Pico Power Project

Appendix 8.1-J
Cooling Tower Impact Analysis

October 2002

Cooling Tower Impact Analysis for the Pico Power Project, Santa Clara, California

An analysis of the potential fogging impacts from cooling towers at the Pico Power Project was performed. Wet cooling towers emit water predominately as evaporated water vapor, and to a minor extent as water droplets that are emitted as "drift" in the tower airflow. For some meteorological conditions, such as cold wintertime conditions, the water vapor will condense and be visible as an off-white plume. If the plume reaches the ground, it can obscure visibility similar to a fog, and if it reaches the ground during freezing conditions, it can cause the formation of a layer of ice under certain conditions. The Seasonal/Annual Cooling Tower Impact Program (SACTI) computer model was used with meteorological data from Moffet Naval Air Station for the years 1988-1993 to model the potential for fogging from the cooling tower. Impacts due to freezing events was not evaluated due to the rare nature of said events.

Computer Model and Input Data

SACTI was developed by Argonne National Laboratory and is based upon both field data and laboratory studies. The model system consists of 4 programs. The first program processes hourly surface and twice-daily upper air meteorological data and analyzes the data in conjunction with the physical layout of the tower cells. This preprocessor program develops a set of meteorological "categories", generates representative model input cases for each category, and determines the frequency of occurrence by wind direction of each of the categories. The next program, PLUME, then calculates the cooling tower plume characteristics for each meteorological category defined in step 1. These characteristics include plume heights, sizes, and the visual characteristics of the plume. Fogging is assumed to occur when a visible plume strikes the ground, and icing occurs when the plume strikes the ground under freezing conditions. The third program, TABLES, uses the frequency of occurrence wind distribution calculated in step 1 to factor the PLUME results and summarize the frequency of occurrence of fogging and icing impacts as a function of wind direction. The fourth PAGEPLOT program creates plots of results.

The following vendor provided cooling tower data was used in the SACTI analysis:

Number of Cells in Tower	3
Height of Tower	18.9 meters
Equivalent Total Cell Diameter	15.5 meters
Tower Heat Dissipation Rate	87 MW
Total Tower Air Flow	1,746 kg/s (total)
Tower Water Circulation Rate	Approx. 36,000 gpm
Tower Liquid Drift Rate	11.4 gm/sec (0.0005% drift rate)
"Salt" Concentration	0.59E-2 gm/gm (10,000 ppm TDS)
Density of Salt	2.17 gm/gm

The size distribution for liquid drift droplets was also provided by the tower vendor as follows:

Droplet Particle Size (microns)	% Frequency
10	12
15	8
35	20
65	20
115	20
170	10
230	5
375	4
525	1

Figure 1 illustrates the geometric layout of the cooling tower cells for the facility, with the cooling tower long axis having a north-south orientation. Figure 2 presents a wind rose for the years 1988 through 1993. The "Representative Wind Directions" input to SACTI for the multiple cell tower were N/S, E/S, and NE/SW, to cover the entire range of predominate wind directions.

SACTI Model Results

Results from SACTI indicate that that there will be virtually no fogging impacts from the proposed cooling tower. The maximum predicted occurrence is less than 1 hour a year at all directions within 10,000 meters (approximately 6 miles). Predictions of plume shadowing show impacts of less than 10 hours a year at distances of greater than 500-600 meters from the towers. A maximum prediction of up to 80 hours a year of plume shadowing will occur at distances approaching 100 meters (300 feet) east of the facility. The extent of the actual plume length extending beyond the facility boundaries is illustrated in Figure 3. The plume is predicted to extend just beyond the facility fenceline for about 500 hours a year , or 6% of the time. The plume is predicted to extend to a distance of approximately 300 meters 25 times a year, or 0.3% of the time. When these plumes do exist, the dimensions of the plume are predicted to be small, with an average height of 65 feet, and an average radius of 35 feet.

