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Tennessee Valley Authority
Office of Natural Resources and Economic Development
Division of Air and Water Resources
Engineering Laboratory

SEQUOYAH NUCLEAR PLANT HISTORICAL THERMAL EVALUATION

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SUMMARY

The Sequoyah Nuclear Plant (SQN) essential raw cooling water system is designed for a maximum intake cooling water temperature of 83°F. Exceeding this limit could jeopardize safe shutdown of the plant. In this study, 11 years of hourly ambient temperatures are presented to show the maximum intake temperatures during July and August. Available data indicates that 1986 was the only year that the intake temperature exceeded the maximum intake cooling temperature limit. The occurrence of intake temperature equal to or greater than the maximum intake cooling temperature of 83°F (28.3°C) during the 11-year period was less than 0.01 percent. During this period the occurrence of intake temperature greater than 82°F (27.8°C) was 0.31 percent. Computed reservoir flow at SQN and intake temperature are presented for the two years with the highest intake temperatures (1980 and 1986). Data indicates both flow and release temperatures from Watts Bar Reservoir play important roles in determining the intake temperature at SQN.

A second component of this study deals with water temperature variations at the SQN intake under the scenario that Chickamauga Reservoir no longer exists due to the failure of Chickamauga Dam. In this case, the river reach between Watts Bar Dam and SQN becomes a riverine channel. Longitudinal daily maximum and minimum water temperature variations under a steady flow condition are presented for various riverflows. A riverflow of 70,000 cubic feet per second (cfs) was required to maintain SQN intake temperatures below the 83°F (28.3°C) limit under the extreme meteorological conditions used in this evaluation. In addition, the effect of thermal discharge from Watts Bar Nuclear Plant (WBN) on the SQN intake temperature was evaluated. Results indicate the WBN thermal discharge has only a slight effect on river temperature at SQN.

Sensitivity analysis indicates that the effect of meteorology on river temperatures is most important when riverflow is the lowest. With increasing riverflow, however, the effect of Watts Bar Dam release temperature on SQN intake temperature becomes more pronounced. Eventually the increase in riverflow reduces the effect of meteorology on river temperature to a minimum.

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SEQUOYAH NUCLEAR PLANT HISTORICAL THERMAL EVALUATION

INTRODUCTION

The SQN essential raw cooling water system is designed for a maximum intake cooling water temperature of 83°F (28.3°C). Recent extreme water temperature data have been observed to approach and exceed this value. The technical specifications for the plant require that the plant be shutdown when this temperature is reached and exceeding this limit could jeopardize safe shutdown of the plant. In this study, the ambient river temperatures are presented using the hourly intake temperatures at SQN in July and August for 11 years (1973-1976, 1980-1986). The frequency of occurrence for hourly intake temperatures between 78°F (25.6°C) and 84°F (28.9°C) are provided. Also presented are the computed reservoir flows and intake temperatures at SQN for 1980 and 1986, the two years with the highest intake temperatures.

Water temperature variations at the SQN intake under the scenario that Chickamauga Reservoir no longer exists due to the failure of Chickamauga Dam were also evaluated. In this case, the river reach between Watts Bar Dam and SQN becomes a riverine channel. Using a steady flow assumption, ambient river temperatures under different meteorological conditions and Watts Bar release temperatures were examined for various riverflows. In addition, the effects of the WBN thermal discharge on the SQN intake temperature were evaluated.

HOURLY INTAKE WATER TEMPERATURES AT SQN

To examine the occurrence of temperature exceeding the intake cooling water limit (83°F), hourly ambient water temperatures in July and August are presented in Figures 1 to 11. Monitors at Station 9 were plotted from 1973 to 1976 and Station 13 was plotted from 1980 to 1986. Station 9 was the ambient monitor used until 1980 and was located at Tennessee River Mile (TRM) 485.2. During the summer of 1977, 1978, and 1979, reservoir bottom temperatures recorded at this station were erratic, and since there is no guarantee that these temperatures are accurate, these three years (1977-1979) were omitted in the presentations. Station 13 is the current ambient monitoring station and is located on the intake skimmer wall at TRM 484.5. The bottom thermistor at this station normally provides a good estimate of the intake cooling water temperature. However, the thermistors occasionally malfunctioned, especially during the early years. Periods of malfunction are shown in the figures as missing gaps.

An examination of the intake temperatures shown in Figures 1 to 11 indicates that 1986 is the only year with temperatures exceeding the maximum intake temperature limit of 83°F (28.3°C). The summer of 1986 was the driest on record in East Tennessee. The combination of warmer than normal release temperature at Watts Bar Dam and below average hydro releases at Watts Bar and Chickamauga Dams probably contributed to the high intake temperature at SQN. The second highest intake temperature was recorded in 1980 with a maximum intake temperature of 81.7°F (27.6°C). The frequency of occurrence for the hourly intake temperatures between 78°F (25.6°C) and 83.5°F (28.6°C) for the 11-year period is given in Table 1 and is shown in Figure 12.

For 1986 and 1980, the two years with the highest recorded intake temperatures, reservoir flows at SQN were computed for the 2-month period (July and August) using a one-dimensional dynamic flow routing model developed for Chickamauga Reservoir (Ferrick and Waldrop, 1977; McIntosh, et al., 1983). The following assumptions were used in the model:

1) One-dimensional incompressible flow;
2) Uniform velocity throughout each cross section;
3) Free surface is level at each cross section;
4) Course of the river can be analyzed as a straight line, no river bends;
5) Vertical pressure distribution is hydrostatic;
6) Slope of the riverbed is small; and
7) Effects of friction and turbulence can be included as a resistance force which is a function of the square of the velocity and the depth of the stream (Manning equation).

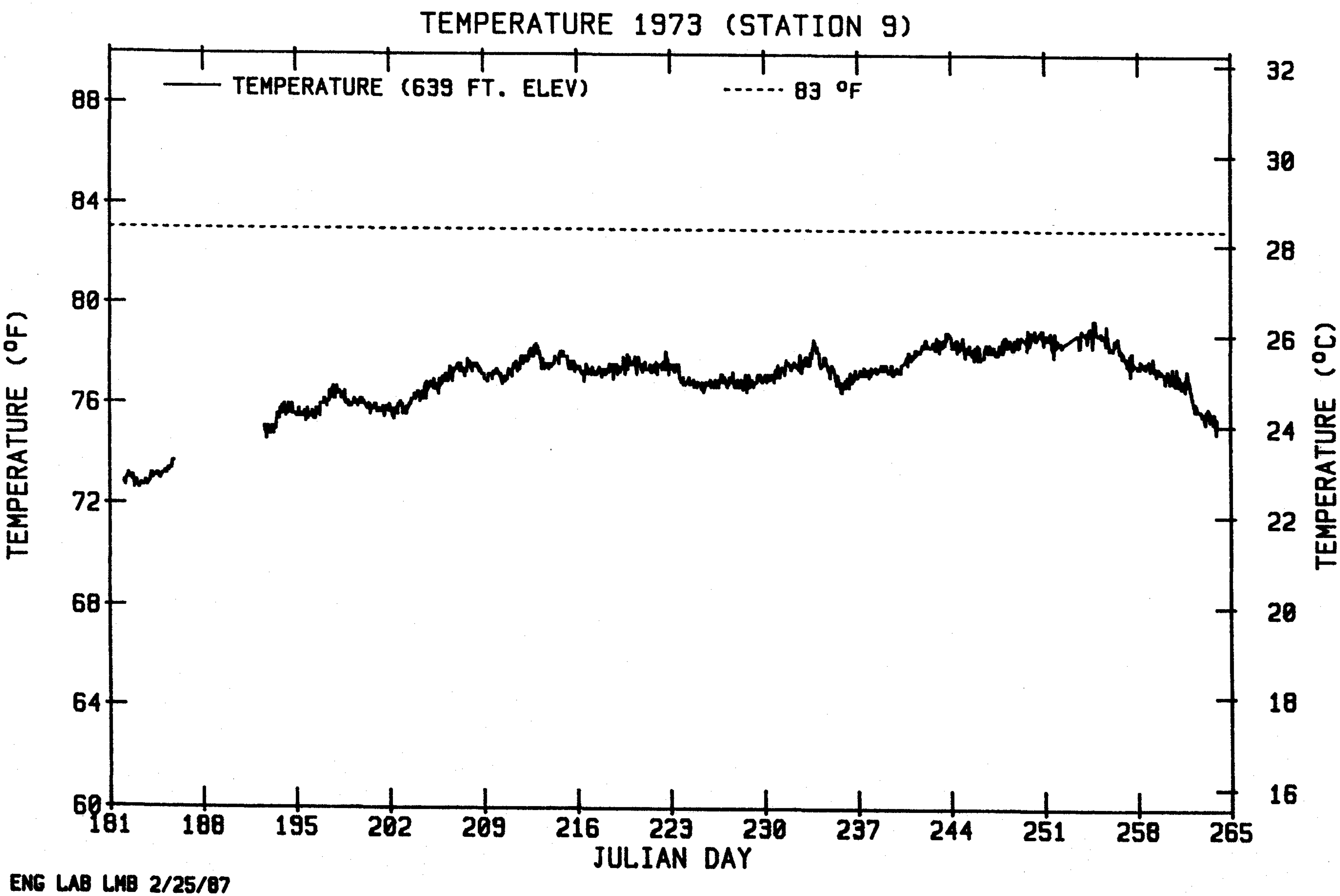

Figure 1. Hourly Water Temperatures (Station 9) in July and August, 1973.

