## 2.3 Meteorology

### 2.3.1 General

Travelers Research Corporation analyzed the meteorology of the plant site. Initial design criteria related to meteorology were based on data taken at St. Cloud and Minneapolis. Since the original Facility Description and Safety Analysis Report was written, a meteorological program was established to provide actual on-site meteorological data. The data obtained from this program are summarized in USAR Tables 2.3-5 through 2.3-21. These data confirm the adequacy of the initial design criteria used in the plant design.

The general climatic regime of the site is that of a marked continental type characterized by wide variations in temperature, scanty winter precipitation, normally ample summer rainfall, and a general tendency to extremes in all climatic features. Of special interest are the extremes in annual snowfall, which may be as little as six inches or as much as 88 inches; a temperature range of 145°F for the period of record; occasional severe thunderstorms with heavy rainfall and high winds; and the possibility of an occasional tornado or ice storm. These and other pertinent meteorological data are presented in the following sections. 2.4

### 2.3.2 Temperature

Average and extreme monthly air temperatures for the Monticello site are not available, but 54 years of data for St. Cloud and Minneapolis - St. Paul have been adjusted to give representative average values for the site area. The site is approximately 13 miles closer to St. Cloud than to Minneapolis. A summary of monthly air temperatures from January to December is given in Table 2.3-1.

### 2.3.3 Precipitation

Precipitation in the Monticello area is typical for the marked continental climate, with scanty winter precipitation and normally ample summer rainfall. The months of May through September have the greatest amounts of precipitation; average fall of rain during this period is 17-18 inches, or more than 70% of the annual rainfall. Thunderstorms are the principal source of rain during May through September and the Monticello area normally experiences 36 of these annually. The heaviest rainfall also occurs during a particularly severe thunderstorm. A summary of precipitation statistics is shown in Table 2.3-2 (based on St. Cloud and Minneapolis - St. Paul averages). Average monthly snowfall statistics are given in Table 2.3-3.

Intense rainfall is produced by an occasional severe thunderstorm. The return period of extreme short interval rainfall is a useful guide. The nearest location for which return period data are available and which should be reasonably representative for the Monticello area is Minneapolis. This data is shown in Figure 2.3-1.

Snow load data available from a Housing and Home Finance Agency (HHFA) study conducted in 1952 (Reference 18) are given in Table 2.3-4.

Data relating to freezing rain and resultant formation of glaze ice on highways and utility lines are available from the following studies:

American Telephone and Telegraph Company, 1917-18 to 1924-25 (Reference 19)
Edison Electric Institute, 1926-27 to 1937-38 (Reference 20)
Association of American Railroads, 1928-29 to 1936-37 (Reference 21)
Quartermaster Research and Engineering Command, U.S. Army, 1959 (Reference 22)

The U.S. Weather Bureau also maintains annual summaries. The following is a fairly accurate description of the glaze-ice climatology of middle Minnesota.

Time of occurrence - October through April
Average frequency without regard to ice thickness,
1-2 storms per year
Duration of ice on utility lines - 36 hours (mean) to 83 hours
(maximum of record)

Return periods for freezing rain storms producing ice of various thickness are:

0.25 inch - Once every 2 years
0.50 inch - Once every 2 years
0.75 inch - Once every 3 years

## 2.3.4 Winds and Wind Loading

The preoperational meteorological data program is described in Sections 2.3.4 and 2.3.5 of the FSAR. The Monticello plant is currently provided with a 100-meter meteorological tower. Wind speed direction, and temperature difference instrumentation is located at approximately ten meters and at the elevation of the plant effluent point (43 meters and 100 meters). In addition, temperature, humidity, and rainfall instruments are provided. Meteorological data is used to compute dispersion (X/Q) and deposition (D/Q) factors for use in the dose assessment of airborne releases. Wind speed, direction, and atmosphere stability class are averaged over the release period and serve as inputs to a dispersion model. Stability class is determined using temperature difference measurements between the ten meter elevation and the elevation of the release.

