 3 | 2 | 2 | 2 | 53 | 8.9 | 2.57 |
| 3.6 - 7.5 | 11 | 9 | 6 | 17 | 15 | 3 | 8 | 10 | 175 | 29.4 | 5.11 |
| 7.6 - 12.5 | 5 | 2 | 13 | 15 | 18 | 4 | 1 | 5 | 186 | 31.2 | 9.66 |
| 12.6 - 18.5 | 0 | 6 | 18 | 18 | 6 | 0 | 0 | 2 | 117 | 19.6 | 14.68 |
| 18.6 - 24.5 | 0 | 4 | 18 | 6 | 4 | 0 | 0 | 1 | 53 | 8.9 | 20.65 |
| 24.6+ | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 5 | 0.8 | 27.22 |
| TOTAL | 23 | 31 | 61 | 63 | 46 | 10 | 11 | 20 | 596 | 100.0 | 6.49 |
| PERCENT | 3.9 | 5.2 | 10.2 | 10.6 | 7.7 | 1.7 | 1.8 | 3.4 | 100.0 | --- | --- |
| AVG SPEED | 5.4 | 8.1 | 13.4 | 11.9 | 9.6 | 5.9 | 4.8 | 8.0 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 9.9 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 0 | | | | | | | | | | | |

## Table 2.3-9d

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > -1.0 but ≤ -0.9 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 7 | 1.2 | 1.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 2.1 - 3.5 | 3 | 2 | 1 | 1 | 0 | 1 | 6 | 7 | 53 | 8.9 | 2.57 |
| 3.6 - 7.5 | 7 | 11 | 14 | 13 | 8 | 16 | 14 | 13 | 175 | 29.4 | 5.11 |
| 7.6 - 12.5 | 8 | 4 | 13 | 12 | 19 | 45 | 13 | 9 | 186 | 31.2 | 9.66 |
| 12.6 - 18.5 | 3 | 0 | 3 | 3 | 15 | 19 | 21 | 3 | 117 | 19.6 | 14.68 |
| 18.6 - 24.5 | 0 | 0 | 0 | 1 | 5 | 3 | 11 | 0 | 53 | 8.9 | 20.65 |
| 24.6+ | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 5 | 0.8 | 27.22 |
| TOTAL | 22 | 17 | 31 | 30 | 48 | 84 | 66 | 33 | 596 | 100.0 | 6.49 |
| PERCENT | 3.7 | 2.9 | 5.2 | 5.0 | 8.1 | 14.1 | 11.1 | 5.5 | 100.0 | --- | --- |
| AVG SPEED | 7.7 | 6.5 | 7.9 | 8.7 | 12.2 | 10.6 | 11.6 | 6.6 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 9.9 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 0 | | | | | | | | | | | |

## Table 2.3-9e

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > -0.9 but ≤ -0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0.4 | 1.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 2.1 - 3.5 | 5 | 7 | 3 | 4 | 7 | 2 | 1 | 4 | 50 | 7.0 | 2.62 |
| 3.6 - 7.5 | 6 | 5 | 10 | 32 | 33 | 3 | 9 | 8 | 216 | 30.1 | 5.34 |
| 7.6 - 12.5 | 11 | 15 | 26 | 18 | 23 | 6 | 1 | 9 | 223 | 31.1 | 9.63 |
| 12.6 - 18.5 | 2 | 14 | 31 | 16 | 9 | 2 | 0 | 1 | 149 | 20.8 | 14.69 |
| 18.6 - 24.5 | 1 | 4 | 13 | 10 | 7 | 0 | 1 | 1 | 62 | 8.6 | 20.90 |
| 24.6+ | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 14 | 2.0 | 28.01 |
| TOTAL | 25 | 45 | 84 | 87 | 79 | 14 | 12 | 23 | 717 | 100.0 | 7.22 |
| PERCENT | 3.5 | 6.3 | 11.7 | 12.1 | 11.0 | 2.0 | 1.7 | 3.2 | 100.0 | --- | --- |
| AVG SPEED | 8.0 | 10.6 | 13.1 | 11.3 | 8.9 | 7.8 | 7.4 | 8.1 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 10.4 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 1 | | | | | | | | | | | |

## Table 2.3-9f

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > -0.9 but ≤ -0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 0.4 | 1.00 |
| CALM+ - 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 2.1 - 3.5 | 3 | 1 | 2 | 1 | 0 | 4 | 2 | 4 | 50 | 7.0 | 2.62 |
| 3.6 - 7.5 | 8 | 15 | 18 | 8 | 9 | 18 | 23 | 11 | 216 | 30.1 | 5.34 |
| 7.6 - 12.5 | 7 | 6 | 19 | 19 | 10 | 27 | 13 | 13 | 223 | 31.1 | 9.63 |
| 12.6 - 18.5 | 6 | 0 | 5 | 4 | 15 | 25 | 15 | 2 | 149 | 20.8 | 14.69 |
| 18.6 - 24.5 | 0 | 0 | 0 | 1 | 4 | 10 | 8 | 2 | 62 | 8.6 | 20.90 |
| 24.6+ | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 3 | 14 | 2.0 | 28.01 |
| TOTAL | 24 | 22 | 45 | 33 | 42 | 84 | 63 | 35 | 717 | 100.0 | 7.22 |
| PERCENT | 3.3 | 3.1 | 6.3 | 4.6 | 5.9 | 11.7 | 8.8 | 4.9 | 100.0 | --- | --- |
| AVG SPEED | 8.2 | 6.4 | 8.2 | 9.5 | 13.0 | 11.4 | 11.6 | 10.3 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 10.4 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 1 | | | | | | | | | | | |

## Table 2.3-9g

**JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)**

| Temperature Difference > -0.8 but ≤ -0.3 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 7 | 4 | 1 | 1 | 7 | 5 | 1 | 3 | 57 | 0.8 | 1.00 |
| CALM+ - 2.0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 8 | 0.1 | 1.75 |
| 2.1 - 3.5 | 36 | 47 | 28 | 42 | 62 | 49 | 42 | 50 | 704 | 10.1 | 2.77 |
| 3.6 - 7.5 | 101 | 66 | 50 | 79 | 132 | 167 | 128 | 105 | 1706 | 24.6 | 5.56 |
| 7.6 - 12.5 | 161 | 115 | 77 | 91 | 126 | 110 | 53 | 121 | 2349 | 33.8 | 9.65 |
| 12.6 - 18.5 | 29 | 74 | 74 | 92 | 42 | 31 | 9 | 53 | 1554 | 22.4 | 14.95 |
| 18.6 - 24.5 | 5 | 13 | 12 | 20 | 16 | 1 | 2 | 6 | 462 | 6.7 | 20.88 |
| 24.6+ | 2 | 2 | 3 | 6 | 0 | 0 | 0 | 0 | 103 | 1.5 | 27.85 |
| TOTAL | 343 | 321 | 245 | 331 | 386 | 363 | 235 | 339 | 6943 | 100.0 | 6.97 |
| PERCENT | 4.9 | 4.6 | 3.5 | 4.8 | 5.6 | 5.2 | 3.4 | 4.9 | 100.0 | --- | --- |
| AVG SPEED | 8.4 | 9.7 | 10.7 | 10.4 | 8.0 | 7.2 | 6.4 | 8.2 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 10.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 3 | | | | | | | | | | | |

## Table 2.3-9h

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > -0.8 but ≤ -0.3 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 1 | 4 | 3 | 3 | 4 | 3 | 4 | 6 | 57 | 0.8 | 1.00 |
| CALM+ - 2.0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 8 | 0.1 | 1.75 |
| 2.1 - 3.5 | 33 | 44 | 62 | 42 | 40 | 42 | 45 | 40 | 704 | 10.1 | 2.77 |
| 3.6 - 7.5 | 96 | 109 | 166 | 130 | 115 | 134 | 60 | 68 | 1706 | 24.6 | 5.56 |
| 7.6 - 12.5 | 168 | 89 | 147 | 216 | 343 | 253 | 116 | 163 | 2349 | 33.8 | 9.65 |
| 12.6 - 18.5 | 80 | 21 | 24 | 86 | 331 | 267 | 212 | 129 | 1554 | 22.4 | 14.95 |
| 18.6 - 24.5 | 10 | 0 | 1 | 7 | 81 | 132 | 120 | 36 | 462 | 6.7 | 20.88 |
| 24.6+ | 0 | 0 | 0 | 2 | 12 | 17 | 49 | 10 | 103 | 1.5 | 27.85 |
| TOTAL | 389 | 267 | 404 | 486 | 927 | 849 | 606 | 452 | 6943 | 100.0 | 6.97 |
| PERCENT | 5.6 | 3.8 | 5.8 | 7.0 | 13.4 | 12.2 | 8.7 | 6.5 | 100.0 | --- | --- |
| AVG SPEED | 9.5 | 7.0 | 7.2 | 9.2 | 12.3 | 12.7 | 14.7 | 11.2 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 10.3 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 3 | | | | | | | | | | | |

## Table 2.3-9i

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > -0.3 but ≤ 0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 5 | 6 | 7 | 9 | 12 | 12 | 8 | 5 | 113 | 1.3 | 1.00 |
| CALM+ - 2.0 | 7 | 9 | 6 | 15 | 18 | 17 | 12 | 14 | 181 | 2.0 | 1.93 |
| 2.1 - 3.5 | 28 | 23 | 27 | 27 | 54 | 56 | 79 | 65 | 963 | 10.9 | 2.72 |
| 3.6 - 7.5 | 42 | 36 | 23 | 33 | 106 | 213 | 171 | 208 | 3439 | 38.8 | 5.48 |
| 7.6 - 12.5 | 41 | 17 | 26 | 22 | 59 | 51 | 26 | 158 | 2672 | 30.1 | 9.55 |
| 12.6 - 18.5 | 17 | 4 | 6 | 6 | 11 | 7 | 1 | 47 | 905 | 10.2 | 14.66 |
| 18.6 - 24.5 | 5 | 1 | 4 | 2 | 0 | 0 | 0 | 6 | 441 | 5.0 | 21.06 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 151 | 1.7 | 27.77 |
| TOTAL | 145 | 96 | 99 | 114 | 260 | 356 | 297 | 503 | 8865 | 100.0 | 5.70 |
| PERCENT | 1.6 | 1.1 | 1.1 | 1.3 | 2.9 | 4.0 | 3.4 | 5.7 | 100.0 | --- | --- |
| AVG SPEED | 7.5 | 5.5 | 6.7 | 5.5 | 5.8 | 5.4 | 4.8 | 7.5 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 8.6 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 8 | | | | | | | | | | | |

## Table 2.3-9j

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > -0.3 but ≤ 0.8 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 9 | 14 | 12 | 3 | 2 | 2 | 4 | 3 | 113 | 1.3 | 1.00 |
| CALM+ - 2.0 | 16 | 22 | 9 | 13 | 9 | 6 | 4 | 4 | 181 | 2.0 | 1.93 |
| 2.1 - 3.5 | 72 | 127 | 166 | 82 | 52 | 30 | 36 | 39 | 963 | 10.9 | 2.72 |
| 3.6 - 7.5 | 426 | 473 | 672 | 439 | 281 | 169 | 90 | 57 | 3439 | 38.8 | 5.48 |
| 7.6 - 12.5 | 418 | 190 | 305 | 424 | 523 | 294 | 71 | 47 | 2672 | 30.1 | 9.55 |
| 12.6 - 18.5 | 149 | 20 | 25 | 110 | 270 | 114 | 74 | 44 | 905 | 10.2 | 14.66 |
| 18.6 - 24.5 | 25 | 1 | 2 | 28 | 76 | 78 | 157 | 56 | 441 | 5.0 | 21.06 |
| 24.6+ | 0 | 0 | 0 | 5 | 20 | 31 | 76 | 19 | 151 | 1.7 | 27.77 |
| TOTAL | 1115 | 847 | 1191 | 1104 | 1233 | 724 | 512 | 269 | 8865 | 100.0 | 5.70 |
| PERCENT | 12.6 | 9.6 | 13.4 | 12.5 | 13.9 | 8.2 | 5.8 | 3.0 | 100.0 | --- | --- |
| AVG SPEED | 8.6 | 6.1 | 6.4 | 8.4 | 10.7 | 11.5 | 15.6 | 12.2 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 8.6 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 8 | | | | | | | | | | | |

## Table 2.3-9k

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > 0.8 but ≤ 2.2 ( °F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | WIND DIRECTION | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 2 | 2 | 3 | 2 | 8 | 7 | 3 | 7 | 56 | 2.9 | 1.00 |
| CALM+ - 2.0 | 6 | 3 | 1 | 2 | 1 | 6 | 4 | 7 | 77 | 4.0 | 1.92 |
| 2.1 - 3.5 | 7 | 8 | 6 | 10 | 38 | 16 | 27 | 28 | 428 | 22.1 | 2.74 |
| 3.6 - 7.5 | 0 | 4 | 5 | 8 | 32 | 45 | 27 | 74 | 1155 | 59.7 | 5.19 |
| 7.6 - 12.5 | 0 | 0 | 6 | 3 | 9 | 3 | 1 | 11 | 203 | 10.5 | 8.78 |
| 12.6 - 18.5 | 0 | 1 | 1 | 2 | 2 | 2 | 2 | 0 | 16 | 0.8 | 13.95 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 15 | 18 | 22 | 27 | 90 | 79 | 64 | 127 | 1935 | 0.0 | 3.88 |
| PERCENT | 0.8 | 0.9 | 1.1 | 1.4 | 4.7 | 4.1 | 3.3 | 6.6 | 100.0 | --- | --- |
| AVG SPEED | 2.2 | 3.6 | 5.7 | 5.0 | 4.4 | 4.5 | 4.0 | 4.6 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 5.0 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 7 | | | | | | | | | | | |

