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2.4.7 Ice Effects

The circulating water system (CWS) provides cooling water for removal of the power cycle waste heat from the main condensers and transfers this heat to the normal power heat sink. The CWS for VCS is a closed cycle system that uses a cooling basin for heat dissipation. Makeup water to the cooling basin is supplied from the Guadalupe River as described in Subsection 2.4.1. The CWS is not a safety-related system. The safety-related emergency cooling system for VCS would depend on the reactor type selected. Some reactor types use a passive cooling system as the ultimate heat sink (UHS) and other reactor types require mechanical draft UHS cooling towers and storage facilities with sufficient water inventory to maintain the plant in safe shutdown mode for 30 days with no makeup. The safety-related UHS cooling towers would use the cooling basin for makeup water and blowdown, but would not depend on the cooling basin to provide emergency cooling for safe shutdown.

The discussion and analysis presented in this subsection further demonstrate that the nonsafety-related CWS and safety-related UHS are not affected by ice conditions.

2.4.7.1 Historical Ice Accumulation

Historical ice accumulation was evaluated using historical hydrometeorological data and by searching the “Ice Jam Database” of the U.S. Army Corps of Engineers. Results of this evaluation are summarized below.

Air temperature data of two nearby meteorological stations was obtained from the National Climate Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) (Reference 2.4.7-1). These stations include:

- Victoria (WBAN station number 12922, Latitude 28°47' N, Longitude 97°05' W), located about 12 miles (about 19 kilometers) northwest of the site.
- Victoria Regional Airport (WBAN station number 12912, Latitude 28°52' N, Longitude 96°56' W), located about 18 miles (about 29 kilometers) northeast of the site.

Figure 2.4.7-1 shows the location of the two meteorological stations relative to the site. Daily air temperatures at these meteorological stations are available for a continuous 60-year period extending from 1947 to 2007 (Reference 2.4.7-1). Daily air temperatures measured at the Victoria and Victoria Regional Airport meteorological stations indicate that below-freezing temperatures typically occur between December and February, with the temperature dropping below 32°F (0°C) on an average of about 12 mornings per year. (See Victoria Regional Airport station information with WBAN #12912 in Reference 2.4.7-1).

Water temperature data was obtained at the following stream gage stations (Reference 2.4.7-2):

- Guadalupe River near Tivoli (USGS station number 08188800, Latitude 28°30' N, Longitude 96°53' W), located about 12 miles (about 19 kilometers) southeast of the site.
- Guadalupe River at Victoria (USGS station number 08176500, Latitude 28°48' N, Longitude 97°01' W), located about 13 miles (about 21 kilometers) north of the site.
- Guadalupe River at Cuero (USGS station number 08175800, Latitude 29°05' N, Longitude 97°20' W), located about 38 miles (about 61 kilometers) northwest of the site.
- San Antonio River at Goliad (USGS station number 08188500, Latitude 28°39' N, Longitude 97°23' W), located about 22 miles (about 35 kilometers) west of the site.

Figure 2.4.7-1 shows the location of the stream gage stations relative to the site. Water temperature data at these stations is available for the 40-year period from 1966 to 2006. This data represents instantaneous, discrete measurements. Figure 2.4.7-2 plots the water temperature at these four stations for the 1966–2006 period of record. The results indicate that water temperatures generally remain well above the freezing point. A minimum water temperature of 36.5°F (2.5°C) was recorded on January 22, 1970, in the Guadalupe River at Cuero station. This minimum recorded temperature is above the freezing point.

The “Ice Jam Database” is a compilation of information on ice jams and ice events known to the staff of the Ice Engineering Research Division of the U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory. The database is populated using either personal knowledge of U.S. Army Corps of Engineers staff such as that resulting from a site visit, phone conversation, or detailed study, or through reference or description in the literature (Reference 2.4.7-3). The database contains no records of ice jams in the Guadalupe or San Antonio Rivers.

The aquatic biology literature also includes records of freezing events along the Texas coast and associated estuaries. Historical records indicate that freezing events occurred in 1940, 1941, 1947, 1948, 1949, 1951, 1962, 1983, and 1989 (References 2.4.7-4, 2.4.7-5, 2.4.7-6, and 2.4.7-7).