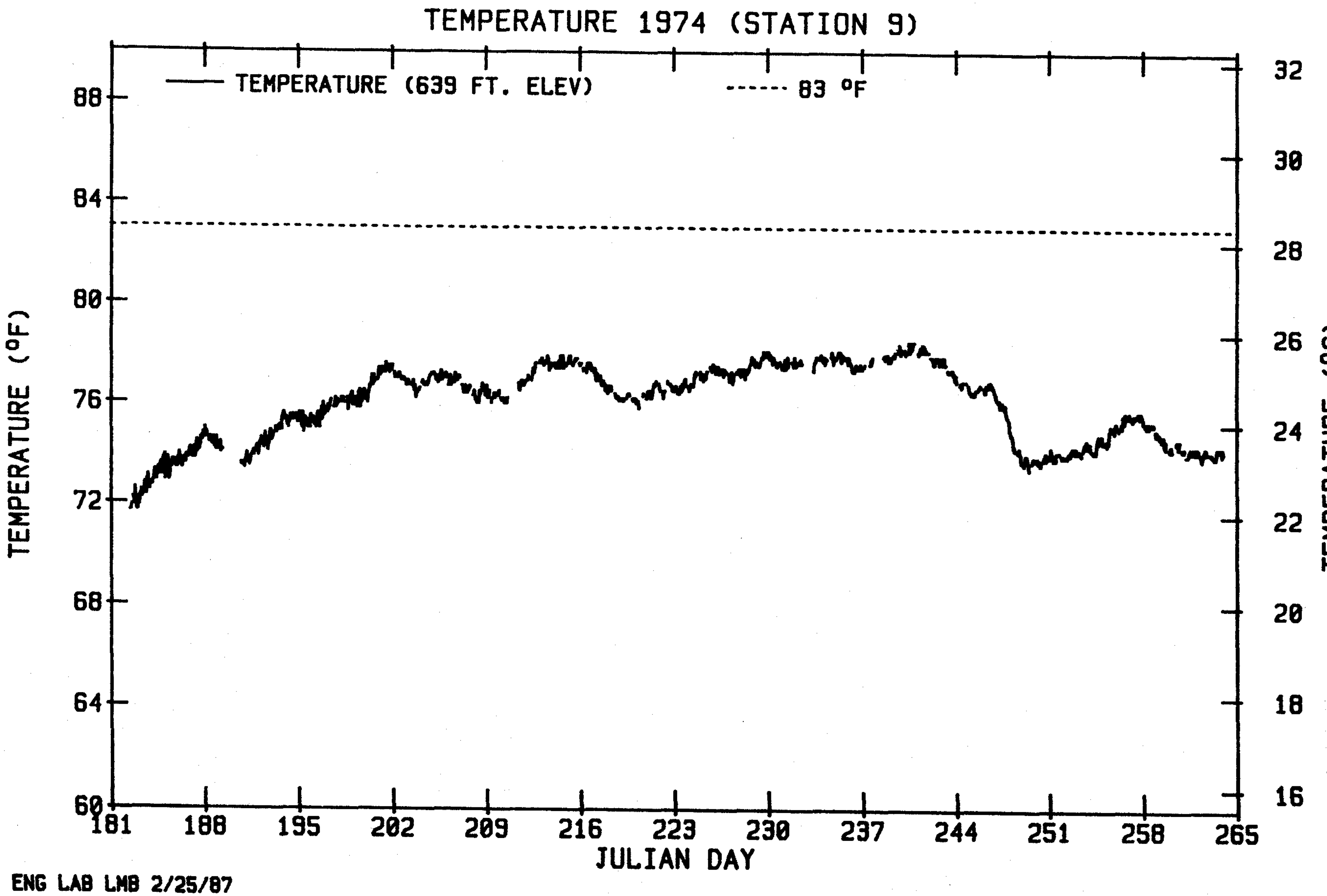

Figure 2. Hourly Water Temperatures (Station 9) in July and August, 1974.

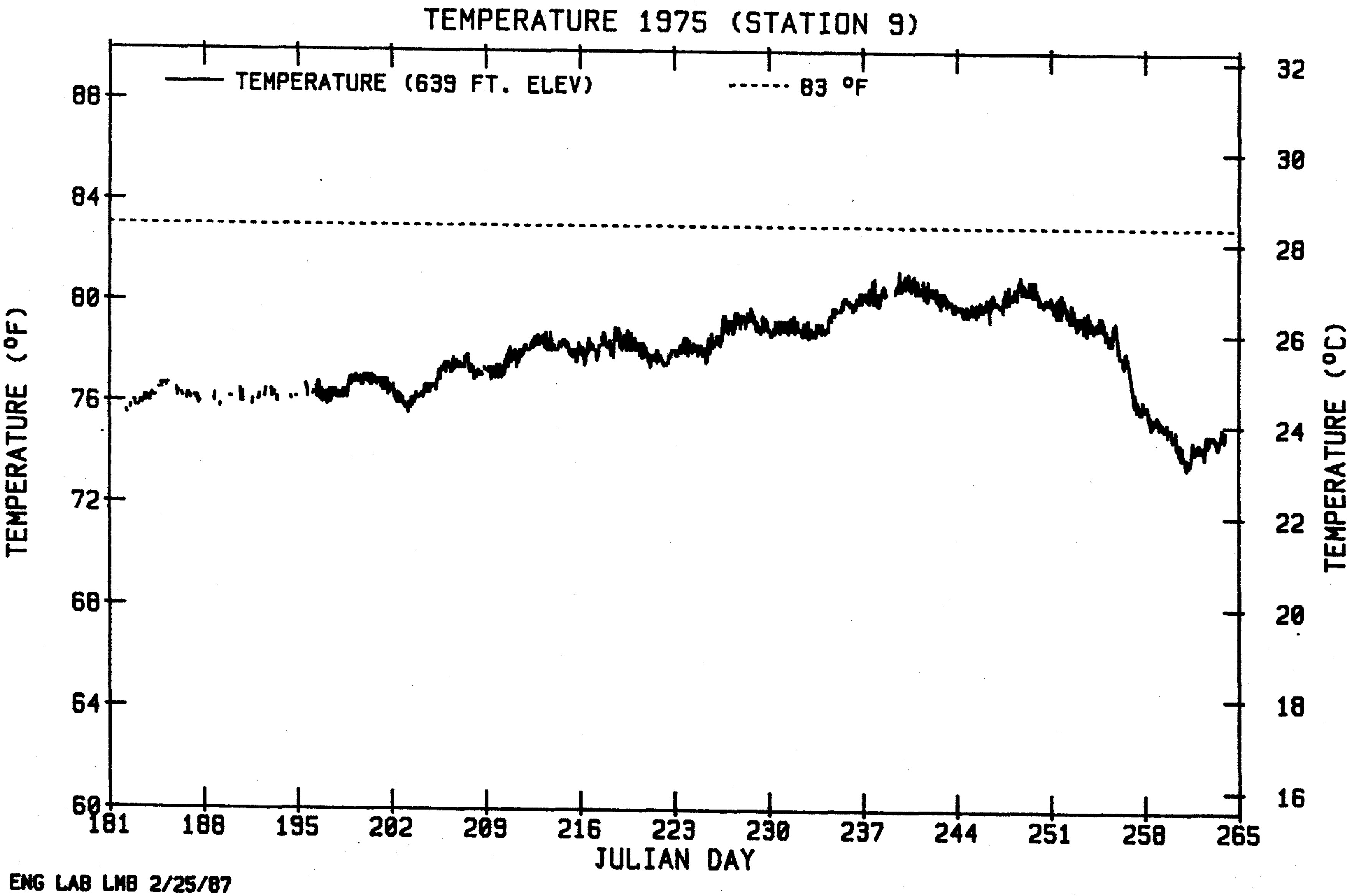

Figure 3. Hourly Water Temperatures (Station 9) in July and August, 1975.

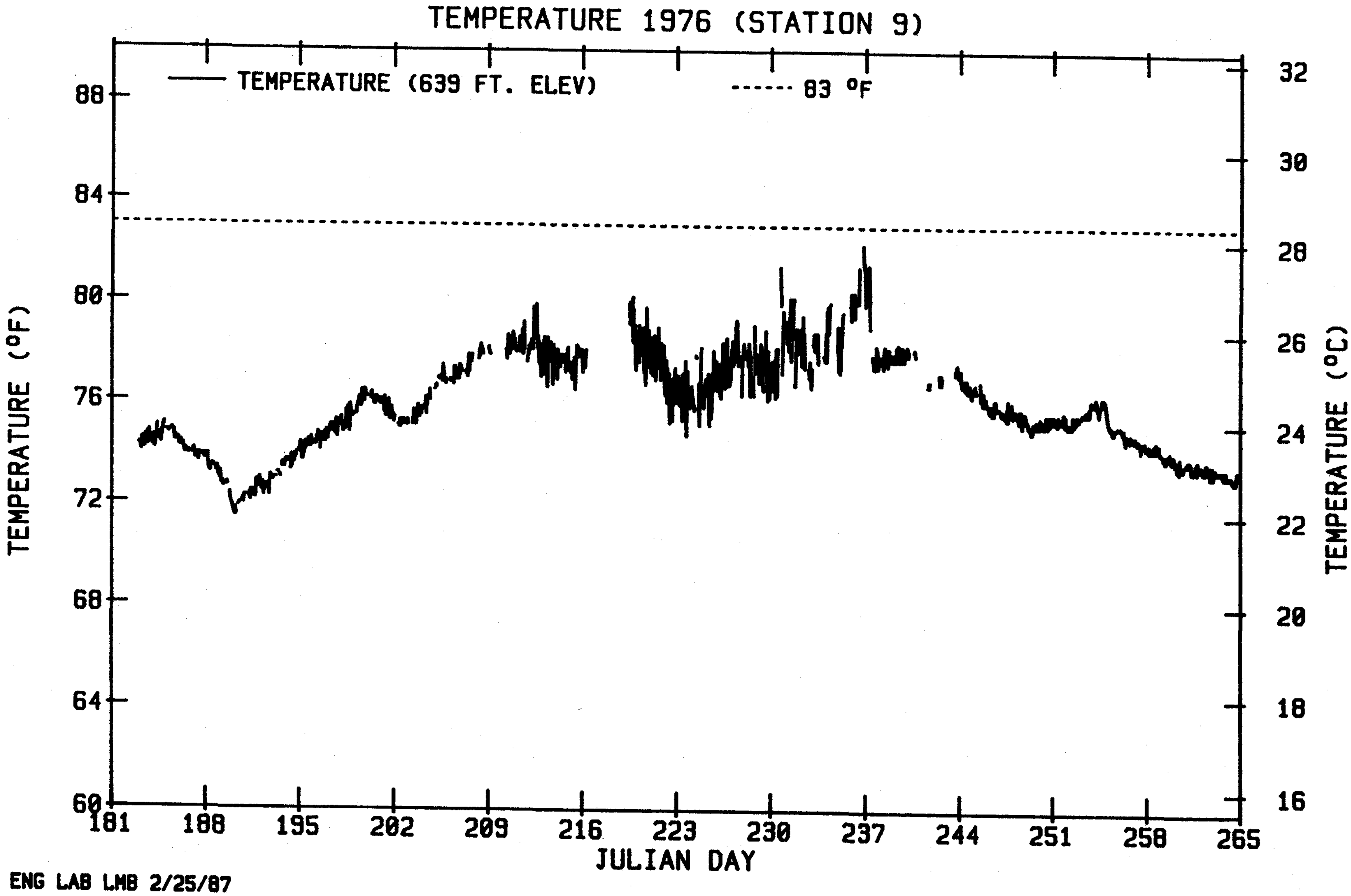

Figure 4. Hourly Water Temperatures (Station 9) in July and August, 1976.