## Table 2.3-9l

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > 0.8 but ≤ 2.2 ( °F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 4 | 6 | 1 | 5 | 1 | 2 | 2 | 1 | 56 | 2.9 | 1.00 |
| CALM+ - 2.0 | 10 | 6 | 8 | 7 | 5 | 5 | 2 | 4 | 77 | 4.0 | 1.92 |
| 2.1 - 3.5 | 43 | 74 | 89 | 33 | 16 | 15 | 12 | 6 | 428 | 22.1 | 2.74 |
| 3.6 - 7.5 | 131 | 226 | 294 | 180 | 74 | 26 | 22 | 7 | 1155 | 59.7 | 5.19 |
| 7.6 - 12.5 | 30 | 39 | 33 | 27 | 20 | 14 | 6 | 1 | 203 | 10.5 | 8.78 |
| 12.6 - 18.5 | 0 | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 16 | 0.8 | 13.95 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 218 | 351 | 425 | 254 | 116 | 64 | 46 | 19 | 1935 | 0.0 | 3.88 |
| PERCENT | 11.3 | 18.1 | 22.0 | 13.1 | 6.0 | 3.3 | 2.4 | 1.0 | 100.0 | --- | --- |
| AVG SPEED | 5.2 | 5.2 | 4.8 | 5.4 | 5.6 | 5.4 | 5.4 | 3.6 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 5.0 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 7 | | | | | | | | | | | |

## Table 2.3-9m

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > 2.2 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | Total | % | GEO MEAN SPD (MPH) |
| CALM | 3 | 6 | 0 | 2 | 3 | 6 | 9 | 5 | 75 | 5.3 | 1.00 |
| CALM+ - 2.0 | 4 | 4 | 1 | 6 | 4 | 3 | 3 | 13 | 81 | 5.8 | 1.93 |
| 2.1 - 3.5 | 3 | 5 | 8 | 15 | 28 | 21 | 21 | 38 | 406 | 28.9 | 2.74 |
| 3.6 - 7.5 | 2 | 1 | 6 | 8 | 28 | 32 | 27 | 38 | 798 | 56.9 | 4.96 |
| 7.6 - 12.5 | 0 | 1 | 0 | 0 | 6 | 3 | 1 | 3 | 42 | 3.0 | 8.58 |
| 12.6 - 18.5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0.1 | 13.16 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 12 | 17 | 15 | 31 | 70 | 65 | 61 | 97 | 1403 | 0.0 | 3.26 |
| PERCENT | 0.9 | 1.2 | 1.1 | 2.2 | 5.0 | 4.6 | 4.3 | 6.9 | 100.0 | --- | --- |
| AVG SPEED | 2.3 | 2.4 | 3.7 | 3.0 | 4.2 | 4.2 | 3.4 | 3.7 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 4.2 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 6 | | | | | | | | | | | |

## Table 2.3-9n

## JOINT FREQUENCY TABLES OF WIND SPEED AND DIRECTION FROM 50-FT LEVEL FOR 1966, 1967, AND 1973-74 (TEMPERATURE DIFFERENCE BETWEEN 150 FT AND 10 FT; ADJUSTED TO 150 FT TO 33 FT. SPEED ADJUSTED TO 33 FT.)

| Temperature Difference > 2.2 (°F/100 FT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND DIRECTION | | | | | | | | | | | |
| SPEED MPH | S | SSW | SW | WSW | W | WNW | NW | NNW | Total | % | GEO MEAN SPD (MPH) |
| CALM | 5 | 7 | 5 | 4 | 10 | 8 | 1 | 1 | 75 | 5.3 | 1.00 |
| CALM+ - 2.0 | 9 | 4 | 10 | 7 | 4 | 2 | 2 | 5 | 81 | 5.8 | 1.93 |
| 2.1 - 3.5 | 50 | 71 | 66 | 27 | 27 | 17 | 8 | 1 | 406 | 28.9 | 2.74 |
| 3.6 - 7.5 | 94 | 191 | 197 | 119 | 42 | 6 | 4 | 3 | 798 | 56.9 | 4.96 |
| 7.6 - 12.5 | 5 | 4 | 8 | 4 | 1 | 2 | 2 | 2 | 42 | 3.0 | 8.58 |
| 12.6 - 18.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 | 13.16 |
| 18.6 - 24.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| 24.6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| TOTAL | 163 | 277 | 286 | 161 | 84 | 35 | 17 | 12 | 1403 | 0.0 | 3.26 |
| PERCENT | 11.6 | 19.7 | 20.4 | 11.5 | 6.0 | 2.5 | 1.2 | 0.9 | 100.0 | --- | --- |
| AVG SPEED | 4.2 | 4.4 | 4.5 | 4.8 | 3.6 | 3.1 | 4.0 | 3.7 | --- | --- | --- |
| AVERAGE SPEED FOR THIS TABLE EQUALS 4.2 | | | | | | | | | | | |
| HOURS IN ABOVE TABLE WITH VARIABLE DIRECTION = 6 | | | | | | | | | | | |

## Table 2.3-10
## GASEOUS DISCHARGE POINTS AT THE GINNA SITE

| System | Vent Number |
|---|---|
| Turbine building ventilation | 1 |
| Auxiliary building ventilation system(ABVS) | 2 |
| Radwaste building ventilation | 2 |
| Containment purge vent | 3 |
| Waste gas processing vent | 2 |
| Condenser air ejector exhaust | 5 |
| Steam generator blowdown exhaust | 4 |
| Steam leakage from secondary system | 1 |

## Table 2.3-11
## VENT DESIGN INFORMATION FOR GINNA

| Vent Number | Location | Discharge Elevation Above Grade (m) | Height of Discharge Above Maximum Building Elevation (m) | Effective[a] Vent Diameter (m) | Velocity[a] at Point of Discharge (m/sec) |
|---|---|---|---|---|---|
| | | | | | |
| 1 | Turbine building roof (with hoods) | NA | Assumed ground release in building wake | NA | NA |
| 2 | Plant vent (intermediate building roof) | 42.0 | 1.0 | 1.8 | 8.8 |
| 3 | Containment purge vent (intermediate building vent) | 42.0 | 1.0 | 0.91 | 14.4 |
| 4 | Blowdown tank vent (intermediate building roof, hooded) | NA | Assumed ground release in building wake | NA | NA |
| 5 | Air ejector vent (turbine building roof) | NA | Assumed ground release in building wake | NA | NA |
| NOTE:— NA = Not applicable | | | | | |

a. Assumed diameter of 0.91 m and velocity of 8.8 m/sec for wake-split runs.

## Table 2.3-12
## TABULATION OF INPUT ASSUMPTIONS FOR CALCULATIONS

| Parameter | Assumed Value or Characteristic |
|---|---|
| Height of meteorological instruments for stack runs | Not applicable to Ginna |
| Height of meteorological instruments for ground level releases | 33-ft speed and direction, delta T 150-33 |
| Height of meteorological instruments for hourly wake split runs | 33 ft and 150 ft |
| Height of meteorological instruments for wake split runs using joint frequency tables | 33 ft |
| Method for determining stability and diffusion coefficients | Temperature difference using Regulatory Guide 1.23 and Pasquill curves |
| Calms treatment | Assumed 0.3 mph and assumed to have same direction as measured |
| Upper limit for $\sigma_Z$ (m) | 1000 |
| Height of tallest structure for computation of $\Sigma$(m) | 41.0 |
| Vent exit conditions | From Table 2.3-11 |
| Delta-temperature correction factor | 0.56 for data prior to July 1975 only |
| Terrain height | See Table 2.3-13 |
| Terrain correction factors | Figure 2 of Regulatory Guide 1.111 |

## Table 2.3-13

## TOPOGRAPHIC ELEVATIONS FEET (MSL) FOR GINNA SITE PLANT GRADE IS 270 FEET

| | Distance in Miles | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Section | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 | 7.5 | 8 | 8.5 | 9 | 9.5 | 10 |
| N | ← | ------lake------ | | | | | | | | | | | | | | | | | | → |
| NNE | ← | ------lake------ | | | | | | | | | | | | | | | | | | → |
| NE | ← | ------lake------ | | | | | | | | | | | | | | | | | | → |
| ENE | ← | ------lake------ | | | | | | | | | | | | | | | | | | → |
| E | 270 | 265 | 265 | 265 | 270 | 270 | 280 | 280 | 290 | 280 | 290 | 280 | 275 | 300 | 300 | 300 | 300 | 300 | 300 | 280 |
| ESE | 270 | 330 | 290 | 300 | 335 | 350 | 330 | 360 | 370 | 375 | 370 | 370 | 405 | 405 | 430 | 420 | 455 | 500 | 500 | 430 |
| SE | 300 | 310 | 330 | 340 | 350 | 375 | 385 | 395 | 415 | 425 | 440 | 450 | 445 | 450 | 500 | 530 | 550 | 460 | 450 | 530 |
| SSE | 330 | 320 | 335 | 370 | 385 | 395 | 410 | 470 | 440 | 450 | 450 | 470 | 510 | 500 | 520 | 540 | 520 | 500 | 520 | 470 |
| S | 310 | 350 | 340 | 370 | 380 | 415 | 430 | 450 | 460 | 460 | 480 | 485 | 490 | 500 | 540 | 535 | 530 | 590 | 550 | 490 |
| SSW | 270 | 300 | 350 | 375 | 380 | 390 | 405 | 430 | 450 | 470 | 495 | 490 | 500 | 500 | 500 | 540 | 540 | 545 | 525 | 545 |
| SW | 270 | 315 | 330 | 360 | 360 | 380 | 400 | 405 | 410 | 430 | 450 | 470 | 475 | 450 | 475 | 480 | 475 | 480 | 515 | 490 |
| WSW | 275 | 305 | 300 | 330 | 320 | 330 | 325 | 330 | 340 | 340 | 335 | 340 | 350 | 345 | 360 | 365 | 375 | 365 | 370 | 360 |
| W | 280 | 285 | 270 | 270 | 270 | 270 | 250 | --- | --- | lake | --- | --- | --- | --- | --- | --- | --- | --- | --- | → |
| WNW | ← | --- | --- | --- | --- | --- | --- | --- | --- | lake | --- | --- | --- | --- | --- | --- | --- | --- | --- | → |
| NW | ← | --- | --- | --- | --- | --- | --- | --- | --- | lake | --- | --- | --- | --- | --- | --- | --- | --- | --- | → |
| NNW | ← | --- | --- | --- | --- | --- | --- | --- | --- | lake | --- | --- | --- | --- | --- | --- | --- | --- | --- | → |

# Table 2.3-14

## ANNUAL DIFFUSION AND DEPOSITION ESTIMATES FOR ALL RECEPTOR LOCATIONS, RELEASE POINT: PLANT VENTS, WAKE-SPLIT

SOURCE: Computer Run ID: GX-3 604-65, 1976

| Direction | Distance to ~~Nearest~~ Residence (m) | $\chi$/Q (sec/m$^3$) | Depleted ~~$\chi$/Q (sec/m$^3$)~~ | D/Q (m$^{-2}$) | Distance to ~~Nearest~~ Vegetable Garden (m) | $\chi$/Q (sec/m$^3$) | Depleted $\chi$/Q (sec /m$^3$) | D/Q (m$^{-2}$) | Nearest ~~Site~~ Boundary (m) | $\chi$/Q (sec/m$^3$) | Depleted ~~$\chi$/Q (sec /m$^3$)~~ | D/Q (m$^{-2}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | lake | | | | NA | NA | NA | NA | lake | | | |
| NNE | lake | | | | | | | | lake | | | |
| NE | lake | | | | | | | | lake | | | |
| ENE | lake | | | | | | | | lake | | | |
| E | 1200 | 1.3E-06 | 1.2E-06 | 4.4E-08 | | | | | 700 | 2.5E-06 | 2.2E-06 | 9.8E-08 |
| ESE | 950 | 1.1E-06 | 9.6E-07 | 4.4E-08 | | | | | 700 | 1.5E-06 | 1.4E-06 | 7.0E-08 |
| SE | 500 | 2.5E-06 | 2.3E-06 | 1.4E-07 | | | | | 650 | 1.8E-06 | 1.7E-06 | 9.2E-08 |
| SSE | 600 | 1.4E-06 | 1.3E-06 | 5.5E-08 | | | | | 600 | 1.4E-06 | 1.3E-06 | 5.5E-08 |
| S | 450 | 1.6E-06 | 1.4E-06 | 6.3E-08 | | | | | 900 | 1.2E-06 | 1.1E-06 | 2.5E-08 |
| SSW | 600 | 7.6E-07 | 7.0E-07 | 3.0E-08 | | | | | 500 | 9.4E-07 | 8.6E-07 | 3.9E-08 |
| SW | 750 | 9.9E-07 | 9.1E-07 | 3.9E-08 | | | | | 500 | 1.6E-06 | 1.5E-06 | 7.3E-08 |
| WSW | 1100 | 8.2E-07 | 7.4E-07 | 1.8E-08 | | | | | 1500 | 7.1E-07 | 6.4E-07 | 1.2E-08 |
| W | 1600 | 7.8E-07 | 7.1E-07 | 1.1E-08 | | | | | 1400 | 8.7E-07 | 7.9E-07 | 1.3E-08 |
| WNW | 2900 | 2.0E-07 | 1.7E-07 | 1.5E-09 | | | | | 600 | 8.8E-07 | 8.0E-07 | 2.1E-08 |
| NW | lake | | | | | | | | lake | | | |
| NNW | lake | | | | | | | | lake | | | |

NOTE:— NA indicates that diffusion information for this run was not used in dose calculations for receptors in this column.