In summary, historical water temperature data and a lack of observed ice jams suggest that ice accumulation has not occurred on rivers in the VCS region. However, historical air temperature data does indicate that sub-freezing air temperatures can occur during the winter months for relatively short durations. Historical evidence also indicates that freezing events have occurred sporadically along the Texas coastline. It is concluded that occasional minor ice formation is possible at VCS.

2.4.7.2 High- and Low-Water Levels

Evidence presented in Subsection 2.4.7.1 indicates that neither the Guadalupe River nor San Antonio River is subject to ice jam events. Therefore, no potential exists for ice jam-related flooding or low flows at VCS.

Historical air temperature measurements at the Victoria and Victoria Regional Airport stations indicate that mean daily temperatures at the site have occasionally fallen below freezing in the winter. This introduces the possibility of blockage of small catch basins and drains. As stated in Subsection 2.4.2.3, the stormwater drainage system would be designed at the COL application stage to divert the local PMP runoff away from the power block area so that the peak discharges from the PMP would not adversely impact safety-related facilities. All culverts, catch basins, and storm drains will be assumed blocked in the COL stage evaluation of the combined flooding impact on the safety-related facilities as a result of local PMP coincidental with ice formation. The stormwater drainage system will be designed to preclude flooding of any safety-related facility, as a result of local PMP coincidental with ice formation.

2.4.7.3 Ice Sheet Formation

Because subfreezing air temperatures can occur during the winter months, ice sheet formation in water storage reservoirs is possible. The reduction in liquid water storage capacity of water storage reservoirs due to the presence of the ice sheet was therefore estimated as described below.

The maximum surface ice thickness that may form at VCS was calculated using historical air temperature data from the nearby Victoria and Victoria Regional Airport meteorological stations for the period of 1947 through 2007. Surface ice thickness was estimated as a function of accumulated freezing degree-days (AFDD) using the modified Stefan equation (Reference 2.4.7-8). AFDDs are obtained by summing the freezing degree-days for each day, which is the difference between the freezing point (32°F, 0°C) and the average daily air temperature. Table 2.4.7-1 summarizes the estimated maximum AFDDs and the corresponding ice thickness estimate. As indicated in Table 2.4.7-1, for the water years 1947 through 2007, the maximum AFDD is 39 degree-days occurring on February 2, 1951, with the corresponding ice thickness conservatively estimated to be approximately 5 inches (12.7 centimeters). The predicted ice events given in Table 2.4.7-1 coincide with the historical freezing events reported in References 2.4.7-4, 2.4.7-5, 2.4.7-6, and 2.4.7-7, which serves to validate the results of the analysis.

The UHS storage facilities would provide a source of cooling water, if needed, to maintain the plant in a safe mode. The design of the UHS would consider the potential presence of up to 5 inches (12.7 centimeters) of surface ice sheet formation.

Ice sheet formation in the CWS cooling basin during plant operation is not possible due to the CWS waste heat discharge to the cooling basin. Ice sheet formation could occur only if the plant is shut down for an extended period that coincides with subfreezing air temperatures. Because this scenario is unlikely and because the cooling basin is not a safety-related facility, no allowance has been made for a reduction in cooling basin storage capacity due to ice sheet formation.

2.4.7.4 Ice-Induced Forces and Blockages

The VCS design has no safety-related SSCs that are subject to ice-induced forces or blockages from either sheet ice or frazil ice.

The safety-related UHS design, for the reactor technology that requires it, would consider the presence of up to 5 inches (12.7 centimeters) of surface ice sheet formation to ensure the mechanical draft cooling towers would withstand any icing potential.

The formation of any type of ice in the nonsafety-related CWS cooling basin is precluded during plant operation, as discussed in Subsection 2.4.7.3.

Wind-driven ice ridges and the formation of frazil or anchor ice have not been reported in the VCS region and are not expected based on historical water temperature data.

2.4.7.5 Consideration of Other Site-Related Evaluation Criteria

There is no additional site information that would indicate an icing scenario more severe than has been described above.