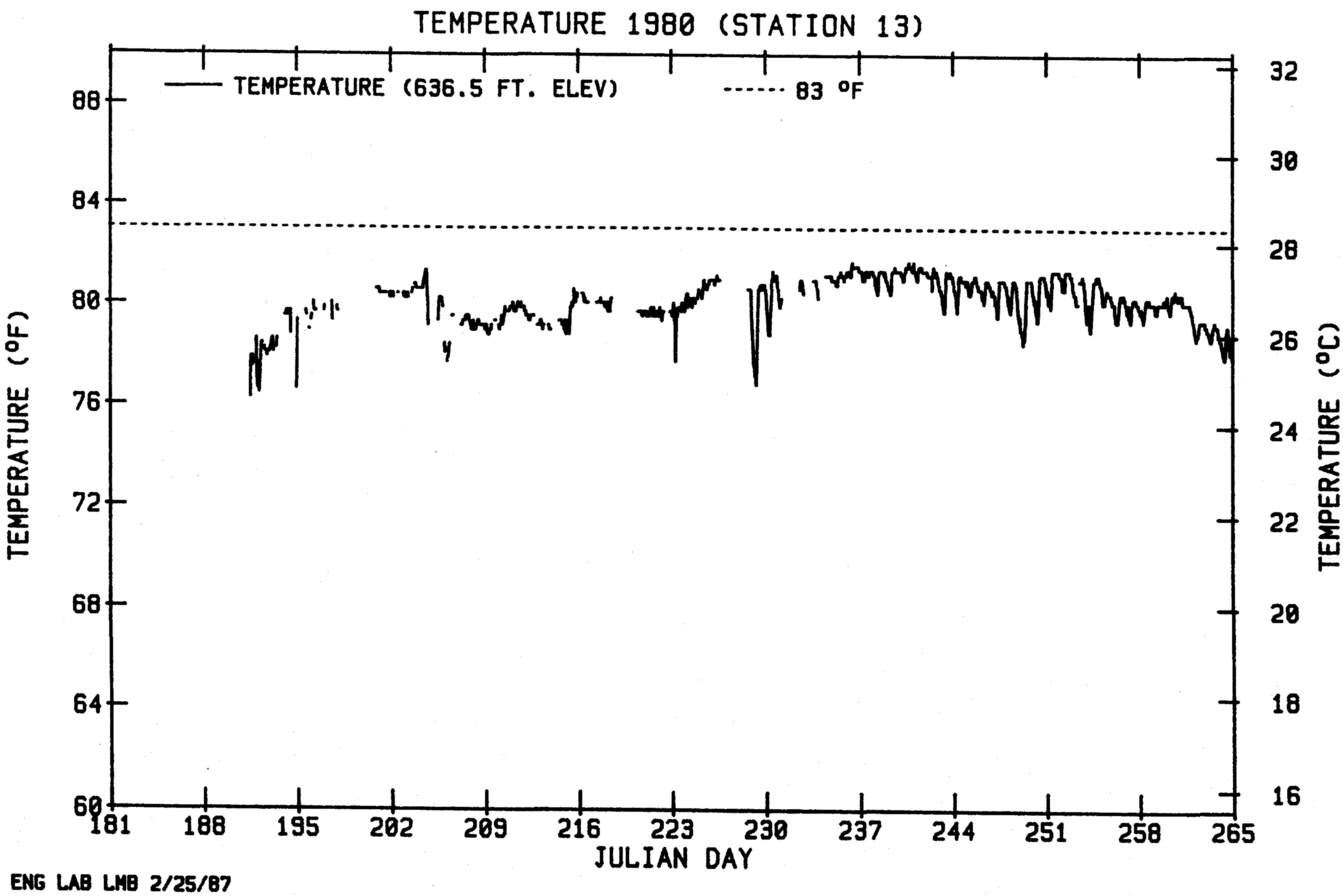

Figure 5. Hourly Water Temperatures (Station 13) in July and August, 1980.

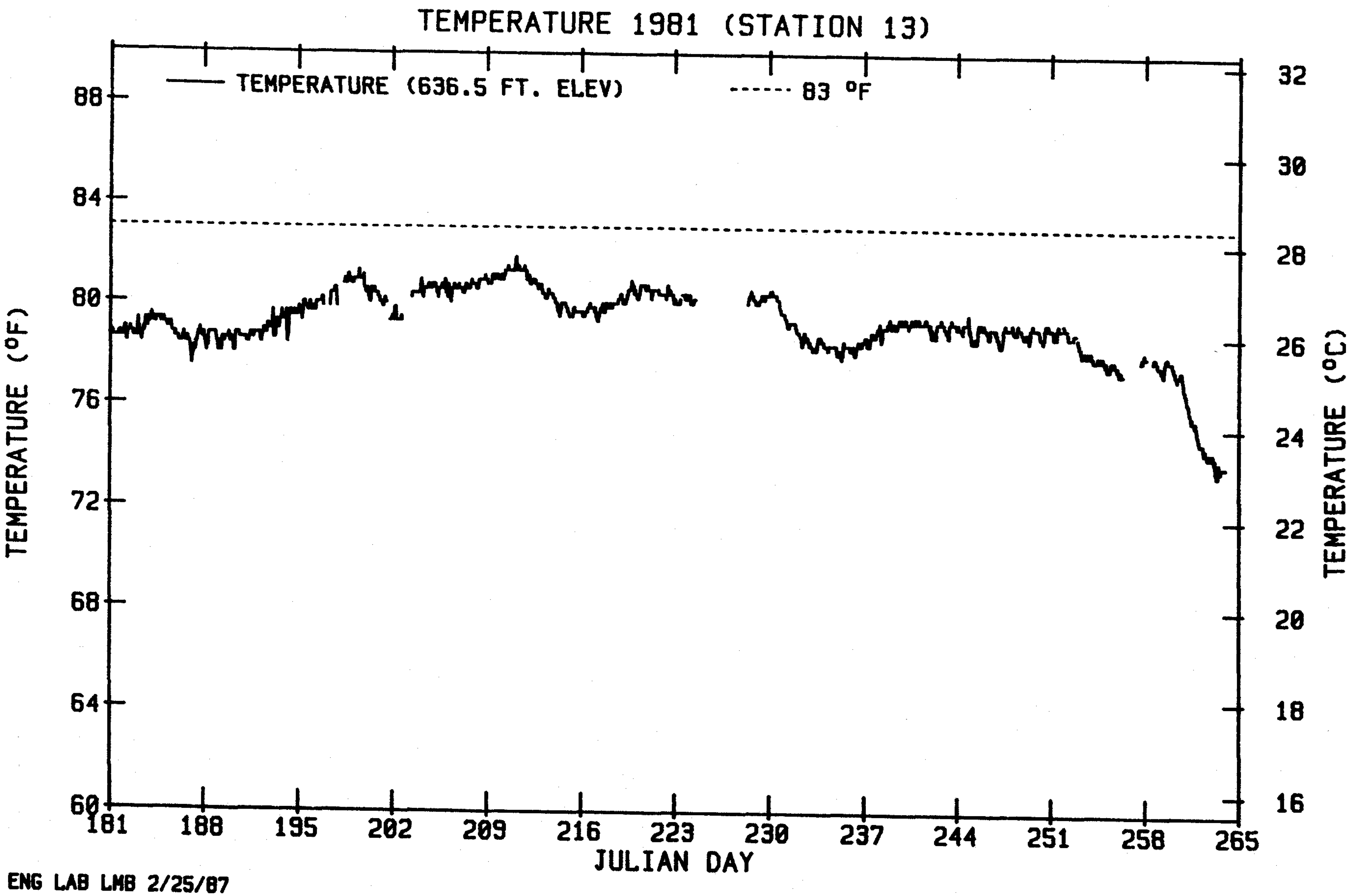

Figure 6. Hourly Water Temperatures (Station 13) in July and August, 1981.