# Table 2.3-15

## GRAZING SEASON DIFFUSION AND DEPOSITION ESTIMATES FOR LIVESTOCK RECEPTOR LOCATIONS, RELEASE POINT: PLANT VENTS, WAKE-SPLIT

SOURCE: Computer Run ID: GX-1 604-64, 1976

| Direction | Distance to Nearest Milk Cow (m) | χ/Q (sec/m³) | Depleted χ/Q (sec/m³) | D/Q (m⁻²) | Distance to Nearest Meat Animal (m) | χ/Q (sec/m³) | Depleted χ/Q (sec/m³) | D/Q (m⁻²) | Distance to Nearest Milk Goat (m) | χ/Q (sec/m³) | Depleted χ/Q (sec/m³) | D/Q (m⁻²) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | lake | | NA | | lake | | NA | | lake | | NA | |
| NNE | lake | | | | lake | | | | lake | | | |
| NE | lake | | | | lake | | | | lake | | | |
| ENE | lake | | | | lake | | | | lake | | | |
| E | --- | 5.7E-08 | | 6.6E-10 | --- | 5.7E-08 | | 6.6E-10 | --- | 5.7E-08 | | 6.6E-10 |
| ESE | 8000 | 4.4E-08 | | 4.5E-10 | 1000 | 1.1E-06 | | 3.8E-08 | --- | 4.4E-08 | | 4.5E-10 |
| SE | --- | 4.7E-08 | | 2.8E-10 | 2200 | 5.2E-07 | | 4.7E-09 | --- | 4.7E-08 | | 2.8E-10 |
| SSE | 5500 | 8.1E-08 | | 3.5E-10 | 4800 | 9.7E-08 | | 4.3E-10 | --- | 4.2E-08 | | 1.8E-10 |
| S | --- | 5.9E-08 | | 2.8E-10 | --- | 5.9E-08 | | 2.8E-10 | --- | 5.9E-08 | | 2.8E-10 |
| SSW | 7000 | 8.4E-08 | | 2.7E-10 | 2200 | 5.4E-07 | | 3.1E-09 | --- | 6.5E-08 | | 2.1E-10 |
| SW | --- | 1.0E-07 | | 5.0E-10 | 2500 | 8.0E-07 | | 6.4E-09 | --- | 1.0E-07 | | 5.0E-10 |
| WSW | 4700 | 4.9E-07 | | 7.2E-10 | --- | 6.0E-08 | | 2.4E-10 | --- | 6.0E-08 | | 2.4E-10 |
| W | --- | 4.0E-08 | | 1.7E-10 | --- | 4.0E-08 | | 1.7E-10 | --- | 4.0E-08 | | 1.7E-10 |
| WNW | --- | 2.8E-08 | | 1.2E-10 | --- | 2.9E-08 | | 1.2E-10 | --- | 2.9E-08 | | 1.2E-10 |
| NW | lake | | | | lake | | | | lake | lake | | |
| NNW | lake | | | | lake | | | | lake | lake | | |

NOTE:— NA indicates that diffusion information for this run was not used in dose calculations for receptors in this column.
NOTE:— (-) Indicates receptor distance is greater than 8000 m, diffusion values given are for 8000 m.

## Table 2.3-16

## GRAZING SEASON DIFFUSION AND DEPOSITION ESTIMATES FOR ALL RECEPTOR LOCATIONS, RELEASE POINT: PLANT VENTS, WAKE-SPLIT

SOURCE: Computer Run ID: GX-1 604-64, 1976

| Direction | Distance to Nearest Residence (m) | χ/Q (sec/m$^3$) | Depleted χ/Q (sec/m$^3$) | D/Q (m$^{-2}$) | Distance to Nearest Vegetable Garden (m) | χ/Q (sec/m$^3$) | Depleted χ/Q (sec/m$^3$) | D/Q (m$^{-2}$) | Nearest Site Boundary (m) | χ/Q (sec/m$^3$) | Depleted χ/Q (sec/m$^3$) | D/Q (m$^{-2}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | lake | | NA | | lake | | NA | | lake | | NA | |
| NNE | lake | | | | lake | | | | lake | | | |
| NE | lake | | | | lake | | | | lake | | | |
| ENE | lake | | | | lake | | | | lake | | | |
| E | 1200 | 1.5E-06 | | 5.1E-08 | 6600 | 8.0E-08 | | 9.6E-10 | 700 | 2.6E-06 | | 1.0E-07 |
| ESE | 950 | 1.2E-06 | | 4.0E-08 | 950 | 1.2E-06 | | 4.0E-08 | 700 | 1.6E-06 | | 6.4E-08 |
| SE | 500 | 1.8E-06 | | 5.3E-08 | 2800-3800 | 3.3E-07 | | 2.6E-09 | 650 | 1.4E-06 | | 3.8E-08 |
| SSE | 600 | 1.2E-06 | | 2.6E-08 | 3600 | 1.7E-07 | | 7.9E-10 | 600 | 1.2E-06 | | 2.6E-08 |
| S | 450 | 1.7E-06 | | 5.4E-08 | 2100-4200 | 8.0E-07 | | 5.7E-09 | 900 | 1.7E-06 | | 2.5E-08 |
| SSW | 600 | 8.4E-07 | | 2.3E-08 | 2300-3600 | 5.3E-07 | | 2.8E-09 | 500 | 9.5E-07 | | 2.9E-08 |
| SW | 750 | 1.4E-06 | | 5.5E-08 | 5300 | 2.1E-07 | | 1.1E-09 | 500 | 2.3E-06 | | 1.0E-07 |
| WSW | 1100 | 1.0E-06 | | 1.6E-08 | 1400 | 9.8E-07 | | 1.2E-08 | 1500 | 9.6E-07 | | 1.1E-08 |
| W | 1600 | 6.7E-07 | | 7.0E-09 | 5600 | 6.9E-08 | | 3.6E-10 | 1400 | 7.4E-07 | | 8.5E-09 |
| WNW | 2900 | 1.7E-07 | | 1.3E-09 | 4400 | 7.7E-08 | | 4.5E-10 | 600 | 7.6E-07 | | 1.9E-08 |
| NW | lake | | | | lake | | | | lake | | | |
| NNW | lake | | | | lake | | | | lake | | | |

NOTE:— NA indicates that diffusion information for this run was not used in dose calculations for receptors in this column.

## Table 2.3-17

## ANNUAL DIFFUSION AND DEPOSITION ESTIMATES FOR ALL RECEPTOR LOCATIONS, RELEASE POINT: GROUND RELEASE IN BUILDING WAKE

**SOURCE: Computer Run ID: GX-5 604-63, 1976**

| Direction | Distance to ~~Nearest~~ Residence (m) | χ/Q (sec/m$^3$) | Depleted ~~χ/Q (sec/m$^3$)~~ | D/Q (m$^{-2}$) | Distance to ~~Nearest~~ Vegetable Garden (m) | χ/Q (sec/m$^3$) | Depleted χ/Q (sec/m$^3$) | D/Q (m$^{-2}$) | Nearest ~~Site~~ Boundary (m) | χ/Q (sec/m$^3$) | Depleted ~~χ/Q (sec /m$^3$)~~ | D/Q (m$^{-2}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | lake | | | | NA | NA | NA | NA | lake | | | |
| NNE | lake | | | | | | | | lake | | | |
| NE | lake | | | | | | | | lake | | | |
| ENE | lake | | | | | | | | lake | | | |
| E | 1200 | 2.5E-06 | 2.1E-06 | 5.7E-08 | | | | | 700 | 6.1E-06 | 5.2E-06 | 1.4E-07 |
| ESE | 950 | 2.3E-06 | 1.9E-06 | 5.5E-08 | | | | | 700 | 3.8E-06 | 3.3E-06 | 9.3E-08 |
| SE | 500 | 7.3E-06 | 6.4E-06 | 1.8E-07 | | | | | 650 | 4.8E-06 | 4.1E-06 | 1.2E-07 |
| SSE | 600 | 4.2E-06 | 3.6E-06 | 7.2E-08 | | | | | 600 | 4.2E-06 | 3.6E-06 | 7.2E-08 |
| S | 450 | 7.8E-06 | 6.9E-06 | 1.0E-08 | | | | | 900 | 2.6E-06 | 2.2E-06 | 3.2E-08 |
| SSW | 600 | 4.4E-06 | 3.8E-06 | 5.1E-08 | | | | | 500 | 5.9E-06 | 5.2E-06 | 7.0E-08 |
| SW | 750 | 5.7E-06 | 4.9E-06 | 5.9E-08 | | | | | 500 | 1.1E-05 | 9.4E-06 | 1.2E-07 |
| WSW | 1100 | 2.3E-06 | 1.9E-06 | 2.7E-08 | | | | | 1500 | 1.4E-06 | 1.1E-06 | 1.7E-08 |
| W | 1600 | 1.8E-06 | 1.4E-06 | 1.7E-08 | | | | | 1400 | 2.2E-06 | 1.7E-06 | 2.1E-08 |
| WNW | 2900 | 3.7E-07 | 2.7E-07 | 2.5E-09 | | | | | 600 | 5.8E-06 | 5.0E-06 | 5.8E-08 |
| NW | lake | | | | | | | | lake | | | |
| NNW | lake | | | | | | | | lake | | | |

NOTE:— NA indicates that diffusion information for this run was not used in dose calculations for receptors in this column.

# Table 2.3-18

## GRAZING SEASON DIFFUSION AND DEPOSITION ESTIMATES FOR LIVESTOCK RECEPTOR LOCATIONS, RELEASE POINT: ASSUMED GROUND RELEASE IN BUILDING WAKE

SOURCE: Computer Run ID: GX-4 604-62, 1976

| Direction | Distance to Nearest Milk Cow (m) | $\chi$/Q (sec/$m^3$) | Depleted $\chi$/Q (sec/$m^3$) | D/Q ($m^{-2}$) | Distance to Nearest Meat Animal (m) | $\chi$/Q (sec/$m^3$) | Depleted $\chi$/Q (sec/$m^3$) | D/Q ($m^{-2}$) | Distance to Nearest Milk Goat (m) | $\chi$/Q (sec/$m^3$) | Depleted $\chi$/Q (sec /$m^3$) | D/Q ($m^{-2}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | lake | | NA | | lake | | NA | | lake | | NA | |
| NNE | lake | | | | lake | | | | lake | | | |
| NE | lake | | | | lake | | | | lake | | | |
| ENE | lake | | | | lake | | | | lake | | | |
| E | --- | 6.7E-08 | | 7.9E-10 | --- | 6.7E-08 | | 7.9E-10 | --- | 6.7E-08 | | 7.9E-10 |
| ESE | 8000 | 4.5E-08 | | 5.0E-10 | 1000 | 2.6E-06 | | 5.0E-08 | --- | 4.5E-08 | | 5.0E-10 |
| SE | --- | 4.6E-08 | | 2.9E-10 | 2200 | 7.2E-07 | | 6.4E-09 | --- | 4.6E-08 | | 2.9E-10 |
| SSE | 5500 | 7.7E-08 | | 4.2E-10 | 4800 | 9.6E-08 | | 5.3E-10 | --- | 3.9E-08 | | 1.8E-10 |
| S | --- | 5.7E-08 | | 2.8E-10 | --- | 5.7E-08 | | 2.8E-10 | --- | 5.7E-08 | | 2.8E-10 |
| SSW | 7000 | 7.9E-08 | | 2.7E-10 | 2200 | 8.9E-07 | | 4.7E-09 | --- | 6.1E-08 | | 2.1E-10 |
| SW | --- | 1.0E-07 | | 5.1E-10 | 2500 | 1.2E-06 | | 8.2E-09 | --- | 6.7E-08 | | 3.2E-10 |
| WSW | 4700 | 1.8E-07 | | 1.1E-09 | --- | 6.7E-08 | | 3.2E-10 | --- | 6.7E-08 | | 3.2E-10 |
| W | --- | 5.8E-08 | | 2.4E-10 | --- | 5.8E-08 | | 2.4E-10 | --- | 5.8E-08 | | 2.4E-10 |
| WNW | --- | 4.4E-08 | | 1.9E-10 | --- | 4.4E-08 | | 1.9E-10 | --- | 4.4E-08 | | 1.9E-10 |
| NW | lake | | | | lake | | | | lake | lake | | |
| NNW | lake | | | | lake | | | | lake | lake | | |

NOTE:— NA indicates that diffusion information for this run was not used in dose calculations for receptors in this column.
NOTE:— (-) Indicates receptor distance is greater than 8000 m, diffusion values given are for 8000 m.

## Table 2.3-19

## GRAZING SEASON DIFFUSION AND DEPOSITION ESTIMATES FOR ALL RECEPTOR LOCATIONS, RELEASE POINT: ASSUMED GROUND RELEASE IN BUILDING WAKE

| SOURCE: Computer Run ID: GX-4 604-62, 1976 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction | Distance to ~~Nearest~~ Residence (m) | $\chi/Q$ $(sec/m^3)$ | Depleted ~~$\chi/Q$ $(sec/m^3)$~~ | D/Q $(m^{-2})$ | Distance to ~~Nearest~~ Vegetable Garden (m) | $\chi/Q$ $(sec/m^3)$ | Depleted $\chi/Q$ $(sec/m^3)$ | D/Q $(m^{-2})$ | Nearest ~~Site~~ Boundary (m) | $\chi/Q$ $(sec/m^3)$ | Depleted ~~$\chi/Q$ $(sec/m^3)$~~ | D/Q $(m^{-2})$ |
| N | lake | | NA | | lake | | NA | | lake | | NA | |
| NNE | lake | | | | lake | | | | lake | | | |
| NE | lake | | | | lake | | | | lake | | | |
| ENE | lake | | | | lake | | | | lake | | | |
| E | 1200 | 3.2E-06 | | 6.1E-08 | 6600 | 9.7E-07 | | 1.2E-09 | 700 | 7.7E-06 | | 1.4E-07 |
| ESE | 950 | 2.9E-06 | | 5.5E-08 | 950 | 2.9E-06 | | 5.5E-08 | 700 | 4.8E-06 | | 9.2E-08 |
| SE | 500 | 8.7E-06 | | 9.8E-08 | 2800-3800 | 4.0E-07 | | 3.4E-09 | 650 | 5.7E-06 | | 6.1E-08 |
| SSE | 600 | 4.9E-06 | | 4.4E-08 | 3600 | 1.8E-07 | | 1.1E-09 | 600 | 4.9E-06 | | 4.4E-08 |
| S | 450 | 1.2E-05 | | 1.1E-07 | 2100-4200 | 9.6E-07 | | 7.0E-09 | 900 | 4.2E-06 | | 3.4E-08 |
| SSW | 600 | 7.4E-06 | | 5.2E-08 | 2300-3600 | 8.1E-07 | | 4.2E-09 | 500 | 9.9E-06 | | 7.1E-08 |
| SW | 750 | 9.5E-06 | | 8.4E-08 | 5300 | 2.1E-07 | | 1.2E-09 | 500 | 1.8E-05 | | 1.7E-07 |
| WSW | 1100 | 3.3E-06 | | 2.8E-08 | 1400 | 2.3E-06 | | 1.9E-08 | 1500 | 2.1E-06 | | 1.7E-08 |
| W | 1600 | 1.6E-06 | | 1.1E-08 | 5600 | 1.0E-07 | | 5.1E-10 | 1400 | 2.0E-06 | | 1.4E-08 |
| WNW | 2900 | 3.3E-07 | | 2.0E-09 | 4400 | 1.3E-07 | | 7.0E-10 | 600 | 5.4E-06 | | 4.6E-08 |
| NW | lake | | | | lake | | | | lake | | | |
| NNW | lake | | | | lake | | | | lake | | | |
| NOTE:— NA indicates that diffusion information for this run was not used in dose calculations for receptors in this column. | | | | | | | | | | | | |

## Table 2.3-20
## EXCLUSION AREA BOUNDARY DISTANCES

| Direction[a] | Distance (m) |
|---|---|
| N | 8000[b] |
| NNE | 8000 |
| NE | 8000 |
| ENE | 8000 |
| E | 747 |
| ESE | 640 |
| SE | 503 |
| SSE | 450 |
| S | 450 |
| SSW | 450 |
| SW | 503 |
| WSW | 915 |
| W | 945 |
| WNW | 701 |
| NW | 8000 |
| NNW | 8000 |

a. From plant toward exclusion area boundary.
b. For calculational purposes, exclusion area boundary distances offshore were assumed to be 8000 m.