2.4.7.6 References

2.4.7-1 U.S. Department of Commerce, NOAA, NCDC Victoria (WBAN #12922) and Victoria Regional Airport (WBAN #12912) Station Data. Available at http://lwf.ncdc.noaa.gov/oa/climate/stationlocator.html, accessed April 13, 2008.

2.4.7-2 USGS, *Water-Quality Data for the Nation*, water temperatures for Guadalupe River (Station #08188800, 08176500, 08175800) and San Antonio River (Station #08188500). Available at http://nwis.waterdata.usgs.gov/nwis/qwdata?search_criteria=search_site_no&submitted_form=introduction, accessed April 13, 2008.

2.4.7-3 U.S. Army Corps of Engineers, *Ice Jam Database,* Cold Region Research and Engineering Laboratory (CRREL). Available at http://144.3.144.33/page2.htm, accessed March 6, 2008.

2.4.7-4 Gunter, G., Hildebrand, H.H., *Destruction of Fishes and Other Organisms On the South Texas Coast by the Cold Wave of January 28 – February 3, 1951*, Ecology, 32(4), 731–736,1951.

2.4.7-5 Gunter, G., *The Import of Catastrophic Mortalities for Marine Fisheries Along the Texas Coast*, Journal of Wildlife Management, 16(1), 63–69, 1952.

2.4.7-6 Corpus Christi Bay National Estuary Program CCBNEP-06A, *Current Status and Historical Trends of the Estuarine Living Resources within the Corpus Christi Bay National Estuary Program Study Area*, January 1996.

2.4.7-7 McEachron, L.W., Matlock, G.C., Bryan, C.E., Unger, P., Cody, T.J., Martin, J.H., *Winter Mass Mortality of Animals in Texas Bays*, Northeast Gulf Science, 13(2), 121–138,1994.

2.4.7-8 U.S. Army Corps of Engineers, ERDC/CRREL, Method to *Estimate River Ice Thickness Based on Meteorological Data*, Technical Note 04-3, June 2004.

Table 2.4.7-1
Peak AFDD and Estimated Ice Thickness at Victoria County Station

Water Year	Peak AFDD		Estimated Ice Thickness	Water Year	Peak AFDD		Estimated Ice Thickness
	°F days	Date	inch		°F days	Date	inch
1947	4.5	01/1947	1.7	1978	2	01/1978	1.1
1948	7.5	01/1948	2.2	1979	7.5	01/1979	2.2
1949	16.5	01/1949	3.2	1980	0	—	0.0
1950	0	—	0.0	1981	2	02/1981	1.1
1951	39	02/1951	5.0	1982	10.5	01/1982	2.6
1952	0	—	0.0	1983	0	—	0.0
1953	0	—	0.0	1984	36	12/1983	4.8
1954	0	—	0.0	1985	9.5	02/1985	2.5
1955	0	—	0.0	1986	0	—	0.0
1956	0	—	0.0	1987	0	—	0.0
1957	0	—	0.0	1988	0	—	0.0
1958	0	—	0.0	1989	13.5	02/1989	2.9
1959	5	01/1959	1.8	1990	23	12/1989	3.8
1960	0	—	0.0	1991	7	12/1990	2.1
1961	0	—	0.0	1992	0	—	0.0
1962	17.5	01/1962	3.3	1993	0	—	0.0
1963	5.5	01/1963	1.9	1994	0	—	0.0
1964	0	—	0.0	1995	0	—	0.0
1965	0	—	0.0	1996	0	—	0.0
1966	1	01/1966	0.8	1997	4	01/1997	1.6
1967	0	—	0.0	1998	0	—	0.0
1968	0.5	01/1968	0.6	1999	0	—	0.0
1969	0	—	0.0	2000	0	—	0.0
1970	0	—	0.0	2001	0	—	0.0
1971	0	—	0.0	2002	0	—	0.0
1972	0	—	0.0	2003	0	—	0.0
1973	2.5	01/1973	1.3	2004	0	—	0.0
1974	0	—	0.0	2005	1	12/2004	0.8
1975	0	—	0.0	2006	0	—	0.0
1976	0	—	0.0	2007	0	—	0.0
1977	0	—	0.0	—	—	—	—