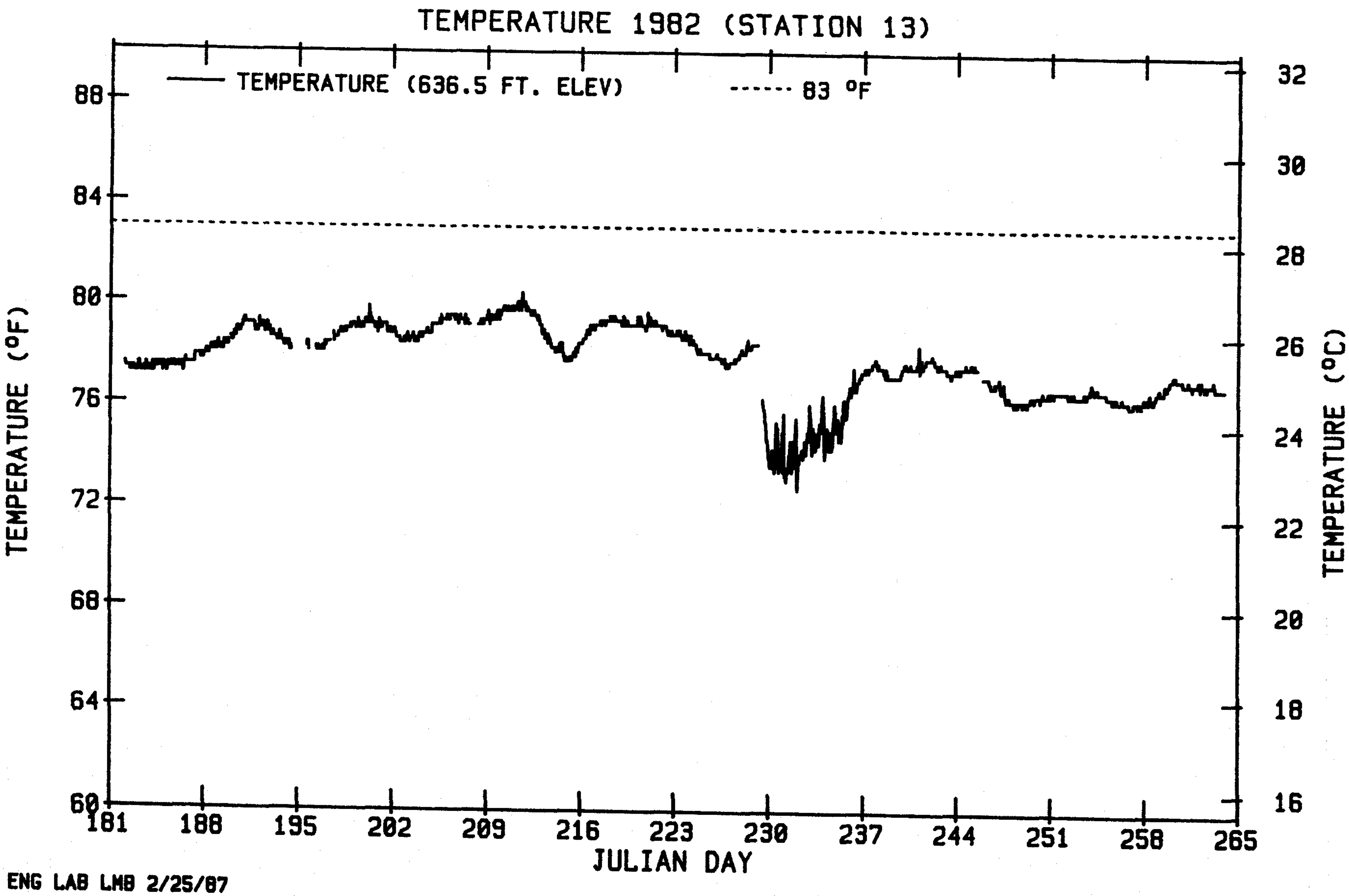

Figure 7. Hourly Water Temperatures (Station 13) in July and August, 1982.

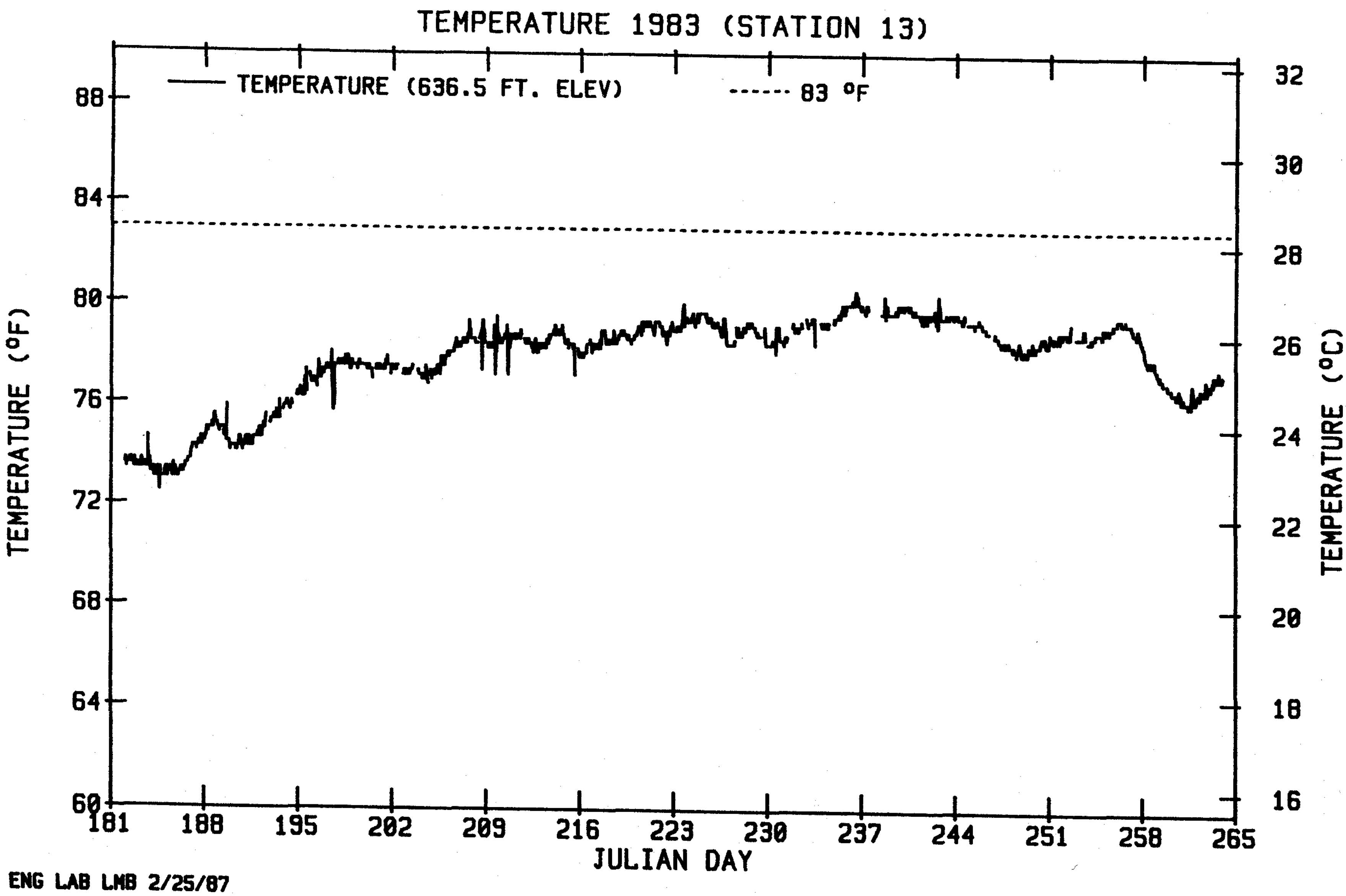

Figure 8. Hourly Water Temperatures (Station 13) in July and August, 1983.

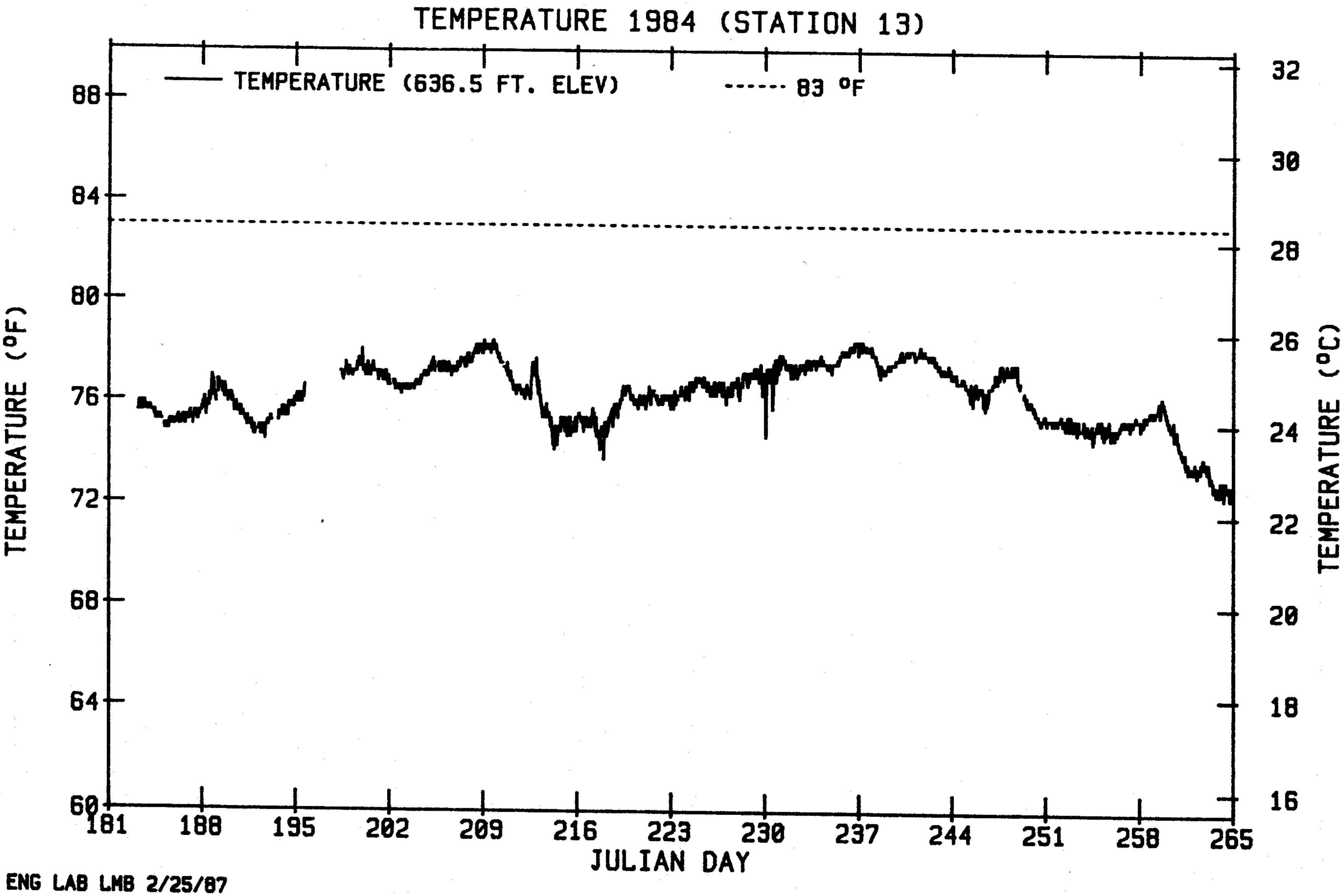

Figure 9. Hourly Water Temperatures (Station 13) in July and August, 1984.