# Table 2.3-21

## KRPavan DIRECTION-DEPENDENT EAB $\chi$/Q SUMMARY

**RELATIVE CONCENTRATION ($\chi$/Q) VALUES (SEC/CUBIC METER) VERSUS AVERAGING TIME**

| DOWNWIND SECTOR | DISTANCE (METERS) | 0-2 HOURS | 0-8 HOURS | 0-24 HOURS | 1-4 DAYS | 4-30 DAYS | ANNUAL AVERAGE | HOURS PER YR MAX 0-2 HR $\chi$/Q IS EXCEEDED IN SECTOR | DOWNWIND SECTOR |
|---|---|---|---|---|---|---|---|---|---|
| S | 450. | 1.70E-04 | <1.10E-04 | 8.86E-05 | 5.53E-05 | 2.81E-05 | 1.23E-05 | 29.3 | S |
| SSW | 450. | 2.08E-04 | 1.30E-04 | 1.02E-04 | 6.13E-05 | 2.94E-05 | 1.19E-05 | 40.9 | SSW |
| SW | 503. | 2.11E-04 | 1.27E-04 | 9.84E-05 | 5.67E-05 | 2.56E-05 | 9.72E-06 | 42.7 | SW |
| WSW | 915. | 1.53E-04 | 8.91E-05 | 6.80E-05 | 3.78E-05< | 1.63E-05 | 5.82E-06 | 12.8 | WSW |
| W | 945. | <1.73E-04 | 1.07E-04 | 8.41E-05 | 4.99E-05 | 2.73E-05 | 9.48E-06 | 14.8 | W |
| WNW | 701. | 1.29E-04 | 7.86E-05 | 6.13E-05 | 3.57E-05< | 1.64E-05 | 6.34E-06 | 17.2 | WNW |
| NW | 8000. | 6.16E-06 | 2.79E-05 | 1.88E-06 | 7.98E-07 | 2.33E-07 | 5.16E-08 | 0.5 | NW |
| NNW | 8000. | 1.44E-05 | 6.24E-06 | 4.11E-06 | 1.65E-06 | 4.49E-07 | 9.10E-08 | 0.6 | NNW |
| N | 8000. | 2.25E-05 | 1.02E-05 | 6.89E-06 | 2.93E-06 | 8.56E-07 | 1.90E-07 | <1.1 | N |
| NNE | 8000. | 4.01E-05 | 1.81E-05 | 1.21E-05 | 5.12E-06 | 1.48E-06 | 3.24E-07 | 4.5 | NNE |
| NE | 8000. | 2.24E-05 | 1.03E-05 | 7.03E-06 | 3.04E-06 | 9.10E-07 | 2.08E-07 | 0.3 | NE |
| ENE | 8000. | 1.96E-05 | 8.71E-06 | 5.80E-06 | 2.40E-06 | 6.76E-07 | 1.44E-07 | 0.1 | ENE |
| E | 747. | 1.24E-04< | 8.15E-05 | 6.61E-05 | 4.20E-05 | 2.19E-05 | 9.87E-06 | 2.5 | E |
| ESE | 640. | 1.56E-04 | 1.01E-04 | 8.18E-05 | 5.13E-05> | 2.62E-05 | 1.15E-05 | 23.9 | ESE |
| SE | 503. | 2.17E-04 | 1.36E-04 | 1.08E-04 | 6.48E-05 | 3.12E-05 | 1.28E-05 | 43.7 | SE |
| SSE | 450. | 1.66E-04 | 9.90E-05 | 7.65E-05 | 4.36E-05 | .95E-05 | 7.28E-06 | 25.0 | SSE |
| MAX $\chi$/Q | | 2.17E-04 | | | TOTAL HOURS AROUND SITE: | | | 269.8 | |
| SRP 2.3.4 | 450. | 8.00E-04 | 4.04E-04 | 2.87E-04 | 1.37E-04 | 4.71E-05 | 1.28E-05 | | |
| SITE LIMIT | | 0.00E+ | 0.00E+ | 0.00E+ | 0.00E+ | 0.00E+ | 1.28E-05 | | |

**RELATIVE CONCENTRATION (χ/Q) VALUES (SEC/CUBIC METER) VERSUS AVERAGING TIME**

| DOWNWIND SECTOR | DISTANCE (METERS) | 0-2 HOURS | 0-8 HOURS | 0-24 HOURS | 1-4 DAYS | 4-30 DAYS | ANNUAL AVERAGE | HOURS PER YR MAX 0-2 HR χ/Q IS EXCEEDED IN SECTOR | DOWNWIND SECTOR |
|---|---|---|---|---|---|---|---|---|---|

0.5 PERCENT χ/Q TO AN INDIVIDUAL IS LIMITING

NOTE: THE MAXIMUM χ/Q IS UNDERLINED ALONG WITH THE ASSOCIATED SECTOR (SE) VALUES

## Table 2.3-22
## KRPavan DIRECTION-DEPENDENT LPZ $\chi$/Q SUMMARY

**RELATIVE CONCENTRATION ($\chi$/Q) VALUES (SEC/CUBIC METER) VERSUS AVERAGING TIME**

| DOWNWIND SECTOR | DISTANCE (METERS) | 0-2 HOURS | 0-8 HOURS | 0-24 HOURS | 1-4 DAYS | 4-30 DAYS | ANNUAL AVERAGE | HOURS PER YR MAX 0-2 HR $\chi$/Q IS EXCEEDED IN SECTOR | DOWNWIND SECTOR |
|---|---|---|---|---|---|---|---|---|---|
| S | 4827. | 7.39E-06 | 3.72E-06 | 2.64E-06 | 1.26E-06 | 4.32E-07 | 1.17E-07 | 6.6 | S |
| SSW | 4827. | 9.76E-06 | 4.65E-06 | 3.21E-06 | 1.44E-06 | 4.54E-07 | 1.11E-07 | 179.0 | SSW |
| SW | 4827. | 1.44E-05 | 6.43E-06 | 4.30E-06 | 1.80E-06 | 5.14E-07 | 1.11E-07 | 5.0 | SW |
| WSW | 4827. | 3.00E-05 | 1.29E-05 | 8.47E-06 | 3.39E-06 | 9.10E-07> | 1.82E-07 | 14.9> | WSW |
| W | 4827. | 3.48E-05 | 1.60E-05 | 1.09E-05 | 4.69E-06 | 1.40E-06 | 3.19E-07 | 15.4 | W |
| WNW | 4827. | 1.30E-05> | 6.07E-06 | 4.15E-06 | 1.82E-06 | 5.57E-07 | 1.31E-07 | 7.1 | WNW |
| NW | 4827. | 1.12E-05 | 5.35E-06 | 3.71E-06 | 1.67E-06 | 5.31E-07 | 1.31E-07 | 8.3 | NW |
| NNW | 4827. | 2.48E-05 | 1.14E-05 | 7.77E-06 | 3.36E-06 | 1.01E-06 | 2.31E-07 | 10.5 | NNW |
| N | 4827. | 3.63E-05 | 1.77E-05 | 1.24E-05 | 5.70E-06 | 1.87E-06 | 4.77E-07 | 23.3 | N |
| NNE | 4827. | 4.97E-05 | 2.51E-05 | 1.78E-05 | 8.50E-06 | 2.93E-06 | 7.97E-07 | 43.7 | NNE |
| NE | 4827. | 3.52E-05 | 1.76E-05 | 1.24E-05 | 5.82E-06 | 1.97E-06 | 5.21E-07 | 20.9 | NE |
| ENE | 4827. | 3.31E-05 | 1.57E-05 | 1.08E-05 | 4.84E-05 | 1.52E-06 | 3.68E-07 | 9.8 | ENE |
| E | 4827. | 1.33E-05 | 6.68E-06 | 4.74E-06 | 2.25E-06 | 7.74E-07 | 2.09E-07 | 5.9 | E |
| ESE | 4827. | 1.53E-05 | 7.39E-06 | 5.14E-06 | 2.34E-06 | 7.57E-07 | 1.90E-07 | 4.6 | ESE |
| SE | 4827. | 1.44E-05 | 6.74E-06 | 4.60E-06 | 2.01E-06 | 6.14E-07 | 1.44E-07 | 4.1 | SE |
| SSE | <4827. | 6.68E-06 | 3.12E-06 | 2.14E-06 | 9.36E-07 | 2.86E-07 | 6.72E-08 | 2.4 | SSE |
| MAX $\chi$/Q | | 4.97E-05 | | | | TOTAL HOURS AROUND SITE: | | 361.7 | |
| SRP 2.3.4 | 4827. | <5.31E-05 | 2.65E-05 | 1.87E-05 | 8.82E-06 | 2.99E-06 | <7.97E-07 | | |
| SITE LIMIT | | 3.56E-05 | 1.90E-05 | 1.39E-05 | 7.02E-06 | 2.64E-06 | 7.97E-07 | | |

**RELATIVE CONCENTRATION (χ/Q) VALUES (SEC/CUBIC METER) VERSUS AVERAGING TIME**

| DOWNWIND SECTOR | DISTANCE (METERS) | 0-2 HOURS | 0-8 HOURS | 0-24 HOURS | 1-4 DAYS | 4-30 DAYS | ANNUAL AVERAGE | HOURS PER YR MAX 0-2 HR χ/Q IS EXCEEDED IN SECTOR | DOWNWIND SECTOR |
|---|---|---|---|---|---|---|---|---|---|

0.5 PERCENT χ/Q TO AN INDIVIDUAL IS LIMITING

NOTE: THE MAXIMUM χ/Q IS UNDERLINED ALONG WITH THE ASSOCIATED SECTOR (NNE) VALUES

# 2.4 HYDROLOGIC ENGINEERING

## *2.4.1 HYDROLOGIC DESCRIPTION*

The hydrology of the site region has been examined to provide a basis for assessing and limiting regulated radioactive liquid releases to the lake, for assessing and mitigating possible effects of accidental radioactive liquid releases on the ground or into the lake, and for establishing high and low-flow water protection criteria.

Lake Ontario, on which the site is located, is about 190 miles long, 50 miles wide, a maximum of 780 ft deep, and covers an area of about 7500 square miles. The average lake level, based on over 100 years of record, is 246 ft mean sea level (msl). The highest instantaneous stillwater level was 250.2 ft msl.

The surface of the land on the southern shore of Lake Ontario, at the site and east and west of it, is either flat or gently rolling. It slopes upward to the south from an elevation of about 255 ft msl near the edge of the lake to 440 ft msl at Ridge Road (New York State Highway 104), 3.5 miles south of the lake.

Water flows into Lake Ontario from other Great Lakes to the west of it through the Niagara River at the west end, from numerous small streams, and from four rivers along the south shore (the Genesee, Oswego, Salmon, and Black). It flows out through the St. Lawrence River at the east end of the lake. There is an annual cycle of water level variation with high water in the late spring or summer and low water in the winter as is indicated in Figure 2.4-1.

The site, in open, rolling terrain, is well-ventilated and not subject to flooding. There are no perennial streams on the site except Deer Creek, an intermittent stream with a drainage area of about 13.3 square miles (Figure 2.1-2) which enters the site from the west, passes south of the plant, and empties into the lake near the northeastern corner of the site.

The predominant surface currents in Lake Ontario are from west to east and they tend to swing toward the south shore. This has been substantiated by bottle tests which were made from 1892 to 1894 and in the summer of 1957 in the vicinity of Rochester. This water movement would be expected due to the effect of prevailing winds and rotation of the earth.

## *2.4.2 FLOODS*

### 2.4.2.1 Flood Design Considerations

The probable maximum Lake Ontario water level at the plant site is 250.78 ft msl based on a study conducted in 1968 for RG&E. The report of the study is included as Appendix 2A. The level was revised to 253.28 ft in 1973 based on U.S. Army Corps of Engineers projection (*Reference 1*). This would result from a design tropical storm and associated phenomena. There is no information available regarding major historical flood events in the site region. Though the design basis of the plant did not consider Deer Creek flooding, in 1982, the NRC requested that Ginna, as part of SEP, perform an analysis using conservative flooding assumptions to determine for which structures, systems, and components it would be cost-beneficial to provide protection. The probable maximum flood and flooding elevations at the plant site were developed as discussed in Section 2.4.3. The plant is protected from lake flooding by a breakwater with a top elevation of 261 ft. The plant is protected from Deer Creek flooding to an elevation of 273.8 ft to an elevation equivalent to a 26,000 cfs Deer Creek flood. (See Section 2.4.3.4 for a discussion of beyond-design-basis reevaluated flood hazards, performed in response to the accident at Fukushima Dai-Ichi.)

#### 2.4.2.2 Effects of Local Intense Precipitation

In an evaluation made by the NRC staff of the flood levels which would occur at safety-related buildings assuming an occurrence of the local maximum precipitation on the immediate site area, it was concluded that flood water will pond to an elevation of about 254.5 ft msl at the north area of the site in the vicinity of the screen house. The limiting elevation for safety-related equipment is elevation 254.8 ft (screen house floor elevation of 253.5 plus 1.3 ft to diesel generator buses 17 and 18). Therefore, safety-related equipment would be unaffected by local floods, and the plant would be able to withstand immediate plant area flooding with no detrimental effects. (See Section 2.4.3.4 for a discussion of beyond-design-basis reevaluated flood hazards (including Local Intense Precipitation), performed in response to the accident at Fukushima Dai-Ichi.)