Figure 1 – Cooling Tower Layout with Shadowing Impacts

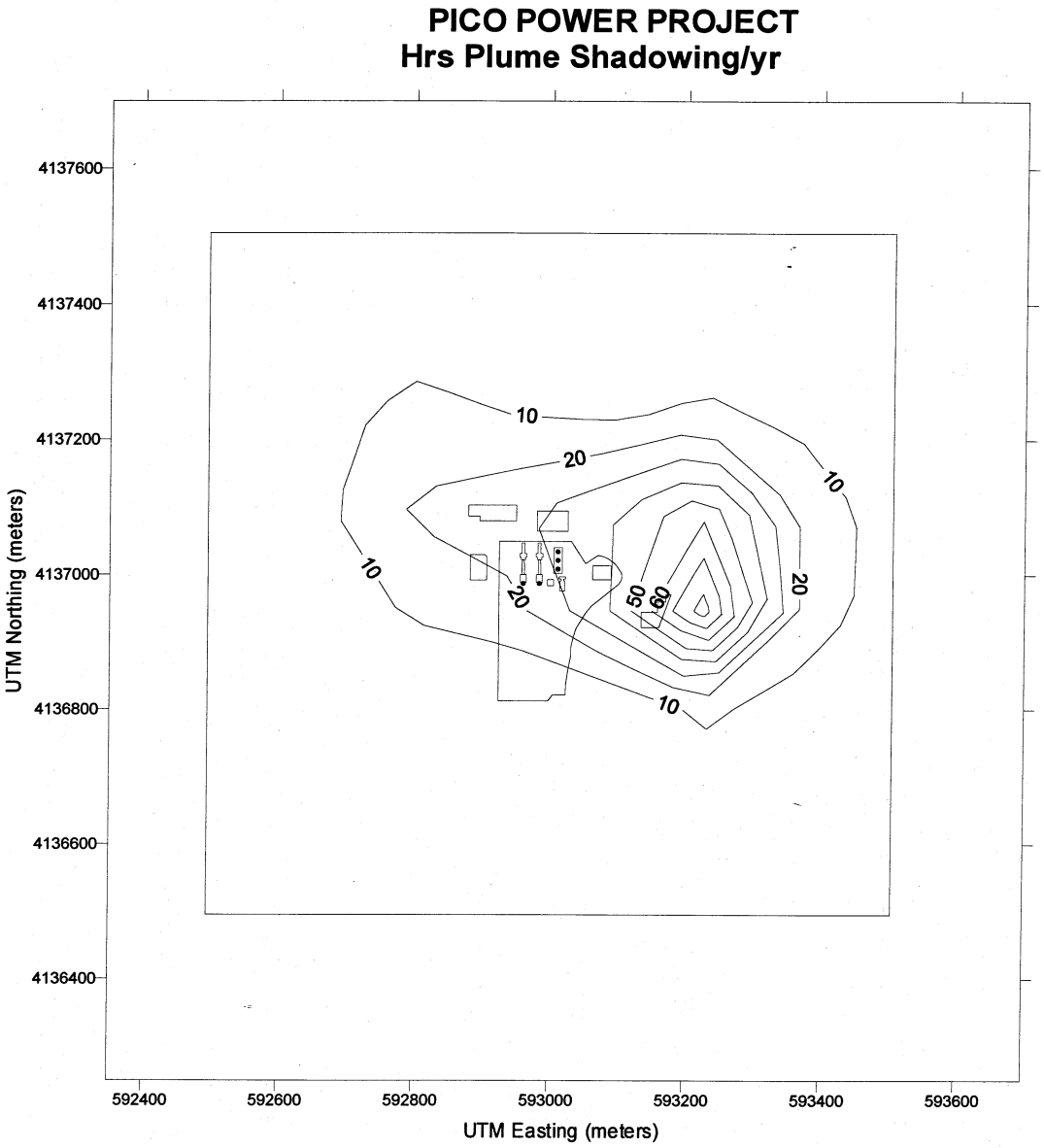

Figure 2 – Wind Rose for Moffet Wind data for the year 1988-1993

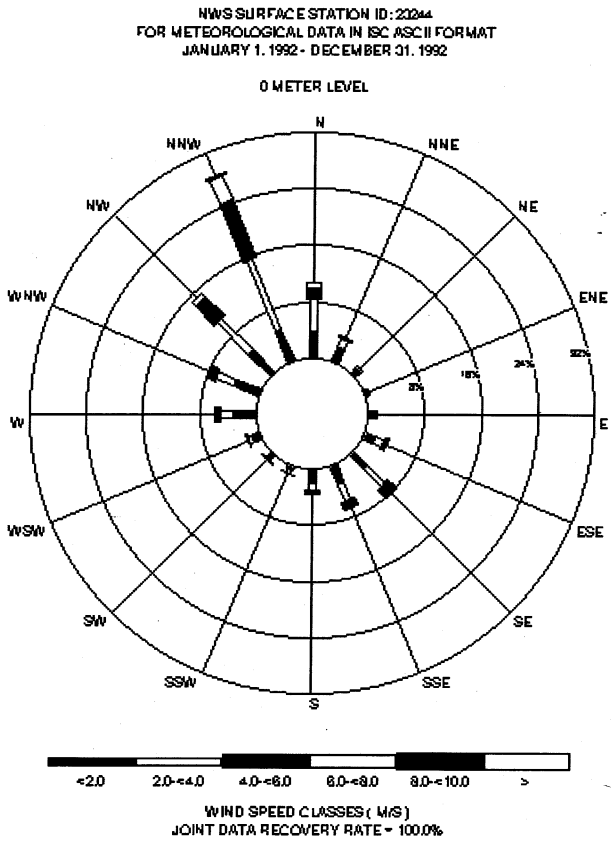

Figure 3 – Cooling Tower Layout with Shadowing Impacts