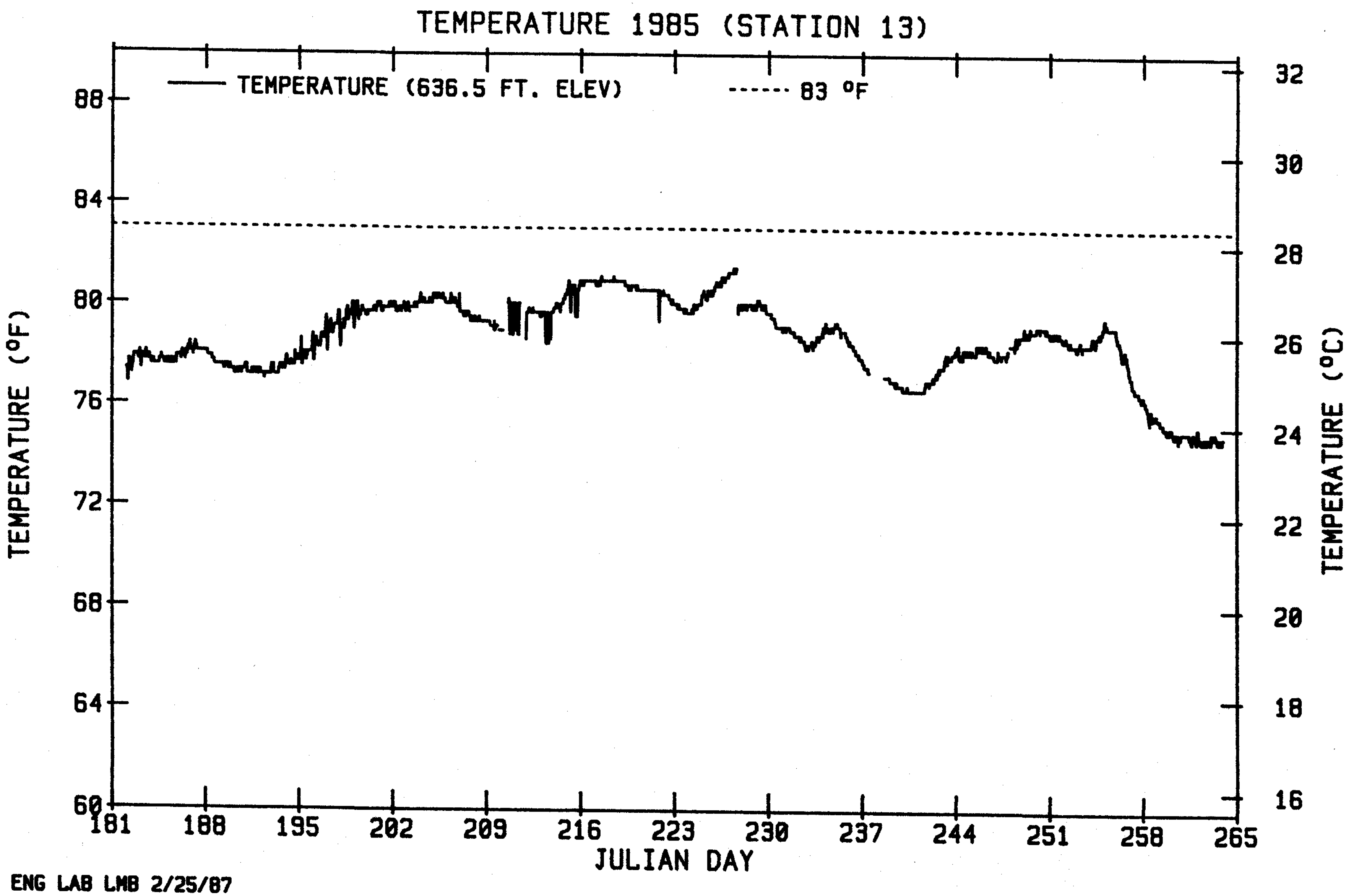

Figure 10. Hourly Water Temperatures (Station 13) in July and August, 1985.

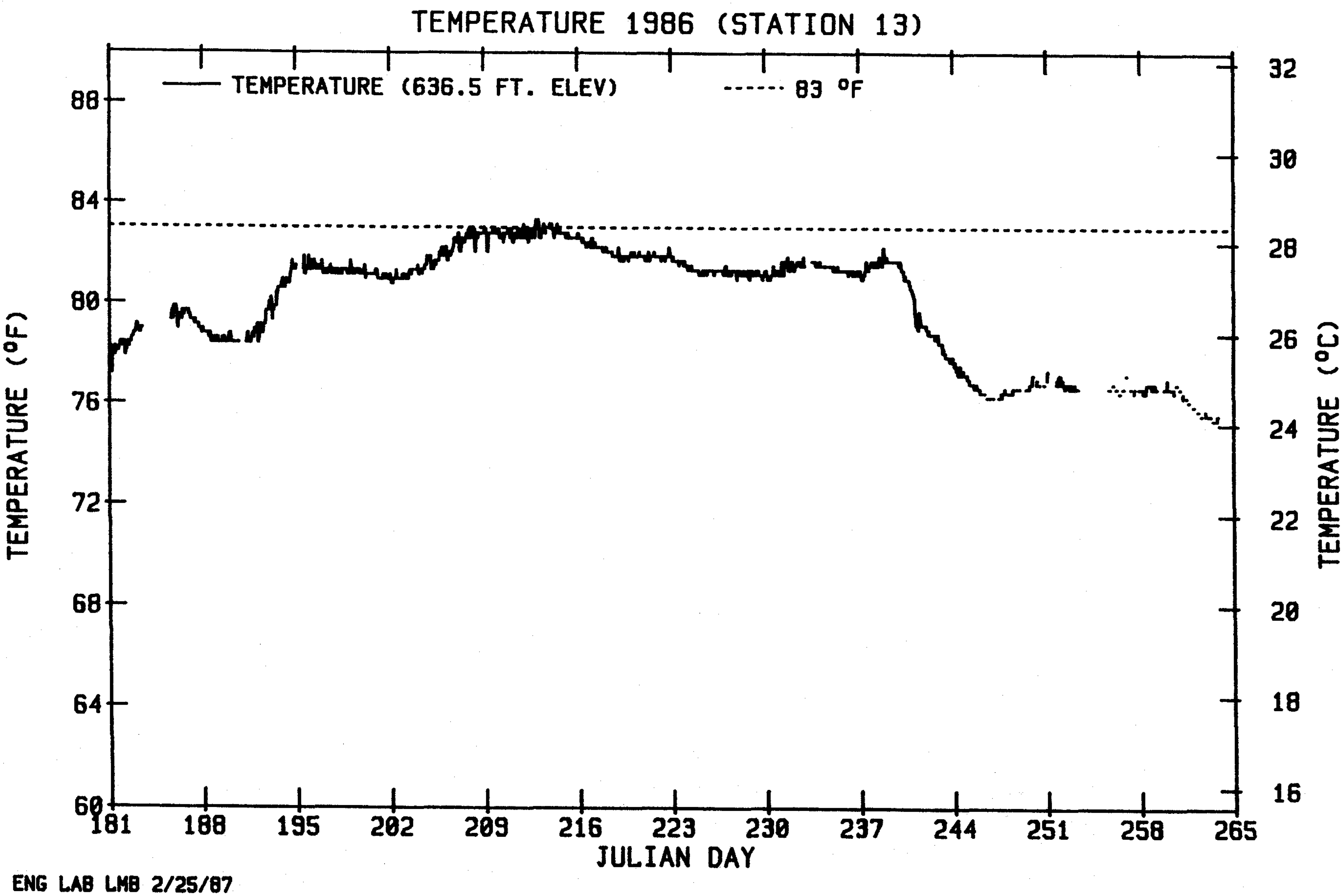

Figure 11. Hourly Water Temperatures (Station 13) in July and August, 1986.

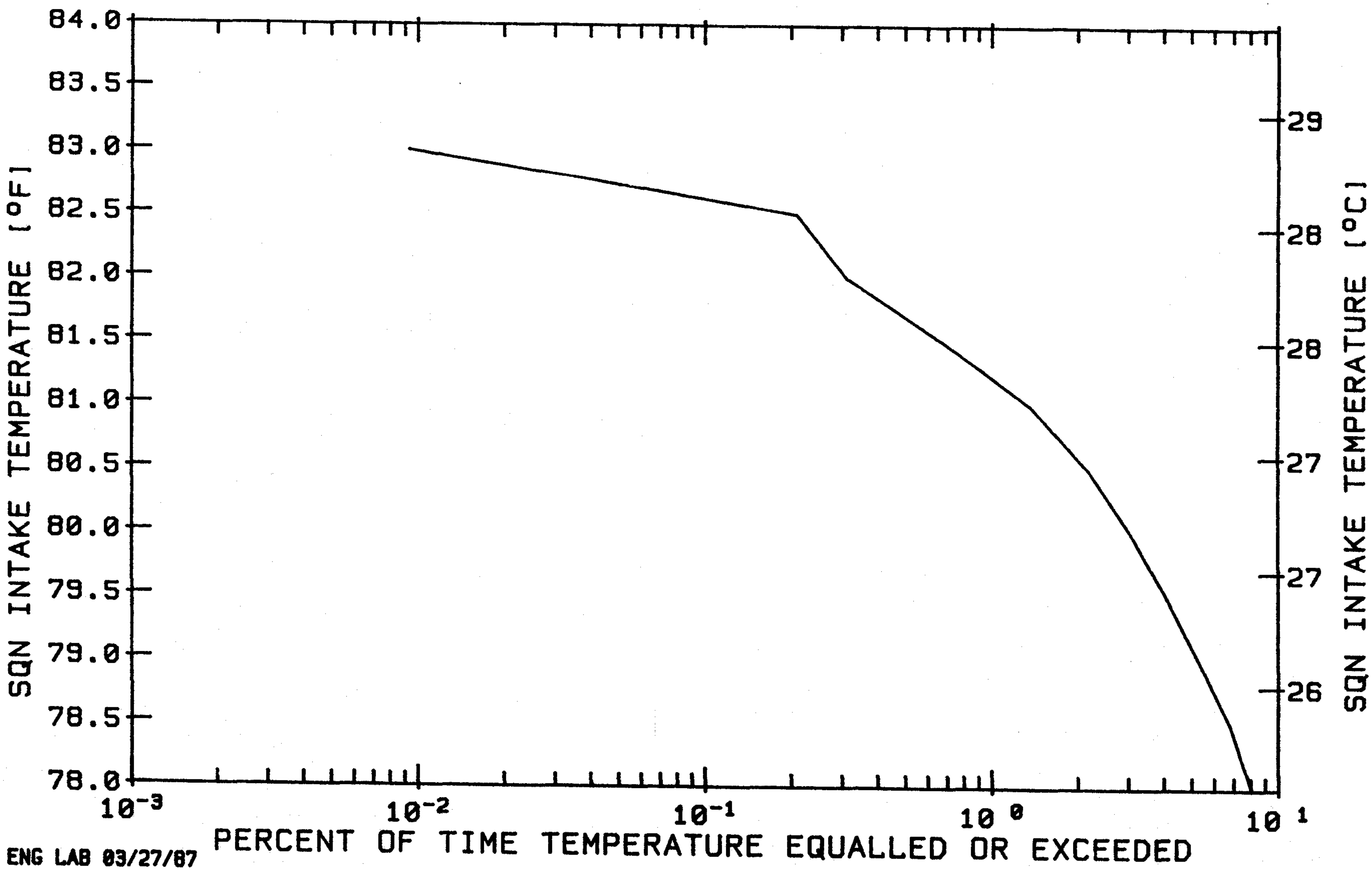

Figure 12. Frequency of Intake Temperatures at SQN (1973-1976, 1980-1986).