### *2.4.3 PROBABLE MAXIMUM FLOOD ON STREAMS AND RIVERS*

#### 2.4.3.1 Flood Evaluation Summary

The RG&E flooding evaluation (*Reference 2*) estimated Deer Creek flood flow discharges using the HEC-1 surface runoff modeling routine (*Reference 3*). This computer program uses the Soil Conservation Services Runoff Curve Number concept and a developed unit response hydrograph in combination with a selected total storm depth and a rain storm distribution (obtained from the U.S. Corps of Engineers) to estimate the watershed flood hydrograph. The 24-hour rainfall depths having return periods of 5 to 100 years were obtained from a rainfall frequency atlas and return periods of 500 years and greater were estimated from a straight line projection on Gumbel extreme probability paper. Rochester Gas and Electric then used these rainfalls in HEC-1 to predict peak discharge rates for various rainfall depths (including the probable maximum precipitation event). The estimated probable maximum flood (PMF) discharge rate is 32,500 cfs. Flooding elevations about the plant were then predicted using the HEC-2 flood routing routine (*Reference 4*).

An independent flooding evaluation was prepared by Franklin Research Center for the NRC staff (*Reference 5*). The NRC study used runoff records from eight small New York State watersheds varying in size from 1.5 to 44.4 square miles, tabulated the maximum discharge of record, and calculated the discharge per unit area and individual watershed return periods by Log Pearson III procedures. The largest discharge per unit area of 284 cfs/mile$^2$ was for a 13.6 square mile watershed 140 miles from the plant near the Catskill Mountains. The NRC study also predicted the probable maximum flood for Deer Creek using the same HEC-1 computer program model used by RG&E, but with variations in antecedent moisture and rainfall distribution which resulted in a maximum discharge of 38,700 cfs. Flooding depths at the plant were estimated using the same HEC-2 model with some changes in roughness coefficients.

The NRC staff concluded that further analysis should be performed (*Reference 6*). Therefore, RG&E submitted a further analysis to determine water levels across the site from Deer Creek to the screen house, for flood flows up to 38,700 cfs, the largest calculated probable maximum flood (*Reference 7*) (Table 2.4-1). The results of this analysis were a maximum elevation of Deer Creek directly south of the guardhouse of 275.7 ft for the NRC estimated probable maximum flood of 38,700 cfs, 274.8 ft for the RG&E estimated probable maximum flood of 32,500 cfs and 273.8 ft for a flow of 26,000 cfs. A maximum elevation of 262.3 ft msl at the screen house for the 38,700 cfs probable maximum flood was also calculated. Figure 2.4-2 is a north-south cross section of the site showing grade elevations sloping from Deer Creek to Lake Ontario.

The NRC staff recognized that there were inherent conservatisms in its estimate of the probable maximum flood. These conservatisms result in a flood with virtually no chance of being exceeded. The NRC staff reviewed the various conservatisms in the elements of the estimation of the probable maximum flood and made additional estimates of the probability of flooding at Ginna Station, as described in the following section.

### 2.4.3.2 Derivation of Probable Maximum Flood

The construction of the probable maximum flood for an ungauged area consists of two elements: selection of the probable maximum precipitation, and development of the runoff hydrograph from this precipitation. From *Reference 8*, ANSI N170-1976, a probable maximum precipitation is defined as the estimated (precipitation) depth for a given duration, drainage area, and time of year for which there is virtually no risk of its being exceeded. The probable maximum precipitation for a given duration and drainage area approaches and approximates the maximum which is physically possible within the limits of contemporary hydrometeorological knowledge and techniques.

The selected probable maximum precipitation rainfall is then transformed into a flood hydrograph by methods that result in a probable maximum flood that is a hypothetical flood (peak discharge, volume, and hydrograph shape) considered to be the most severe reasonably possible based on comprehensive hydrometeorological application of probable maximum precipitation and other hydrologic factors favorable for maximum flood runoff such as sequential storms and snow melt.

### 2.4.3.3 Deleted

### 2.4.3.4 Beyond-Design-Basis Flooding Hazards Reevaluation Performed in Response to the Accident at Fukushima Dai-Ichi

By letter dated March 12, 2012 (*Reference 16*), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees pursuant to 10 CFR 50.54(f), “Conditions of Licenses.” The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-Ichi nuclear power plant, as documented in the NRC’s Near-Term Task Force report (*Reference 17*). Enclosure 2 to the 10 CFR 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (*Reference 18*).

The Ginna response to this request was submitted to the NRC by letter dated March 11, 2015 (*Reference 19*). The following flood-related hazards were evaluated:

- Local Intense Precipitation;
- Flooding in Streams and Rivers;
- Dam Breaches;
- Storm Surge;
- Seiche;
- Tsunami;
- Ice-Induced Flooding;
- Channel Migration or Diversion; and

- Combined Effects.

The hazards associated with dam breaches, storm surge, seiche, tsunami, ice-induced flooding, and channel migration or diversion were determined to be implausible or completely bounded by other mechanisms. For Local Intense Precipitation, the reevaluated level at the Screenhouse was determined to be 255.8 feet, higher than the previous SEP level of 254.5 feet; however, the Screenhouse is not credited for mitigating a flooding event.

The reevaluated flood from Deer Creek was calculated to have a flowrate of 28,500 cfs, a value greater than the SEP-calculated flowrate of 26,000 cfs. When including combined effects, such as wave runup, the resultant flood levels exceeded the previously calculated levels at the Containment, the Auxiliary Building, the Turbine Building/Battery Room interface, the Control Building, the Standby AFW Building, the Screenhouse, and the Diesel Generator Building; however, all buildings containing flood mitigation equipment, except the Auxiliary Building, could withstand the higher flood levels.

A further amended evaluation of the maximum flood level was pursued, as allowed by the NRC, using site-specific values for Probable Maximum Precipitation (*Reference 20*). This amended evaluation resulted in a calculated peak flood flow of 23,180 cfs. The flood levels for all buildings containing flood mitigation equipment were bounded by this flood with the exception of (1) the Diesel Generator Building, which has substantial available physical margin (3.4 feet) above the amended flood height and (2) the Battery Rooms and Air Handling Room, which have substantial available physical margin (7.4 feet) above the amended flood height (*Reference 21*).

By letters dated December 21, 2017 (*Reference 22*), and February 1, 2018 (*Reference 23*), the NRC concurred with the Ginna Mitigating Strategies Assessment (*Reference 20*) and Focused Evaluation for the Reevaluated Flood Hazard (*Reference 24*), respectively. In a January 24, 2019, Staff Requirements – Affirmation Session (*Reference 25*), the Commission determined that the reevaluated flooding hazard would continue to be assessed via the 10 CFR 50.54(f) process, rather than pursuing backfitting via 10 CFR 50.109 to codify these assessments.

### *2.4.4 LAKE ONTARIO SURGE FLOODING*

As a condition of the Full-Term Operating License, the NRC required the placement of additional shoreline erosion protection. This protection was added to ensure minimum wave overtopping of the concrete wall fronting the plant and lower water levels in the vicinity of the screen house. The NRC performed an analysis using procedures from the Shore Protection Manual, U.S. Army Coastal Engineering Research Center, 1977, of the stability and condition of the revetment fronting the plant site and concluded in April 1981 (*Reference 10*) that if the revetment fronting the plant exists as designed it would be capable of resisting surge flooding from Lake Ontario and therefore it would meet current regulatory criteria. Subsequent inspections of the revetment in November and December 1981 showed that the revetment appears to be structurally sound and stable with no evidence of major structure stability problems. Further, the inspections verified that the revetment had not degraded from the original design. Therefore, it was concluded that adequate protection from surge flooding exists at Ginna Station.

### *2.4.5 ICE EFFECTS*

Lake Ontario seldom freezes over but ice does occur in winter, usually along the southern and northern shores and at the northeastern end of the lake.

The possibility of ice blockage of the Deer Creek discharge is considered remote. In the event of

such an occurrence combined with maximum surface runoff into Deer Creek, it can be seen from Figure 2.4-4 that the site topography is such as to prevent flooding the plant.

There is a large area immediately east of the plant, where the grade levels are 225 to 260 ft, over which the discharge of Deer Creek could spill and reach the lake before the water level would rise to the 270-ft grade level of the plant. The 270-ft grade level of the plant is also interposed between the channel of Deer Creek and the screen house and the surrounding area between the plant and the lake.

### *2.4.6 COOLING WATER CANALS AND RESERVOIRS*

The ultimate source of cooling water (ultimate heat sink) for Ginna Station is Lake Ontario. The intake structure for the plant is on the lake floor about 3000 ft offshore. Water is conveyed from the intake structure to the screen house through a buried concrete-lined tunnel. The circulating water pumps and the service water pumps are located in the screen house. The intake structure and screen house are described in Section 10.6.2.

### *2.4.7 FLOODING PROTECTION REQUIREMENTS*

The main plant area and buildings are at grade elevation 270.0 ft msl; the north side of the turbine building and the screen house are at elevation 253.5 ft msl. The plant grade entrances to the auxiliary building are at elevation 271 ft msl. The lowest limiting elevation of safety-related equipment in the subbasement within the auxiliary building is 221.5 ft msl.

The plant is protected from lake surges and wind-driven waves by a shoreline revetment with a top elevation of 261.0 ft msl.

The equipment required for safe plant shutdown is located in the auxiliary building and the turbine building. Protection in this area (*Reference 11*) is provided to 273.8 ft msl, which is equivalent to an Ginna LLP estimated discharge flow of 26,000 cfs from Deer Creek. Because the probability of flooding beyond 273.8 ft msl is low, it is the NRC staff's judgment that the probable maximum flood accident sequence will not dominate events potentially leading to core damage. Also, Ginna LLP emergency procedures require installation of flood protection devices well before rising flood waters can jeopardize safe shutdown capability as discussed in Sections 3.4.1.1.3 and 13.5.2.2.3 (*Reference 9*).

### *2.4.8 LOW WATER CONSIDERATIONS*

The lowest monthly average water level for Lake Ontario (at the Oswego gauge) for a 107 year period of record ending in 1967 was 242.68 ft (U.S. Coast and Geodetic Survey Datum). For a 65-year period of record, the lowest instantaneous still water level was 242.17 ft on December 23, 1934. For each year during this period, the instantaneous annual low at the Oswego gauge was not more than 1.02 ft below the corresponding annual monthly low.

For an 8-year period of record at the Rochester gauge, the lowest instantaneous level was 241.38 and the annual instantaneous low was not more than 0.59 ft below the corresponding monthly average low.

The minimum mean monthly lake level of record for Lake Ontario at the Rochester, New York, gauge is elevation 243.0 ft msl. The lowest entrance level into the intake structure is elevation 217.0 ft msl. Having 26 ft of water above the intake structure at minimum lake level is more than adequate to accommodate the maximum setdown (negative surge) for this part of the lake, which is less than 5 ft. Low water conditions for Lake Ontario are discussed in Appendix 2A.

## *2.4.9 DISPERSION, DILUTION, AND TRAVEL TIMES OF RELEASES OF LIQUID EFFLUENTS IN SURFACE WATERS*

### 2.4.9.1 Near-Shore Lake Currents

The character of near-shore lake currents during the spring is illustrated by measurements of a polluted mass of water which entered the lake from the Niagara River, March 15, 1933. It moved eastward along the south shore at a rate of about 5 miles per day and was measured in succession by a number of water treatment plants. It was detected at Oswego, about 130 miles east of the Niagara River on April 11, 26 days after entering the lake.

The surface currents in Lake Ontario are generated primarily by wind stress on the water surface. The lake surface wind-driven currents have speeds which average about 1.6% to 2% of the wind speeds (measured at an elevation of about 70 ft above the lake surface), as was demonstrated by experiments described in Appendix 2B; thus, an average wind speed of 15 mph over the lake would generate an average surface current of about 0.2 to 0.3 mph, or about 5 to 7 miles/day. The flow-in from rivers and flow-out through the St. Lawrence River has a negligible effect by comparison.

Current speeds near shore may be somewhat greater or less than offshore speeds--if less, due to friction close to shore and, if greater, due to long shore currents caused by the piling up of water near the shore which is created by winds with a shoreward velocity component. Measurements near the site made in 1965 (Appendix 2B) indicate that a typical near-shore current is about 0.4 ft/sec (0.27 mph) or 6.5 miles/day toward the east.

Experiments were conducted in 1965 to measure the dispersion of liquids released to the lake under several typical conditions. These are described in Appendix 2B. The experiments involved the release of rhodamine-B dye at a constant rate of about 10 lb/day from a point about 1000 ft offshore for three 3-week periods: one in the spring, one in the summer, and one in the fall. Measurements of dye concentration were made with continuously reading instruments in an accurately navigated boat during and after each release period. The results of these experiments were used to develop estimates of dispersion discussed in Sections 2.4.9.2 and 2.4.9.3 below.

### 2.4.9.2 Dispersion of Regulated Radioactive Liquid Releases

#### <u>2.4.9.2.1 Regulated Radioactive Liquid Releases</u>

Regulated releases of radioactive liquids are made intermittently by metered dilution of monitored waste tank effluent into condenser and service water outflow to the lake. During power operation, condenser flow will be about 334,000 gpm and service water outflow about 15,000 gpm.

The annual average concentration of radioactive material attributable to the plant at the point where such outflow enters the lake will be limited so that it will be below the drinking water maximum permissible concentration for unrestricted areas as specified in 10 CFR 20, Appendix B, Table II.

The dose or dose commitment to an individual as calculated in the Offsite Dose Calculation Manual for radioactive materials in liquid effluents released to unrestricted areas is limited during the following items A & B.

A. Any calendar quarter to ≤1.5 mrem to the total body and to ≤5 mrem to any organ.

B. Any calendar year to ≤3 mrem to the total body and ≤10 mrem to any organ.

If the discharge were to be limited to 1/10 maximum permissible concentration, the estimated allowable long-term release rate would be about 5 mCi/sec (primarily tritium) assuming dilution in condenser flow of 334,000 gpm and isotopic composition of releases as shown in Table 11.2-5. The maximum expected long-term average release rate is about 0.05 mCi/sec or about 1/100 of the allowable rate. These estimates are illustrative. Release rate limits are contained in the Offsite Dose Calculation Manual (ODCM). Consideration of re-concentration effects in aquatic biota consumed by humans would not limit allowable release rates.