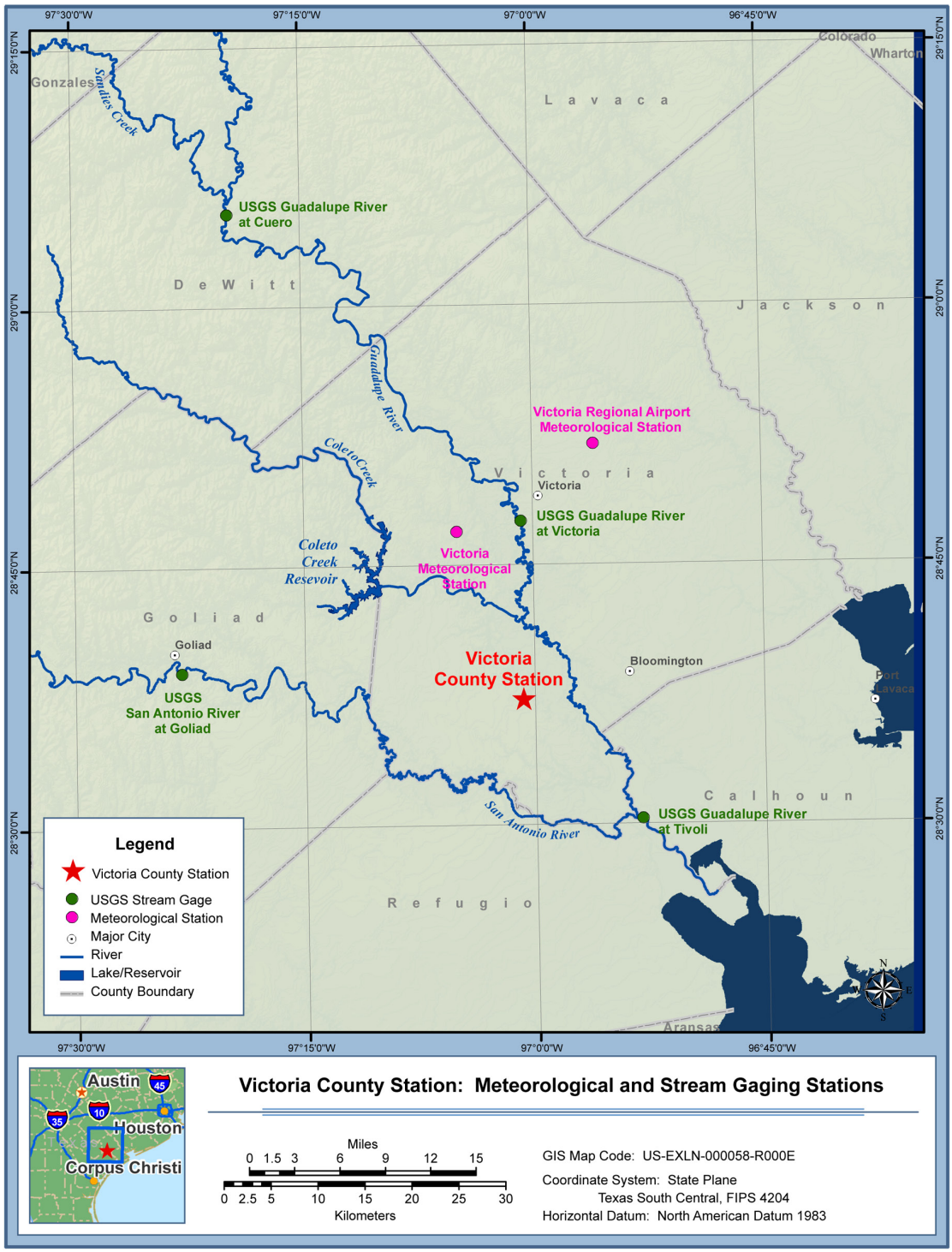

Figure 2.4.7-1 Meteorological Stations and Stream Gage Stations near VCS where Historical Air Temperature and Water Temperature Data were Collected