TABLE 1

Frequency of Intake Temperatures at SQN
(1973-1976, 1980-1986)

Intake Temperature (°F)	Percent of Time Temperature Equalled or Exceeded
83.5	0.00
83.0	0.01
82.5	0.21
82.0	0.31
81.5	0.68
81.0	1.36
80.5	2.17
80.0	3.07
79.5	4.09
79.0	5.30
78.5	6.80
78.0	8.06

Input data required for the computations were flow releases at Watts Bar and Chickamauga Dams, and the initial Chickamauga headwater elevation. The computed reservoir flows are shown along with the hourly intake temperatures in Figures 13-14, for 1980, and Figures 15-16, for 1986. Particular attention is given to the 2-week period preceding the highest intake temperature. The SQN intake temperature and riverflow for the 2-week period are shown in Figures 17 and 18, for 1980 and 1986, respectively.

SQN INTAKE TEMPERATURES IN RIVERINE CONDITION

For this section, water temperatures at SQN intake were evaluated with the scenario that Chickamauga Reservoir no longer existed due to the failure of Chickamauga Dam. Without Chickamauga Dam, the river reach between Watts Bar Dam and SQN would be in a riverine condition, and flow at SQN will be determined primarily by releases from Watts Bar Dam. In the event of Chickamauga Dam failure, the underwater dam located downstream of the SQN intake, which is designed for the retention of reservoir bottom cold water, may not be able to withstand the shearing stress imposed by overflow. As a worst case scenario, the underwater dam was assumed to be totally washed out.

There are limited geometry data available for this section of the Tennessee River under riverine conditions. Existing channel cross sections are at TRMs 480.6, 484.8, 490.5, 496.5, 496.4, 501.8, 506.6, 514.4, 518.0, 523.2, 527.4, and 529.9. Water temperatures were evaluated for the river reach based on a steady flow condition. Depths, velocities, and temperatures were computed using a one-dimensional flow and water quality model developed at the Engineering Laboratory (Hauser and McKinnon, 1987). Longitudinal water temperature variations in the river were simulated for a variety of riverflows (i.e., 3,200; 10,000; 30,000; 50,000; 70,000; 90,000 cfs) using meteorology recorded at SQN on July 14, 1980 (see Table 2), a day which was identified as producing the highest pond equilibrium temperature after examining 34 years (1948 to 1981) of climatological data recorded at the nearby Chattanooga National

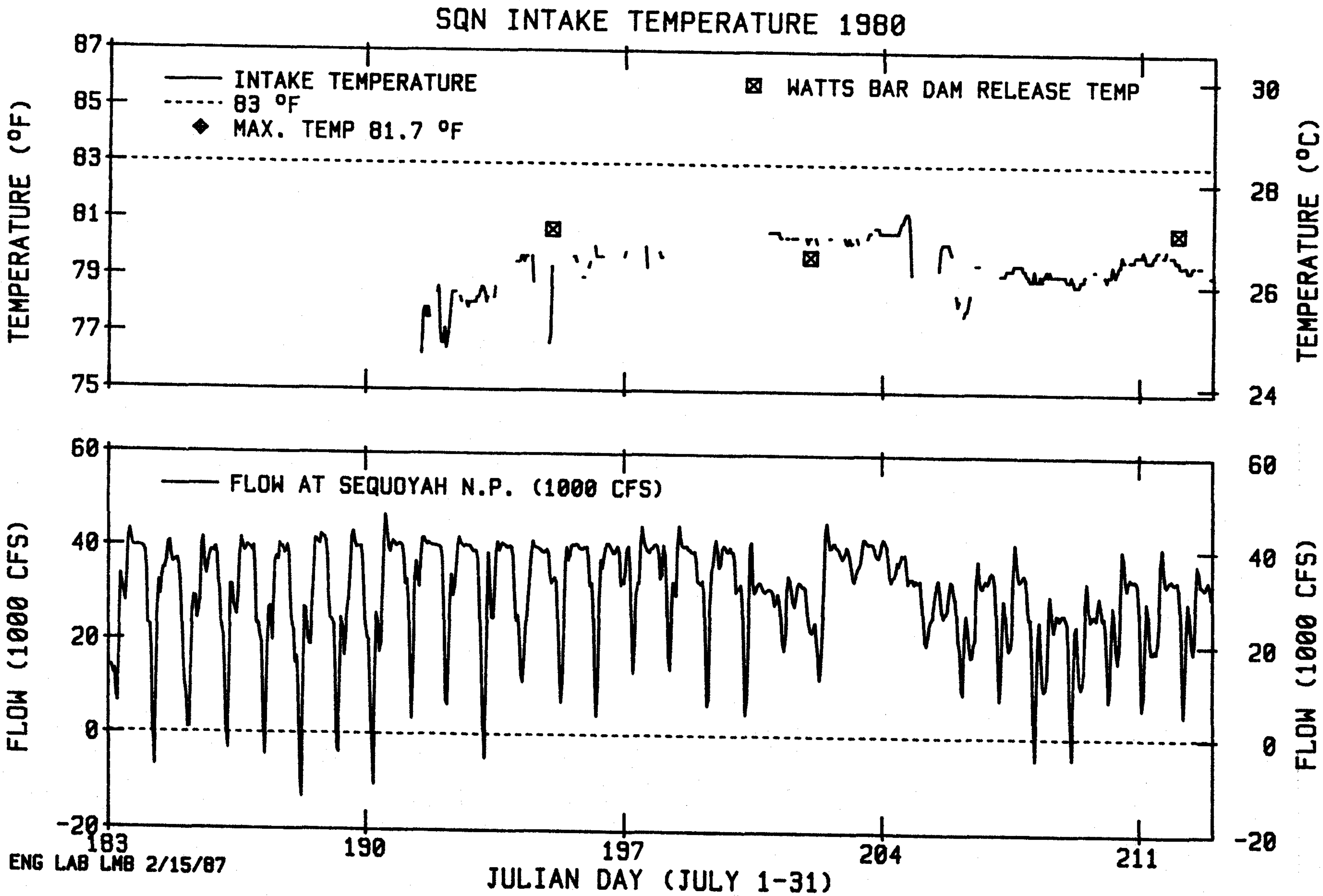

Figure 13. Intake Temperature and Flow at SQN in July 1980.

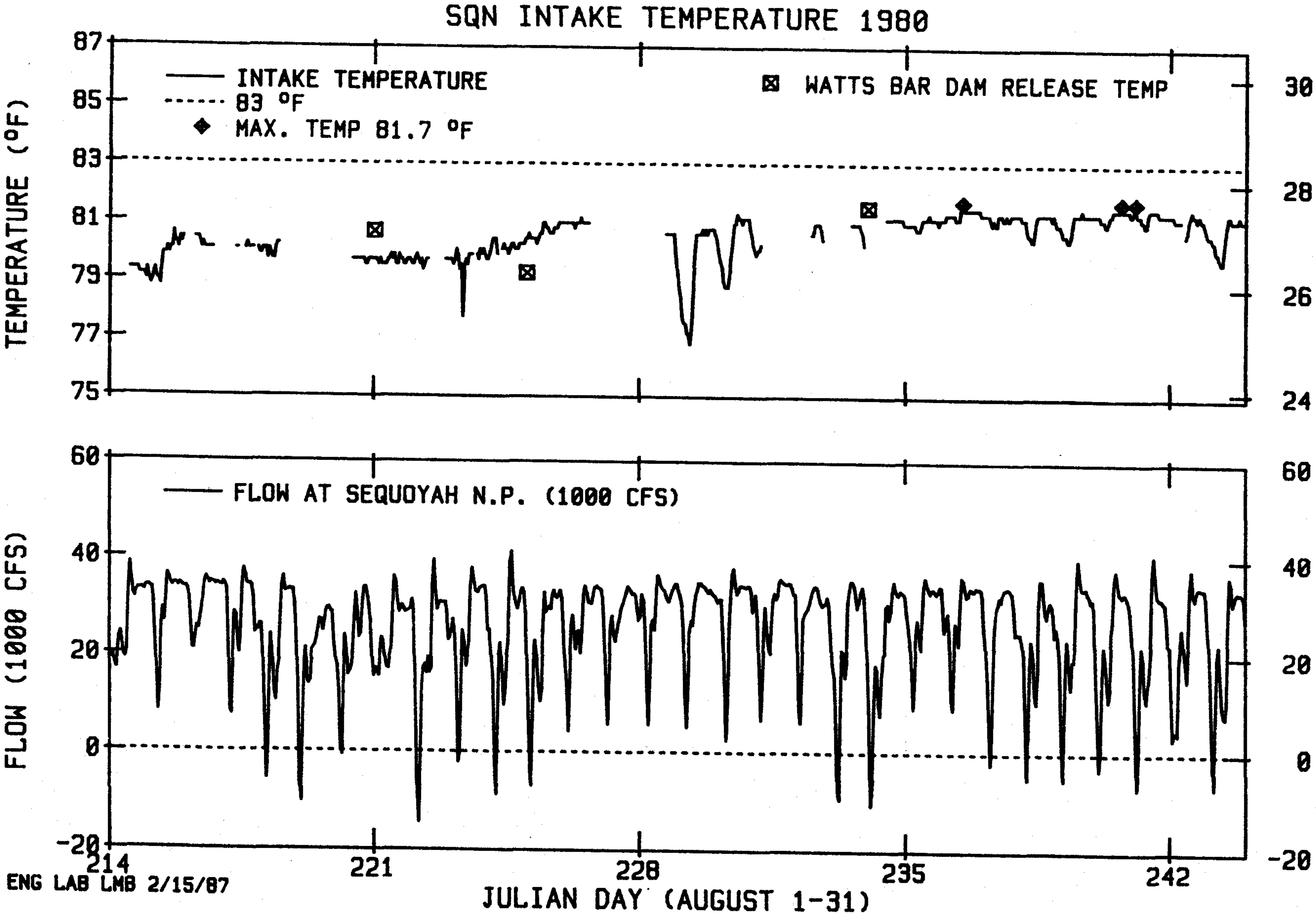

Figure 14. Intake Temperature and Flow at SQN in August 1980.