Liquid waste treatment systems are used to reduce the radioactive materials in liquid wastes prior to their discharge, if necessary, to ensure that cumulative doses due to liquid effluent releases, when averaged over 31 days, does not exceed 0.06 mrem to the total body or 0.2 mrem to any organ.

#### 2.4.9.2.2 Liquid Dispersion

Dispersion of liquids after release into the lake from the site can be estimated by making assumptions concerning the direction and rate of drift of the receiving waters and of the rate of diffusion during injection and drift, including the effects of thermal stratification and shear currents.

For relatively long-term releases (i.e., for a number of hours) at a constant discharge rate, the peak concentration as a function of distance along the direction of mean flow can be predicted by several different theories with equations which differ only by a constant factor. In all of them the concentration is proportional to the reciprocal of distance. The simplest equation for peak concentration as a function of distance is the following one in which the boundary effect of the shore is approximated by doubling concentrations for the unconfined case. The derivation of this equation is described in Appendix 2B.

$$\frac{Sp}{q} = \frac{1}{1.77\,Dwx}\left(\frac{\sec}{m^3}\right)$$

(Equation 2.4-1)

where:

| | | |
|---|---|---|
| | $Sp$ = | peak concentration (μCi/m$^3$) |
| | $q$ = | discharge rate (μCi/sec) |
| | $D$ = | depth of mixing (m) |
| | $w$ = | diffusion velocity (m/sec) |
| | $x$ = | distance from release point (m) |

The program of direct dispersion measurements described in Appendix 2B showed that the near-shore region of Lake Ontario near the site is characterized by an average diffusion velocity (w) of 3.3 x $10^{-3}$ m/sec. Observations in reservoirs, estuaries, and the ocean range from 2 x $10^{-3}$ to 2 x $10^{-2}$ m/sec.

Taking w = 3.3 x $10^{-3}$ and assuming that the discharged material is confined to the upper 3 m of

the lake water, the resulting equation is as follows:

$$\frac{Sp}{q} = \frac{57}{x}\left(\frac{\sec}{m^3}\right)$$

(Equation 2.4-2)

However, near the discharge point this equation is not realistic for the high-volume high-momentum discharge at the site for two reasons: first, because materials will be mixed with the discharge before it is released, and second, because further dilution will occur after release due to momentum mixing of the 2 ft/sec discharge jet with slower moving lake water. If material is mixed in the full discharge flow of 334,000 gpm, then Sp/q at entry to the lake is 5 x $10^{-2}$ sec/$m^3$ or 5 x $10^{-8}$ µCi/$cm^3$ per µCi/sec is released. Momentum mixing will cause further dilution by a factor of about 7, 1 mile from the discharge point as is discussed in Appendix 2B. Between about 1 and 8 miles, additional significant dilution of the peak concentration zone (near shore) would not be expected. At distances greater than about 8 miles along the shore, the dilutions can be predicted by the equation. Estimates made on this basis can be summarized as follows:

| Distance From Site Along Shore | Sp/q (µCi/$cm^3$ per µCi/sec) | Dilution Relative to Concentration at Exit from Discharge Canal |
|---|---|---|
| In cooling water canal exit to lake | 5 x $10^{-8}$ | 1 |
| One mile | 7 x $10^{-9}$ | 7 |
| Five miles | < 7 x $10^{-9}$ | 7 |
| Fifteen miles | 2.4 x $10^{-9}$ | 15 |

The predicted maximum concentrations are for steady-state conditions and would occur only with persistent wind direction; therefore, at distances greater than about 20 miles, the diffusion velocity used above is not descriptive since variation in wind direction during the 50 to 70-hour travel time to these positions will produce more dispersion than predicted above.

### 2.4.9.2.3 Effect of Local Recirculation

Local recirculation from the discharge to the intake, which would produce significantly higher concentrations in the site region than those estimated above, is not expected. The intake for the condenser cooling water is located on the bottom at a depth of 30 ft, about 3000 ft offshore. The density difference produced by heating the condenser cooling water will usually restrict its movement to a surface layer 6 to 10-ft thick until it has mixed with ambient lake water by tenfold or so. As noted above, momentum mixing will dominate in the site region and dilution by 4 to 1 along the direct path from the discharge canal to the surface layer over the intake would be expected if the discharge plume were to be centered over the intake. If the water were then drawn into the intake along with the deeper layer, an additional dilution of approximately threefold would occur to provide a total minimum dilution of approximately twelve-fold, or a recirculation of about 8% for this case. Recirculation would be less than 8% for average conditions where the discharge plume center is not over the intake.

Lake flow reversal in front of the site results in very rapid dilution as indicated in Appendix 2B.

It would be expected to cause recirculation of less than 1%.

#### 2.4.9.2.4 Concentration of Nearest Public Water Supply Intake

If discharges average 1/10 maximum permissible concentration at entry to the lake, concentrations on the average at the intake of the nearest public water supply at Ontario 6000 ft east and 1050 ft offshore will be less than 1/10 of this (see Figure 9, Appendix 2B), or less than 1/100 of maximum permissible concentration even if thermal stratification effects are neglected.

#### 2.4.9.2.5 Environmental Monitoring Program

As indicated in the Offsite Dose Calculation Manual (ODCM), an environmental monitoring program is conducted including radioactivity measurements of aquatic biota and lake surface water. This program provides a check of release limits and a basis for adjusting them if necessary.

### 2.4.9.3 Dispersion of Accidental Radioactive Liquid Releases

#### 2.4.9.3.1 Accidental Releases to the Lake

If accidental releases to the lake occur over relatively long times (hours), resulting concentrations can be predicted using methods similar to those in Section 2.4.9.2; however, accidental releases, if they occur, might be of relatively short duration (i.e., batch releases).

Estimates of concentration of material released in batches can be made by several theories which predict a time dependence inversely proportional to either the second or third power of time. Available data are inadequate to resolve the differences in these theories, but the use of empirical coefficients permits nearly equal statistical fitting with either of several functions; therefore, the following equation of Okudo and Pritchard is used with experimental coefficients, accommodating the boundary effect of the shoreline by doubling the concentrations for the unconfined case:

$$\frac{Sp}{q'} = \frac{2}{3.14 w^2 t^2 D}$$

(Equation 2.4-3)

where:

| | | |
|---|---|---|
| | *Sp* = | peak concentration ($\mu$Ci/m$^3$) |
| | *q′* = | activity discharged ($\mu$Ci) |
| | *w* = | diffusion velocity (m/sec) |
| | *t* = | time (sec) |
| | *D* = | depth of water column (meters) |

It is assumed that the equation above applies, that $w = 3.3 \times 10^{-3}$ m/sec and D = 3 m, so that

$Sp/q' = 20000/t^2$

and that the mean velocity of the water layer is 0.4 ft/sec. Then peak concentrations at various distances from the site in terms of $\mu$Ci/cm$^3$ per $\mu$Ci released will be as follows

| Distance (time) From the Site | µCi/cm3 per µCi Released |
|---|---|
| 1 mile (3.66 hours) | $1.1 \times 10^{-10}$ |
| 5 miles (18.3 hours) | $4.6 \times 10^{-12}$ |
| 15 miles (2.3 days) | $5.1 \times 10^{-13}$ |

#### 2.4.9.3.2 Accidental Spills on the Ground

Accidental spills of radioactive liquids on the ground in the plant area, if they occur, and to the extent they do not enter the ground, will either run off on the surface into the Deer Creek channel and to the lake, or directly to the lake depending on the location of the spill. That part of a spill which enters the ground would be retained in the ground or would move slowly with the ground water northward into the lake. Ground water, bedrock, and ground surface contours are shown in Plate IIB-3 of the PSAR. As indicated in Plate IIB-3, the ground water level in the plant area generally ranges from about elevation 245 to 250 ft and slopes downward toward the lake. Ground water occurs in the overburden soils in most areas but lies beneath the rock surface in part of the southeastern sector where bedrock surface rises more steeply.

Measurements in one test indicate that the rock is almost impermeable to water flow. Soil permeability was observed in six test pits and a test well (described in Plate IB-4 of the PSAR) and ranged from $10^{-3}$ to $10^{-6}$ cm/sec. Most of the ground-water movement within the site will take place in the more permeable soils overlying the rock.

Wells are a source of drinking water in the site vicinity. The wells near the site not owned by Ginna LLC are located mostly along Lake Road east and west of the part of the road which passes through the site. A few are on Ontario Center Road which runs south from Lake Road. The nearest well is approximately 0.5 miles southwest from the center line of the reactor building.

As a result of the stratified nature of the rock, no measurable vertical permeability is indicated. Horizontal bedding limits vertical flow of water through the rock itself, and the cross-bedded nature of the rock precludes any horizontal flow over any appreciable distance. The small grain size, an argillaceous matrix, and the lack of sorting of the grains is not conducive to extensive horizontal permeability. Any movement of water through the rock would have to occur in joints and fractures. The limited extent of joints and fractures in the rock at the site would minimize circulation along these paths. The only opportunity for appreciable movement of water exists near the surface of the rock, where weathering or possible rebound may have opened small joints or fractures. The rock appears to be practically impermeable at the depths sufficient to prevent relief of stresses and consequent open joints. Inspection of the reactor excavation and the relatively dry condition of the tunnels below Lake Ontario confirm this assessment. No flow toward inland wells is expected.

### *2.4.10 DISPERSION, DILUTION, AND TRAVEL TIMES OF RELEASES OF LIQUID EFFLUENTS IN SURFACE WATERS*

#### 2.4.10.1 Design-Basis Groundwater Level

The original groundwater studies were conducted by Dames & Moore in 1964-1965 (Reference 12). The design-basis groundwater elevation for the screen house and emergency service water

structure was 253.5 ft msl, and the design basis for all other safety-related structures was elevation 250 ft msl (Reference 13).

A groundwater monitoring program was established in response to SEP Topic III-3.A to verify the original design-basis groundwater elevation of 250 ft msl (Reference 6). It consisted of three fully encased wells drilled into the groundwater table on the plant site. A liquid level detection and indication unit was installed in one well to continuously monitor and record the groundwater level. The other two wells were available if more data was needed to establish the design basis groundwater level. As a result of monitoring of groundwater levels over a 4-year period from 1983 through 1987 the new design-basis groundwater level was determined to be at elevation 265.0 ft msl. This value was based on a peak groundwater level of 264.69 ft and using a 2% maximum expected error in the recording system. An engineering evaluation was performed of the effects of the new design-basis groundwater level on safety related structures below grade. As a conservative approach, the engineering evaluation considered a design-basis groundwater level at grade elevation 270.0 ft msl or 5 ft higher than the new design-basis level. The evaluation was based on finite element analysis of elastic plates utilizing the MacNeil Schwindler Corporation (MSC) PAL2 computer program and conventional structural engineering techniques. Pressure loads considered in the analysis consisted of hydrostatic, soil, and soil-induced earthquake forces. Four walls representative of the worst-case load conditions of all below-grade safety-related areas of the auxiliary, intermediate, and control buildings were selected for the engineering evaluation. The evaluation demonstrated that the below-grade safety-related structures were adequately designed to resist the design loads associated with groundwater levels at grade (270.0 ft msl) without requiring strengthening modifications.

### 2.4.10.1 Groundwater Protection Program

In 1995 a study (*Reference 14*) was initiated by RG&E and prepared by Dr. Robert Poreda (Professor of Earth and Environmental Sciences at the University of Rochester) to determine the impacts of spent fuel leakage on the environment. This study concluded:

- No significant amount of water from the spent fuel pool (SFP) was migrating off-site.
- Ginna's drain system around Containment provides an effective "capture mechanism" for potential leaks to the groundwater.
- The facility's sub-grade structure acts as a hydraulic barrier (i.e., barrier to groundwater flow); any groundwater leakage through structural imperfections enter the Containment Building's drain system which leads to the sub-basement sump from where it is processed as radwaste.

The study also confirmed that groundwater generally moves from south to north across the site, as was determined in the initial site characterization study (*Reference 12*).

As part of the 1995 study, down gradient groundwater monitoring wells installed to verify the absence of tritium in the groundwater unexpectedly identified tritium concentrations above background levels. When overboard blowdown of the secondary coolant was initiated in the spring of 1996 in preparation for refueling outage (RFO), high levels of tritium were detected in the down gradient wells. Engineering determined that the underground blowdown canal was degraded and introducing secondary coolant to the groundwater under the turbine building. Chemistry determined that leakage from the intermediate building north wall contained tritium and short-lived radioiodine, confirming the reactor coolant system (RCS) rather than the SFP as the source. Secondary coolant system radioactivity was elevated at that time due to significant primary to secondary leakage. The release of tritium to the groundwater was stopped when the underground blowdown canal was repaired and abandoned and the primary to secondary leakage

was eliminated with steam generator replacement. The total tritium released from the site to Lake Ontario via groundwater for the 1996 event was calculated at approximately 1.2E-3 Ci. Since that time, down gradient groundwater monitoring well tritium concentrations have decreased due to diffusion, dispersion, and decay.

In 2006, the industry began a voluntary groundwater protection program involving all nuclear power plant operators to improve the management of situations involving radiological releases to groundwater. Nuclear Energy Institute's industry guideline for the groundwater protection program, "Industry Ground Water Protection Initiative: Final Guidance Document," NEI 07-07, was released in August 2007. New wells (Screenhouse East wells) were installed in 2007 in an effort to enhance the groundwater monitoring program. These wells are located down gradient of the previous monitoring wells to serve as additional and redundant down gradient monitoring points for any potential plant releases. The site's existing groundwater monitoring wells were upgraded to include locking caps and bollards in August 2010. As part of this project, a new groundwater control well was installed approximately 2,000 feet southwest of the reactor. The groundwater protection program was further enhanced in September 2013, when 5 new wells were installed outside of the protected area for increased monitoring. As of September 2013, the site maintained 13 onsite groundwater monitoring wells, and 2 control groundwater monitoring wells. Additionally, water from four onsite storm water catch basins is periodically collected and analyzed as part of the site's Groundwater Protection Program.

#### 2.4.10.2 Water Use

Lake Ontario water is used for industrial and domestic water supplies, recreation, domestic and international shipping, and a limited amount of commercial fishing. A description of historical water intakes on the southern shore of the lake is given in Table 2.4-2.

The town of Ontario has a domestic water intake 1.1 miles east of the site extending approximately 4,000 ft from shore. The demand on this system is approximately 2,200,000 gallons per 24 hour period.