Wind frequency distributions for the 10 and 100 meter tower elevations for the period January 1, 1980 through December 31, 1980 are presented in Tables

2.3-5 through 2.3-20. The distributions are for Stability A through G, as defined in Table 1 of the proposed revision 1 to Regulatory Guide 1.23 issued September 1980 (Reference 39). Annual average dispersion factor (X/Q) and deposition per unit area (D/Q) were computed for this period and are presented in Tables 2.3-22 through 2.3-27. NRC computer code XOQDOQ was used for these calculations (Reference 14). This historical data may be useful in estimating offsite doses due to routine releases of airborne radioactive effluents from the reactor building vent and plant stack.

2.3.4.1 Tornadoes and Severe Thunderstorms

Severe storms such as tornadoes are not numerous, but they do occur occasionally. The latitude of the Monticello site places it at the northern edge of the region of maximum tornado frequency in the United States, but only a few tornadoes have occurred in this vicinity. Eight tornadoes have been reported in Wright County during the period 1916-1967, two of which subsequently moved across the Mississippi River into Sherburne County. 2.4

A 1-degree square[1], lying between 45 and 46 degrees north, and between 93 and 94 degrees west, encompasses the Monticello site. There have been approximately eight tornado occurrences reported in this 1-degree square in the 14-year test period, 1953-1966. The ratio of eight tornadoes in 14 years gives a mean annual tornado frequency of 0.6. This frequency is confirmed by the Mean Annual Tornado Frequency figures published by the U.S. Department of Commerce, Weather Bureau (Reference 31).

Using the methods described by H. C. S. Thom (Reference 2), with a mean annual tornado frequency of 0.6, the probability of a tornado striking a given point in the outlined 1-degree square, which encompasses the Monticello site, can be calculated to be $5 \times 10^{-4}$ per year, or one tornado every 2000 years. The effects of the tornado phenomenon including possible effects of missiles and water loss effects in the fuel pool are discussed in Reference 3 of this section.

Subsequently, it was determined the drywell head could become a missile hazard for the spent fuel pool, however, since the probability is less than $10^{-7}$, it is not a credible missile.

The average number of thunderstorms for Minneapolis and St. Cloud is 36 with more than half of these occurring in June, July, and August. Therefore, it is expected that the Monticello site may experience an average of 36 thunderstorms annually. The fastest wind recorded for 54 years of record for each month at Minneapolis is given in Table 2.3-21. 2.4

2.3.4.2 Conclusions

The meteorology of the site area is basically that of a marked continental area with relatively favorable atmospheric dilution conditions prevailing. Diffusion

1. In this area, a 1-degree square is approximately 3,354 square miles.

climatology comparisons with other locations indicate that the site is typical of the North Central United States. Frequency of inversion is expected to be 30-40% of the year. 2.4

The site is located in an area occasionally traversed by storms and tornadoes. Maximum reported wind speed associated with passage of storm is 92 mph. 2.4

## 2.3.5 Plant Design Based on Meteorology

The station is designed with an off-gas stack to be used for continuous dispersal of gases to the atmosphere. Based on meteorological data at the site, plant operational characteristics, and stack design, the off-site doses arising from routine plant operation will satisfy the guidelines of Appendix I to 10CFR50.

A listing of other relevant reference material is given in References 4 through 9.

Class I and Class II Station structures are designed to withstand the effects of 100 mph winds at 30-feet above ground with a gust factor of 1.1. Structures and systems which are necessary for a safe shutdown of the reactor and maintaining a shutdown condition are designed to withstand tornado wind loadings of 300 mph.

Bibliography:

Rainfall Intensity - Duration - Frequency Curves, Tech. Paper No. 25, U.S. Weather Bureau (1955) (Reference 23).

Climatological Data with Comparative Data, Minneapolis - St. Paul, Minnesota, 1953-1956 - U.S. Weather Bureau (2 publications) (Reference 24).

Climatological Data with Comparative Data, St. Cloud, Minnesota 1953-1965 - U.S. Weather Bureau (2 publications) (Reference 25).

Climatography of the United States, No. 86-17, Minnesota, U.S. Weather Bureau (Reference 26).

Local Climatological Data with Comparative Data, 1965 - U.S. Weather Bureau (Reference 27).

"Snow Load Studies", Housing Research Paper 19, Housing and Home Finance Agency, 1952 (Reference 28).

"Glaze, Its Meteorology and Climatology, Geographical Distribution and Economic Effects, " Quartermaster Research and Engineering Center, 1959 (Reference 29).

Climatography of the United States No. 60-21, Minnesota - U.S. Weather Bureau (Reference 30).