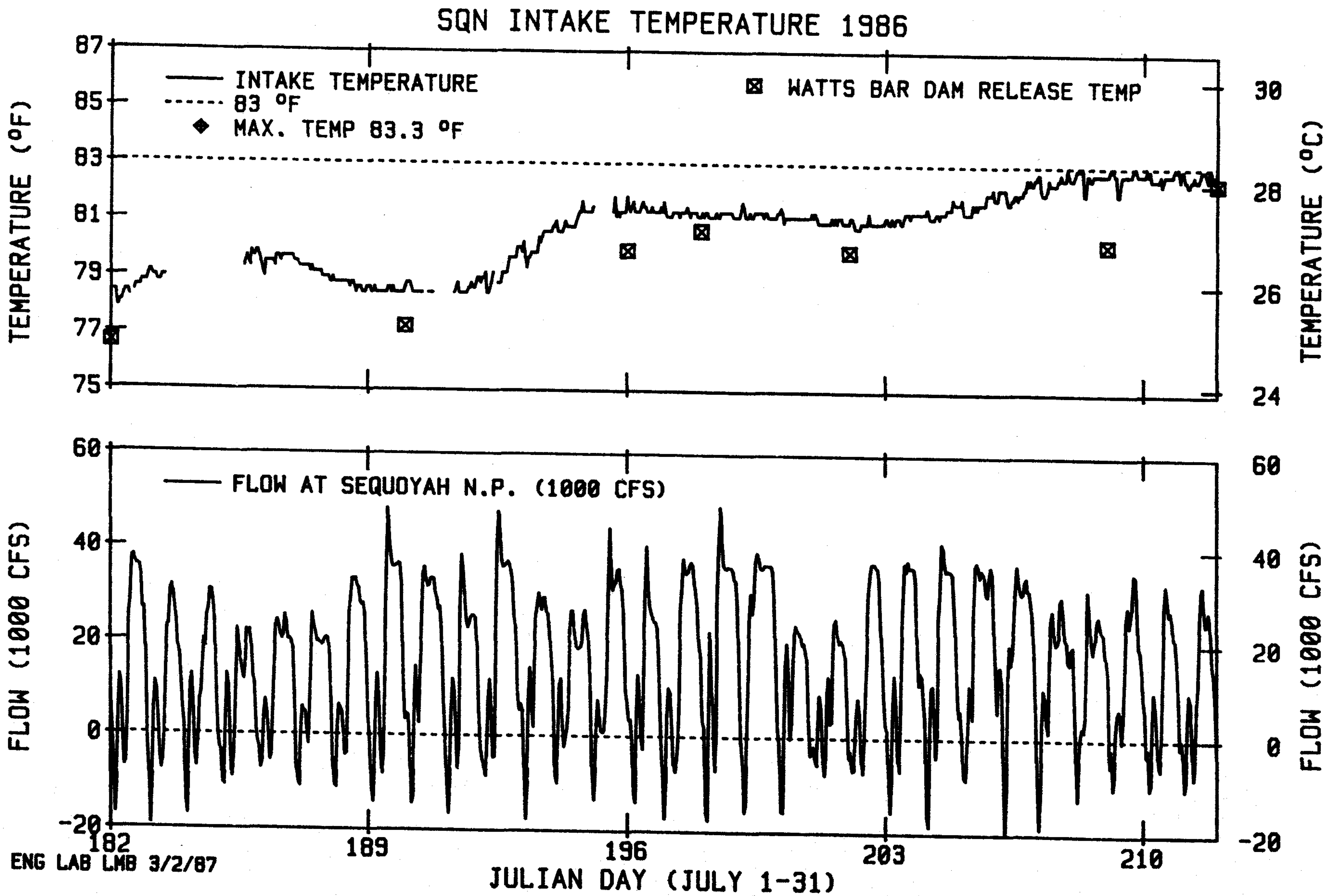

Figure 15. Intake Temperature and Flow at SQN in July 1986.

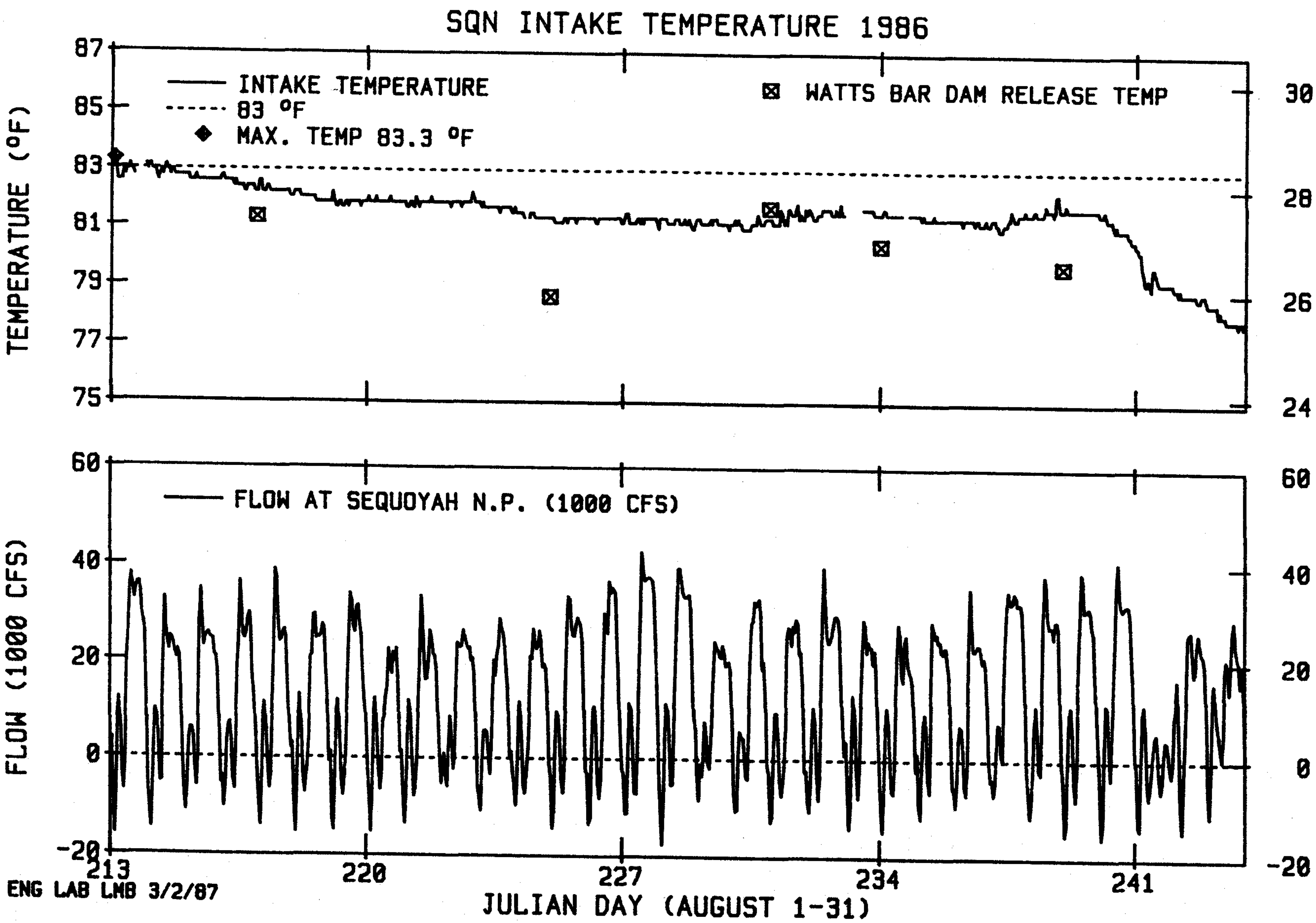

Figure 16. Intake Temperature and Flow at SQN in August 1986.