The capacity of the Ontario water treatment system is 3.0 million gallons per day. The Ontario water system supplies water to the towns of Walworth and Macedon to the south of Ontario, and to the town of Marion to the southeast of Ontario. Marion also purchases water from Williamson to its north. Macedon is partly supplied by a metered connection with the Monroe County Water Authority. The town of Walworth has emergency connections with the Monroe County Water Authority. The town of Ontario has emergency connections with the towns of Williamson and Webster to its east and west, respectively.

During the construction phase of Ginna in the 1960's, a tracer release and dilution study was conducted to determine dilution factors at the Ontario Water District Intake, which was then located 1,100 ft offshore and at a depth of 11 ft. Dye was released continuously for more than 10 days in the spring, summer, and fall of 1965 and concentrations were measured in the study area. Contours of tracer concentrations were mapped and various diffusion analysis were conducted based on the observed tracer concentration and currents under prevailing wind conditions during the study. The 1965 Study projected dilution factors at the Ontario Water District Intake to be 1:20 at the bottom under complete vertically mixed conditions.

In 2002, the Ontario Water District relocated its water intake structure to its current location, which is about 4,000 ft from the shoreline and at about 40 ft water depth. In 2010, a more comprehensive, computer-based hydrodynamic and thermal model was developed to quantify the dilution factors between the Ginna Station and the Ontario Water District Intake. This model incorporated environmental processes that affect dilution, including lake water

elevation, three dimensional current, diffusion, and temperature variations. Annual average dilution factors at the Ontario Water District Intake were estimated to be approximately 1:360 at the bottom. The monthly average dilution factors at the bottom of the lake at the intake were determined to be greater than or equal to 1:200 (*Reference 15*).

In 2013, the Monroe County Water Authority finished construction on a water treatment plant in Webster, New York. The point of intake for this facility is 6,025 feet from the shoreline of Lake Ontario. The demand on the Webster plant in a 24-hour period is approximately 20,000,000 gallons. The maximum daily capacity of the site is 50 MGD.

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3. U.S. Department of the Army, Corps of Engineers, "HEC-1 Flood Hydrograph Package," Hydrologic Engineering Center, Users Manual, (February 1981 version), July 1981.

4. U.S. Department of the Army, Corps of Engineers, "HEC-2 Water Surface Profiles," Hydrologic Engineering Center, Users Manual, (April 1980 version), January 1981.

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16. NRC letter, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 12, 2012. [FCMS ID: WPLNRC-1002518]

17. U.S. Nuclear Regulatory Commission, SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated Jul 12, 2011. [ML11186A959]

18. U.S. Nuclear Regulatory Commission, NUREG/CR-7046, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the Unites States of America," dated November 11, 2011. [ML11321A195]

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## Table 2.4-1
## DEER CREEK OVERFLOW SUMMARY TABLE (SEP Results)

| Total Flood Flow (cfs) | Elevation at Screen House (ft) | Elevation at Deer Creek Section 2380[a] (ft) |
|---|---|---|
| 14,600[b] | 253.5 | 270.0 |
| 15,000[c] | 253.55 | 270.1 |
| 16,000 | 253.7 | 270.6 |
| 17,300[d] | 254.0 | 271.1 |
| 18,000 | 254.2 | 271.4 |
| 20,000 | 254.8 | 272.1 |
| 20,600 | 255.0 | 272.3 |
| 22,000 | 255.4 | 272.8 |
| 24,000 | 256.0 | 273.3 |
| 26,000[f] | 256.0 | 273.8 |
| 28,000 | 257.8 | 274.2 |
| 30,000 | 259.0 | 274.5 |
| 35,000 | 261.6 | 275.1 |
| 38,700[e] | 262.3 | 275.7 |

a. About 100 ft. west of bridge over Deer Creek leading to plant
b. Channel capacity
c. Standard project flood
d. Standard project flood plus 1 ft.
e. Probable maximum flood
f. NRC staff approved design flood level

## Table 2.4-2
## INDUSTRIAL AND MUNICIPAL WATER SUPPLIES

| Name and Location | Type of Water Use | Quantity Used | Treatment Before Use | Location With Respect to Ginna Site (miles) | Comments |
|---|---|---|---|---|---|
| Ontario Water District, Ontario | Domestic | 1,800,000 gpd | Filtration chlorination | 1.1 east | Intake 1050 ft from shore; Serves 3 adjacent towns |
| Williamson Water District, Williamson | Domestic | 149,000 gpd | Filtration chlorination | 5.25 east | Serves 4 adjacent water districts |
| Sodus Point Water District, Sodus | Domestic | 84,000 gpd | Filtration chlorination | 15 east | Serves South Shore water district |
| Wolcott | Domestic | 240,000 gpd | Filtration chlorination | 24 east | Auxiliary source |
| Comstock Foods, Incorporated, Red Creek | Industrail cooling | 100 gpm | Chlorination | 25 east | Operates during months of October and November |
| Marathon Corporation, Oswego | Industrial process | 3 to 4 mgd | Rapid sand filtration, chlorination | 41 east | Water treatment plant has 5 mgd capacity. Intake point about 250 ft from shore |
| Niagara Mohawk Power Corporation, Oswego | Cooling | 500 mgd | None | 41 east | --- |
| Oswego City | Domestic | 5.0 mgd | Chlorination | 41 east | New intake under construction; Serves 4 adjacent water districts |
| Queensboro Farm Products, Incorporated, Lycoming | Boiler and cooling water | Not known | None | 46 east | --- |
| RG&E Russell Station, Greece | Condenser cooling | 166 mgd | None | 16 west | Intake extends 3660 ft from shore |
| Eastman Kodak Company Waterworks, Greece | Industrial processing | 17.3 mgd | Filtration chlorination | 16 west | Two intakes 700 ft apart and extending 7800 ft from shore |
| Rochester Public Water Supply, Greece | Domestic | 34 mgd | Filtration chlorination | 16 west | Pumped fom Eastman Kodak Company intake pipe |
| New York Water Service Corporation, Rochester Plant, Greece | Domestic | 13.5 mgd | Filtration chlorination | 16 west | Two intakes 100 ft apart and extending 4000 ft from shore |

| Name and Location | Type of Water Use | Quantity Used | Treatment Before Use | Location With Respect to Ginna Site (miles) | Comments |
|---|---|---|---|---|---|
| Hilton Public Water Supply, Parma | Domestic | 0.2 mgd | Filtration chlorination | 24 west | Intake extends 350 ft from shore |
| Brockport Public Water Supply, Hamlin | Domestic | 1.3 mgd | Filtration chlorination | 30 west | Intake extends 2600 ft from shore |
| Lyndonville Public Water Sup-ply, Yates | Domestic | 68,000 gpd | Filtration chlorination | 53 west | Intake extends 530 ft from shore |
| Barker Public Water Supply, Somerset | Domestic | 0.1 mgd | Filtration chlorination | 62 west | Intake extends 600 ft from shore |
| Newfane Water District No. 1, Newfane | Domestic | 147,000 gpd | Filtration chlorination | 68 west | Intake extends about 600 ft from shore |
| Wilson Public Water Supply, Wilson | Domestic | 175,000 gpd | Filtration chlorination | 76 west | Intake extends 450 ft from shore |

# 2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

## *2.5.1 BASIC GEOLOGIC AND SEISMIC INFORMATION*

A geological program involving a regional geological survey, borings, and other tests at the site was conducted to provide information needed to assess foundation conditions, seismic activity, and ground-water conditions. The details of these investigations are reported in detail in Appendix 2C (and in the PSAR, Volume 1, Appendix D). Additional studies were performed in 1973 as part of the Sterling alternative site evaluation. This is described in Section 2.5.2.3.

These results and subsequent information discussed below indicate that the rock and compact granular soil on the site provide a suitable foundation for plant structures with allowable bearing pressures in the range of 3 to 5 tons/ft$^2$ for spread or mat foundations on the compact granular soils and 35 tons/ft$^2$ on bedrock.

### 2.5.1.1 Regional Geology

The site is located on the southern shore of Lake Ontario in the eastern portion of the Erie-Ontario Lowlands Physiographic Province (Fenneman, 1938). The regional topography is of low relief and rises gradually from an elevation of +250 mean sea level (msl) at the lake to +500 ft msl at the Portage Escarpment, which is the northern boundary of the Appalachian Plateau Province to the south. A beach ridge 10- to 25-ft high parallels the shoreline of Lake Ontario 4 miles to the south. North of the ridge is the lake plain of former glacial Lake Iroquois. The site lies on this plain.

The southern margin of Lake Ontario is characterized by many promontories which seem to reflect prominent joint directions in bedrock. The site is located near one such promontory called Smokey Point. Major joint directions are north 75° to 85° east and north 10° east to 30° west. Erosional bluffs along the lake range from 15- to 30-ft high. Smokey Point is located at the eastern end of a 5-mile-long ridge, the crest of which is about +310 ft. Relief in the site area is low, with elevations ranging from +350 to +300 ft. The site is underlain by 20 to 60 ft of glacial deposits and approximately 2700 ft of Paleozoic (570 million years to 225 million years before present) sedimentary rocks over crystalline basement. The uppermost Paleozoic unit is sandstone of Upper Ordovician (455 to 430 million years before present) Queenston formation. The Queenston is roughly 1000-ft thick in this area and overlays approximately 80 ft of Oswego sandstone, approximately 600 ft of Lorraine shales, and probably less than 30 ft of Potsdam sandstone. The pre-Cambrian surface is roughly 2600- to 2700-ft deep at the site.

The glacial deposits include at least two till horizons. The lower unit overlies bedrock and varies in thickness from 6 to 25 ft. This unit consists of grayish-red, calcareous, silty clay. The unit is poorly sorted and contains numerous striated and faceted pebbles, cobbles, and boulders. The upper till unit is at or near the ground surface and ranges from 7 to 30 ft in thickness. This unit is composed of relatively uniform olive-gray to yellow-brown silty,

sandy clay, with large boulders several feet in diameter. Between the two till horizons is a zone of lakebed deposits consisting of gray, very plastic clay.

Rochester Gas and Electric Corporation has determined by regional correlation that the lower till unit is associated with the Woodfordian glacial advance, a substage of the Wisconsinan Stage, which took place about 22,000 years ago. The lakebed deposit is believed to have been deposited in the bed of Lake Iroquois. The upper till is related to a minor glacial readvancement that occurred about 12,000 years ago.

#### 2.5.1.2 Site Geology

The major Ginna Station structures are supported in the Queenston formation or atop a thin layer of natural or compacted granular soils immediately above the bedrock. The Queenston formation, which is generally found at depths of 30 to 40 ft, is composed of alternating strata of thinly to thickly bedded, dense, fine-grained sandstone, silty and sandy siltstone, with occasional thin beds of fissile shale. Bedding is essentially horizontal with occasional cross-bedding and shaly partings. The color is predominately red, but random green blotches and layers occur throughout the depths explored. Occasional continuous vertical joints were noted in the borings and during site inspections.

Subsequent to the initial environmental studies, seven additional borings were drilled to depths between 35 and 90 ft in the reactor area for a supplementary foundation study. The locations of these borings are shown in Figure 2.5-1. The soil and rock encountered in the seven borings were similar in all respects to the onsite materials described in the PSAR.

Nine borings were drilled for the proposed intake and discharge tunnels. As shown in Figure 2.5-1, these borings extended from the shore to a distance of about 3000 ft into Lake Ontario.

Prior to construction of the plant foundations, the soil overburden (30 to 40 ft of glacial drift) was removed. The exposed rock surface was observed to be similar to that examined in nearby outcrops. Bedding was horizontal and occasional cross-bedding and shaly partings were evident. A pattern of vertical joints of limited vertical extent was evident in the outcropping rock, particularly along the lakeshore side of the excavation. The observed joints continued to depths of from 20 to 30 ft from the top of the rock, but no evidence of movement along the joints was found. The major joint systems were found to be in accordance with those trends reported in the PSAR. Some minor exfoliation noted in the bottom of the excavation is believed to have been caused primarily by the heavy equipment traffic on the excavation floor and the drying effects of exposure to air.

The cores extracted in the nine borings drilled for the intake structure investigation were compared with the cores of the previous borings drilled at the site. As expected, the rock encountered below the lake was consistent with the rock encountered in onshore borings.

The onshore shaft and tunnels were inspected during construction as well as after completion of the tunneling. Examination of the exposed rock revealed conditions consistent with those encountered during the previous studies. No zones of defective rock were found and no weathered rock was evident in the tunnels. The rock in both tunnels is sound. Water flow was practically nonexistent, being essentially limited to scattered areas of minor moisture

infiltration. The actual conditions found in the tunnel excavations were in agreement with those encountered in all previous borings drilled during the initial subsurface investigation and the other supplementary investigations.

### *2.5.2 VIBRATORY GROUND MOTION*

A seismological program was carried out to provide information for predicting possible seismic effects at the site. Estimates of such effects which are described in this section indicate that the seismic design criteria set forth in Section 3.7 are conservative. Field investigations and predictions are described in the PSAR, Volume 1, Appendix D.

The site is within 150 miles of the St. Lawrence valley area where earthquakes of Richter magnitude 7.0 have been experienced. It is within 50 miles of the area around Buffalo which has experienced moderate earthquake activity of a smaller magnitude, and within 35 miles of the fault system near Attica. Historical and physical evidence described in Appendix D, Volume 1, of the PSAR indicates that the site is seismologically quiet.

#### 2.5.2.1 Seismicity

The following explorations were made to evaluate the seismological characteristics of the Ginna site.

A. An investigation of the earthquake history of the northeastern United States and eastern Canada was used to develop estimates of the maximum expected and maximum credible earthquake which could affect the site. All recorded earthquakes in this region with Modified Mercalli Intensity of V or greater were plotted and considered. Figure 2.5-2 is an updated epicentral map. Table 2.5-1 lists nearby earthquake activity in the mid-1960s.
B. Investigations were made on the site and in the surrounding area to search for any evidence of seismic activity such as would be indicated by faulting. This involved examination of outcrops, including dip and strike measurements, and the development of a bedrock surface profile from onsite borings, probings, and a shallow and deep refraction survey.
C. Microtremor measurements of ground motion and deep refraction surveys to measure the elastic properties of bedrock were made to provide a basis for estimating effects at the site of the maximum expected and maximum potential earthquakes.