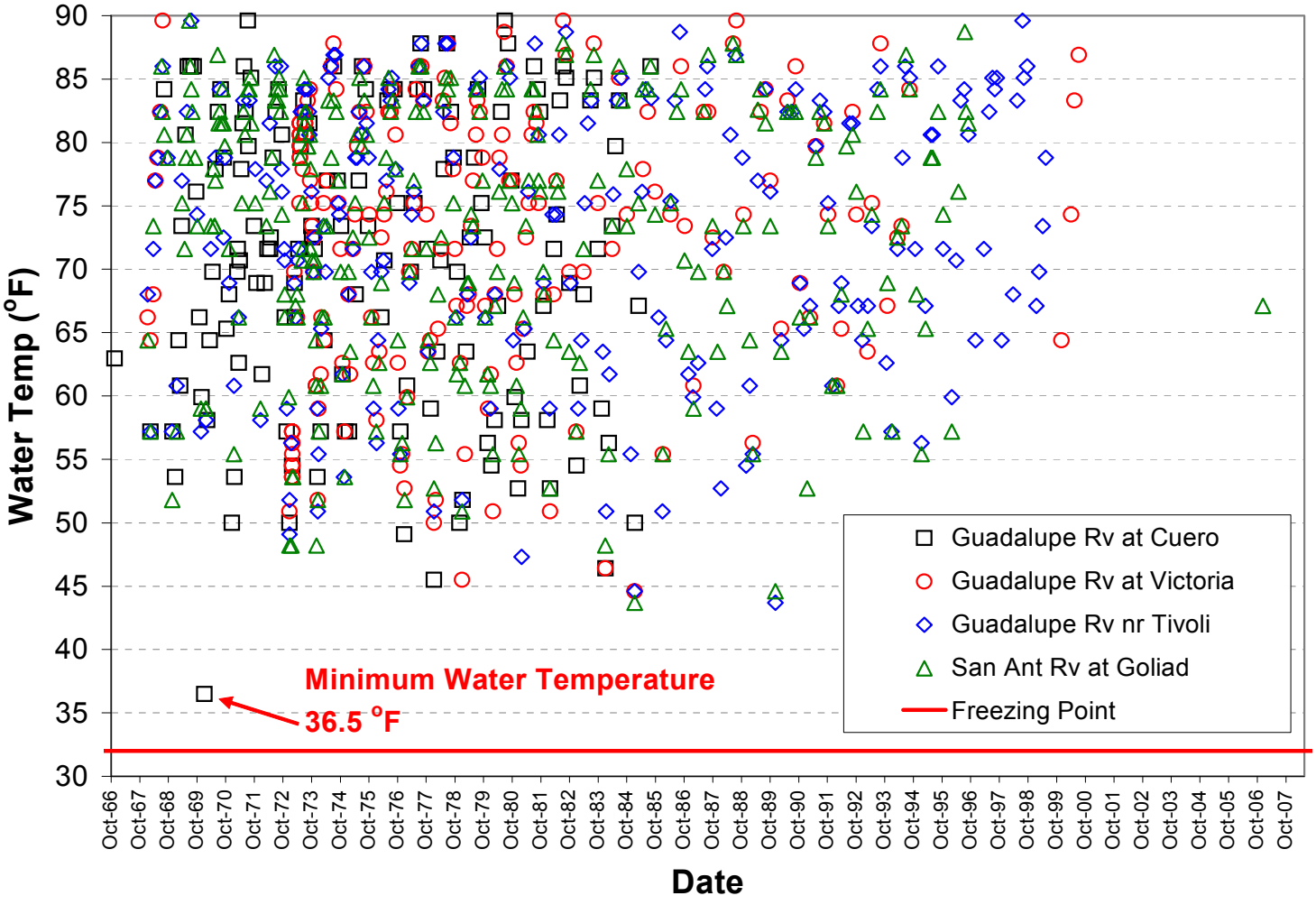

Figure 2.4.7-2 Water Temperatures at the Guadalupe and San Antonio Rivers near Victoria County Station