The northeastern United States and eastern Canada are moderately active earthquake areas as indicated in Figure 2.5-2. However, there is no instrumental or verifiable record of extremely large magnitude shocks (above Richter 8) and as indicated on Figure 2.5-2, there is no record of damaging earthquakes with epicenters within 50 miles of the site.

#### 2.5.2.2 Maximum Earthquake Potential

The historical record indicates the maximum earthquakes to be expected in the site region are the following:

A. A shock of epicentral intensity VIII (Modified Mercalli Scale) at a distance of about 60 miles (similar to the 1929 Attica shock, which is judged to be less than Richter magnitude 6).

B. A shock of epicentral intensity VIII (Richter magnitude 5.5) at a distance of 110 miles (similar to the 1914 Lanark shock).

C. A major shock (Richter magnitude 7.0) far to the east, near Montreal, 200 or more miles away.

These maximum expected earthquakes would not result in significant ground motion at the site. Ground acceleration at the site is estimated to be less than 1% of gravity. It is judged that the maximum credible earthquake would be one of Richter magnitude 6.0 with an epicenter 60 miles from the site or one of magnitude 7.0 at a 90-mile epicentral distance.

A procedure developed by Dames & Moore, using the results of research at the Earthquake Institute in Tokyo, was used to estimate ground motion at a given location if the earthquake magnitude, epicentral distance, and elastic properties of foundation soils and rock are known. Using this method and the assumed maximum credible earthquakes discussed above, maximum acceleration on the site was calculated to be 8% of gravity for soil surface and 7% for bedrock surface. Plant structures, systems, and components designated as Seismic Category I (see Section 3.7) are designed to remain within applicable stress limits for the operating-basis earthquake (0.08g) and the safe shutdown earthquake (0.20g). The ground motion spectrum used in the design are shown in Figures 3.7-1 and 3.7-2.

In 1980, the NRC developed site-specific ground response spectra for the eastern United States. The spectra established ground motion acceleration values to be used in structural analyses to determine seismic loads at those eastern power plants that were a part of the NRC's Systematic Evaluation Program. The ground response spectrum for the Ginna site is shown in Figures 2.5-3 and 3.7-3.

### 2.5.2.3 Surface Faulting

#### 2.5.2.3.1 Nearby Regional Faulting

Within the Ontario lowlands, the nearest regional faulting is the Clarendon-Linden structure near Batavia, New York. The structure trends north-south and is about 35 miles west of Ginna Station. The fault is described as a complex faulted zone with a major north-south set of subparallel normal and reverse faults that have a cumulative displacement of approximately 100 m with east-side up (*Reference 1*). Data suggest that the zone is continuous to the north across Lake Ontario for a total length of as much as 180 km.

No unequivocal evidence of postglacial faulting was found among 36 faults, 6716 joints, and 87 pop-ups studied around the Clarendon-Linden fault system (*Reference 1*). However, numerous earthquakes, including the 1929 Modified Mercalli Intensity VIII earthquake, have occurred within the fault system near Attica. A number of seismologists have concluded that these events are probably related to solution mining of salt.

The presence of faults has been documented at the Nine Mile Point and FitzPatrick nuclear sites approximately 50 miles east of Ginna. The structures are three west-northwest striking high-angle faults, and several north-south striking thrust faults and folds. Displacements range from inches to several feet. Several of the faults mapped at Nine Mile Point Unit 2 have been shown to have undergone some movement during the last 10,000 years. The most

recent displacements are most likely associated with the complex phenomena caused by glacial loading and unloading. However, no such post-Pleistocene (less than 10 million years before present) faults have been identified at Ginna Station.

A structural complex was also discovered at the proposed New Haven site located a few miles east of Nine Mile Point. These structures consist of a large northeast striking anticline with several associated faults. The folds and faults were demonstrated by the applicant to be non-capable (*Reference 2*).

Several minor normal faults with 2 to 15 ft of displacements have been identified between the site and northward projection of the Clarendon-Linden fault. There is no evidence that indicates post-Pleistocene movement along these faults.

#### 2.5.2.3.2 Ginna Site Vicinity Faulting

During an investigation conducted by RG&E in 1973 for an alternate nuclear site adjacent to the Ginna site (proposed Sterling Power Project), evidence of faults was found in core borings. An extensive investigation program was carried out. The investigations included a large trench excavated across the fault zone, additional borings, petrographic and mineralogical analyses, testing of samples from the fault zones, geophysical explorations, and surface geological mapping.

The studies revealed that the fault zone was comprised of three down-to-the-northeast faults that trended north 65° west. The maximum offset is about 26 ft which decreases to about 6 ft to the southeast near the plant. The fault zone passes about 30 ft southwest of the reactor complex. Three geological reconnaissances were made by a staff geologist at the site to review progress of the investigations and examine features exposed in trenches across the fault zone.

A large trench across the fault revealed extensive deformation of glacially deposited horizons but there was no deformation that was directly attributable to tectonic movement along the faults. The strongest evidence that these deformations are not related to tectonic displacement on the bedrock faults is the presence of a horizontal unit at the base of the lower till that lies undisturbed across the southernmost fault and stacking planes (imbricate thrust sheets caused by the southward advancement of the glacier) that cut across the faults without displacements.

Rochester Gas and Electric Corporation also attempted to determine the age of the fault gouge by radiometric techniques but the results were unreliable. However, other lines of evidence indicate a much older age of last movement than Pleistocene. This evidence includes the following:

A. The observation that the contemporary stress field is different from that in which the fault originated. According to Sbar and Sykes, (*Reference 3*) the contemporary stress picture in western New York is one of nearly horizontal compression oriented in an east-west direction. Evidence for this is local squeeze and pop-up features and in situ stress measurements in the region. The existing stress field is not consistent either in orientation or type of stress

field in which the faults were formed; and the stress regime in which the faults were formed was essentially northeast-southwest and tensional.

B. The presence of unsheared hydrothermal crystals within the fault zone demonstrate that faulting predates the hydrothermal event which deposited the crystals and this event probably occurred no later than the Cretaceous (65 million years ago). Analyses carried out by consultants to RG&E show that the mineralization of fluid inclusions in calcite crystals along with sulfide mineralization, particularly pyrrhotite and molybdenite, more than likely reflect hydrothermal mineralization at temperatures of at least 225°C to 300°C. The last known tectonic environment within which such conditions could have developed in the area was about 65 million years ago.

C. No recorded historic earthquake has occurred which could be associated with the faults.

It is concluded that the faults at least predate the latest major glacial advance which occurred about 22,000 years ago. The weight of all the available information indicates that the faults are more than 65 million years old.

Additional information pertaining to the evaluation discussed above can be found in the *Additional References for Section 2.5*.

#### 2.5.2.3.3 Ginna Excavation

Construction photographs of the Ginna excavation were also examined by the NRC staff. There were ample fair-quality photos to cover most of the walls of the major excavation. Bedrock bedding could be clearly seen in many of the photographs and, although there are numerous joints, there was no indication of displacement. It is concluded that there is no faulting directly beneath the major Seismic Category I structures of the plant.

## *2.5.3 STABILITY OF SLOPES*

### 2.5.3.1 General

This topic pertains to the stability of all slopes, whose failure could adversely affect the safety of the plant. The scope of the topic discusses the following subjects: (1) slope characteristics, (2) design criteria and analyses, (3) results of field and laboratory tests, (4) excavation, backfill, and earthwork in slopes, (5) liquefaction potential affecting slopes, and (6) instrumentation and performance monitoring.

The applicable rules and basic acceptance criteria pertinent to this topic are the following:

***A.*** 10 CFR 50, Appendix A: General Design Criteria 1, 2, and 4.

***B.*** 10 CFR 100, Appendix A.

***C.*** Regulatory Guides.

1. Regulatory Guide 1.132, Site Investigations for Foundations of Nuclear Power Plants.
2. Regulatory Guide 1.138, Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants.

### 2.5.3.2 Onsite Slopes

Two onsite slopes, whose failures may be of safety concern, were identified by RG&E (*Reference 4*). The first slope is located about 200 ft northwest of the turbine building while the second slope is located east of the screen house. Both slopes were excavated from the original ground elevation of about 270 ft down to elevation 255 ft in silty clay soil and were graded at approximately 7.5 horizontal to 1 vertical.

The subsurface exploration program of 1964 revealed that the bedrock of red siltstone was at depths ranging from 30 to 40 ft below the original ground surface (*Reference 5*). The over-burden soils consisted of reddish-brown clayey silt, silty clay, and sand and gravel layers. The thicknesses and the engineering properties of those soils varied considerably throughout the site.

One boring (No. 1) was drilled at the first slope, and two borings (No. 3 and No. 119) were drilled at the second slope. The laboratory tests performed in 1964 were very limited and the shear strengths of the soft clayey soil varied in a wide range. In order to assess the stability of those slopes, assumptions have been made about the subsurface conditions and the soil parameters. The sectional profile of the first slope was assumed to be represented by boring No. 1, the second slope by boring No. 3. Conservative soil parameters obtained from the 1964 investigation were used in the slope stability analyses.

### 2.5.3.3 Stability Analyses

Stability analyses, both static and pseudostatic with earthquake load, were performed by the NRC staff using a commercially available computer program, MCAUTO's "Slope" program. Material properties which controlled the stability analyses are shown in Table 2.5-2.

The results of the slope analyses performed by the NRC staff during the Systematic Evaluation Program show that the factors of safety against slope failure under both static and earthquake loading conditions are less than unity, indicating that these slopes are not stable and that failure would take place along an arc of radius about 175 ft. The NRC staff believes that the shear strength of the in situ silty clay soil should have gained strength because of consolidation of the clayey soil, but there is no new data about the in situ soil conditions and strengths, so reasonably conservative soil data has been used by the staff in the analyses.

### 2.5.3.4 Failure Evaluation

Since the slopes were not determined to be stable, the impact of their failures was further evaluated by the NRC staff. The most critical failure arc, as calculated, would intercept the slope at elevation 276 ft, adjacent to the crest and at elevation 257 ft, adjacent to the toe. The lateral spread of the slope failure adjacent to the toe is estimated by the staff to be somewhere around 8 ft, based on postfailure equilibrium.

At the first slope, northwest of the turbine building, there is no structure nor equipment located within or adjacent to the slope except a roadway. Therefore, the failure of that slope would not pose any safety concern but might close the road. The second slope, east of the screen house, is sufficiently removed from any required safety-related equipment. Thus, its failure would not be of safety concern.

## REFERENCES FOR SECTION 2.5

1. R. H. Fakundiny, P. W. Pomeroy, J. W. Pferd, T. A. Nowak, Jr., and J. C. Meyer, Structural Instability Features in the Vicinity of the Clarendon Linden Fault System, Western New York and Lake Ontario, New York State Museum, 1978.

2. New York State Electric and Gas Corporation, Preliminary Safety Analysis Report New Haven Nuclear Site, Appendix 2.5, 1979.

3. M. L. Sbar and L. R. Sykes, "Contemporary Compressive Stress and Seismicity in Eastern North America: An Example of Intra-plate Tectonics," Geological Society of America Bulletin, Vol. 84, pp. 1861-1882, 1973.

4. Letter from J. E. Maier, RG&E, to D. M. Crutchfield, NRC, Subject: SEP Topic II-4.F, Settlement of Foundations and Buried Equipment, dated June 30, 1981.

5. Letter from J. E. Maier, RG&E, to D. M. Crutchfield, NRC, Subject: SEP Topic II-4.D, Stability of Slopes and SEP II-4.F, Settlement of Foundations and Buried Equipment, dated January 15, 1982.

## ADDITIONAL REFERENCES FOR SECTION 2.5

1. Dames & Moore, Nine Mile Point Nuclear Station, Unit 2 Geologic Investigations, for Niagara Mohawk Power Corporation, 1978.

2. Dames & Moore, Geologic and Geophysical Investigations Ginna Site, Ontario, New York, for Rochester Gas and Electric Corporation, 1974.

3. Dames & Moore, Site Evaluation Study, Proposed Brookwood Nuclear Power Plant, Ontario, New York, Rochester Gas and Electric Corporation, 1965.

4. Letter from J. C. Tilson, Environmental Science Services Administration, to H. L. Price, AEC, Subject: 1966 Report on the Seismicity of the Rochester, New York Area, dated February 16, 1966.

5. N. M. Fenneman, Physiography of Eastern United States, McGraw-Hill Book Co., New York, 1938.

6. R. F. Flint, Glacial and Quaternary Geology, John Wiley and Sons, Inc., New York, 1971.

7. Power Authority State of New York, James A. FitzPatrick Nuclear Power Plant Final Safety Analysis Report, 1972.

8. Stone and Webster, Report of Fault Investigations at FitzPatrick Nuclear Power Plant, for Power Authority of the State of New York, 1978.

9. Letter from the Acting Director, U.S. Geological Survey, to H. L. Price, AEC, Subject: Geology and Hydrology of the Proposed

10. Brookwood Nuclear Station No. 1 Site, Wayne County, New York, dated February 28, 1966.

## Table 2.5-1
## EARTHQUAKE ACTIVITY NEAR ATTICA, NEW YORK

| Year | Date | Time | Maximum Intensity |
|---|---|---|---|
| 1965 | July 16 | 06:00 | IV |
| 1965 | August 27 | 20:57 | IV |
| 1966 | January 1 | 08:23 | V-VI |
| 1967 | July 13 | 14:08 | IV-V |

## Table 2.5-2

## MATERIAL PROPERTIES USED IN THE NRC STAFF ANALYSIS OF SLOPE STABILITY

| Soil Layer Number | Soil Type | Thickness Below Top of Slope (ft) | Total Unit Weight (pcf) | Cohesion (psf) | Angle of Interal Friction (degrees) |
|---|---|---|---|---|---|
| 1 | Reddish-brown clay silt | 12 | 107 | 130 | 20 |
| 2 | Brownish-clay silty clay | 24 | 108 | 120 - 250 | 0 |
| 3 | Red fine sand and gravel | 8 | 130 | 0 | 38 |
| 4 | Bedrock (siltstone) | NA | NA | NA | NA |

NOTE:—Ground-water level was assumed at elevation 245 ft above sea level (10 ft below the top of the slopes). The earthquake load used in the analysis is equal to the safe shutdown earthquake, 0.2g, for Ginna Station.