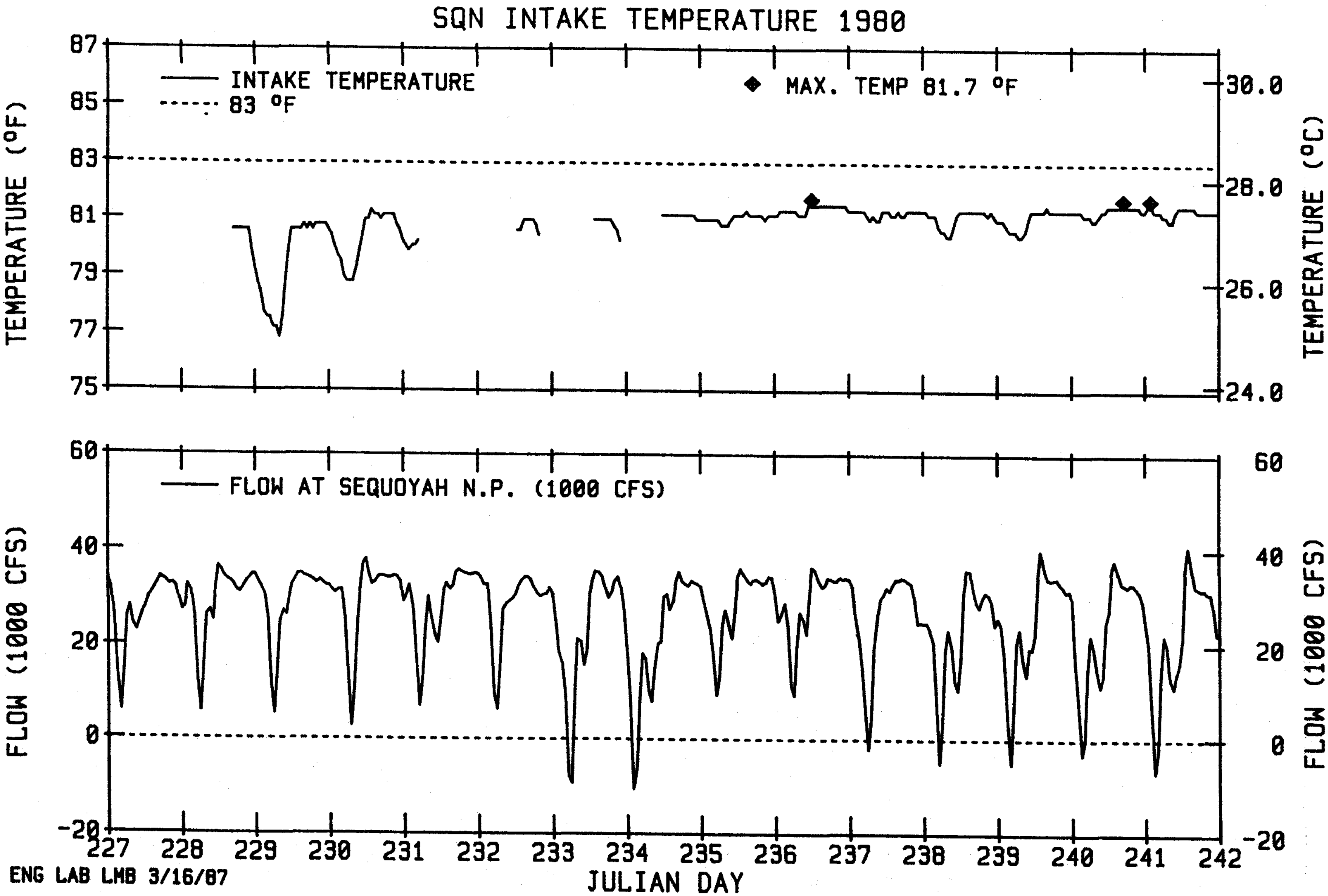

Figure 17. Intake Temperature and Flow at SQN from August 15-30, 1980.

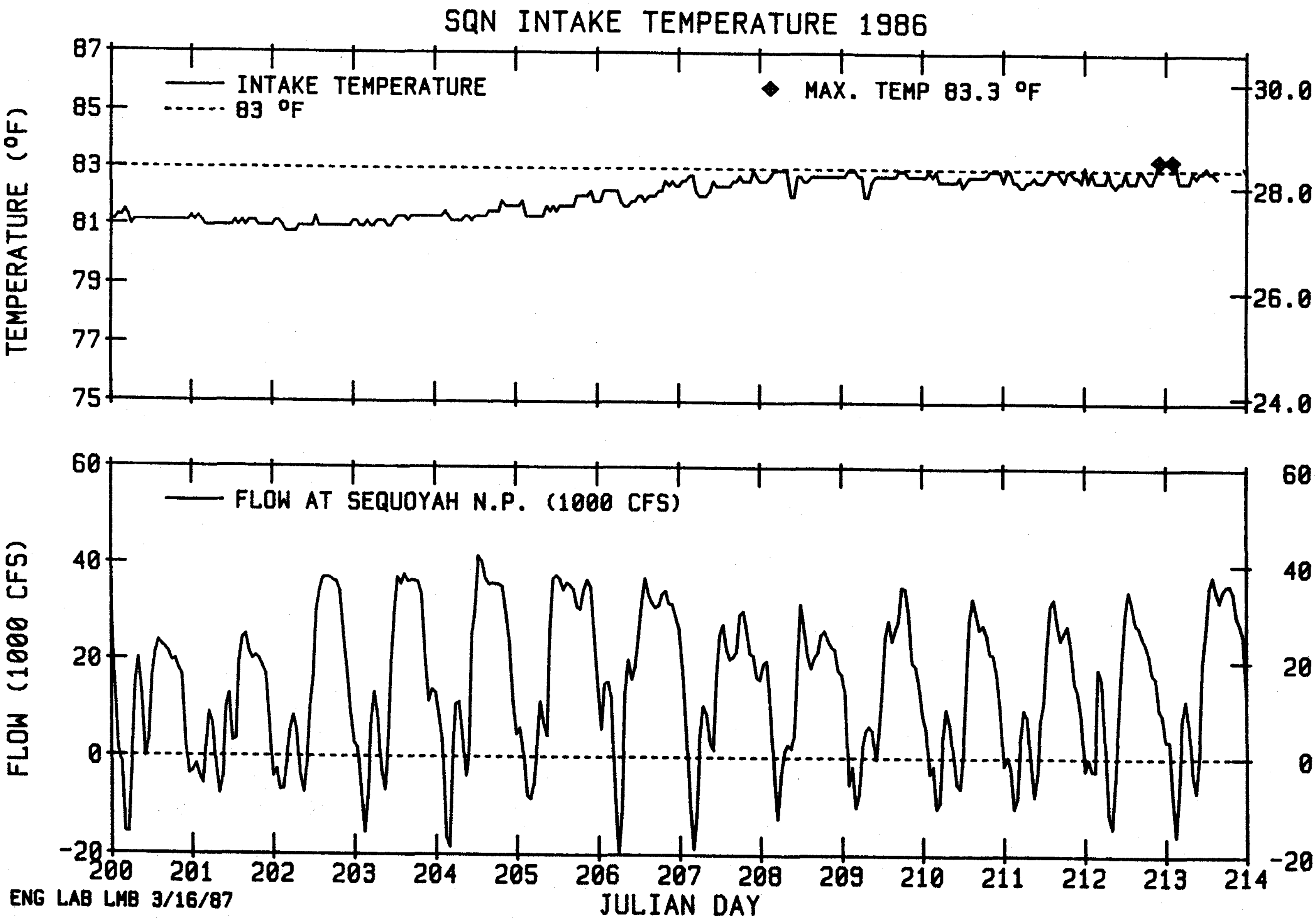

Figure 18. Intake Temperature and Flow at SQN From July 19 to August 2, 1986.

TABLE 2

Meteorological Data at SQN on July 14, 1980
Considered Worst Case Daily Conditions

Year	Julian Day	Hr	Air Temp (°C)	Air Temp (°F)	Dew Point Temp (°C)	Dew Point Temp (°F)	Atm. Press. (mb)	Wind Speed (ft/s)	Solar Radiation (Btu/hr/ft²)
80	194	1	27.1	80.8	21.5	70.7	988.4	4.10	0.0
80	194	2	26.2	79.2	21.5	70.7	988.4	5.28	0.0
80	194	3	25.7	78.3	21.9	71.4	988.7	4.69	0.0
80	194	4	24.8	76.6	21.9	71.4	989.1	3.68	0.0
80	194	5	24.6	76.3	22.0	71.6	989.4	4.40	0.0
80	194	6	24.2	75.6	22.3	72.1	989.7	3.81	2.2
80	194	7	24.5	76.1	22.7	72.9	991.8	3.51	24.3
80	194	8	25.6	78.1	23.1	73.6	991.1	5.71	73.0
80	194	9	26.8	80.2	23.1	73.6	991.1	4.40	130.5
80	194	10	29.6	85.3	22.7	72.9	991.4	5.87	214.5
80	194	11	30.5	86.9	22.9	73.2	991.4	6.89	201.3
80	194	12	31.7	89.1	23.1	73.6	991.4	9.09	283.1
80	194	13	32.3	90.1	22.9	73.2	991.1	10.70	291.9
80	194	14	33.5	92.3	22.3	72.1	990.7	9.09	283.1
80	194	15	34.8	94.6	20.8	69.4	990.4	7.91	265.4
80	194	16	36.0	96.8	18.4	65.1	989.7	5.71	234.4
80	194	17	36.5	97.7	17.3	63.1	989.7	5.41	159.2
80	194	18	35.6	96.1	18.6	65.5	989.7	7.61	114.4
80	194	19	33.6	92.5	21.4	70.5	989.7	10.27	48.7
80	194	20	32.0	89.6	22.4	72.3	989.7	6.30	13.3
80	194	21	30.6	87.1	23.0	73.4	990.4	1.90	0.0
80	194	22	29.5	85.1	23.4	74.1	991.1	3.38	0.0
80	194	23	28.4	83.1	24.0	75.2	991.8	3.67	0.0
80	194	24	27.9	82.2	24.2	75.6	991.8	3.67	0.0

Weather Service Station (TVA, 1984). The lowest unregulated daily riverflow at Chattanooga from 1874 until the closure of Chickamauga Dam in January 1940 was 3,200 cfs (SQN-FSAR, 1986). A frequency distribution of monthly releases during July and August from Chickamauga Dam from 1945 to 1986 is shown in Figure 19. The mean summer discharge during this period was about 27,000 cfs. Average inflow from the Hiwassee River is generally small with a 10-year average of about 1,500 and 1,650 cfs for July and August, respectively (see Table 3). The effect of Hiwassee riverflows on SQN intake temperature is not considered significant.

Watts Bar Dam release temperatures in the summer months range from 75°F (23.9°C) to 82.4°F (28°C) during the period from 1973 to 1986 (from EPA-STORET database) and are influenced by seasonal meteorology, hydrology, and operation of the reservoir system. Operation of the reservoir system above Watts Bar Dam determines the retention time (or travel time) of water from its origin until it is discharged from Watts Bar Dam. As the retention time increases the temperature of water above Watts Bar Dam increases (and consequently the release temperature becomes warmer). As a worst case scenario, a constant Watts Bar Dam release temperature of 82.4°F (28°C) was used. Additionally, the thermal discharge from WBN may affect water temperatures at SQN and its effects on river temperature at the SQN intake are addressed below.

The water travel time under riverine conditions from Watts Bar Dam to SQN ranged from about 24 hours for a riverflow of 90,000 cfs to about 130 hours for a flow of 3,200 cfs. In this study, temperature computations for each flow condition were performed for a period of seven days by repeating the same set of (daily) extreme meteorology shown in Table 2.

The daily temperature variation at any river mile can be represented by computed daily maximum and minimum temperatures which define the range of the diurnal temperature variation. The diurnal temperature envelopes (or the longitudinal daily maximum and minimum temperature profiles) computed for the range of riverflows described above are shown in Figures 20 to 25.

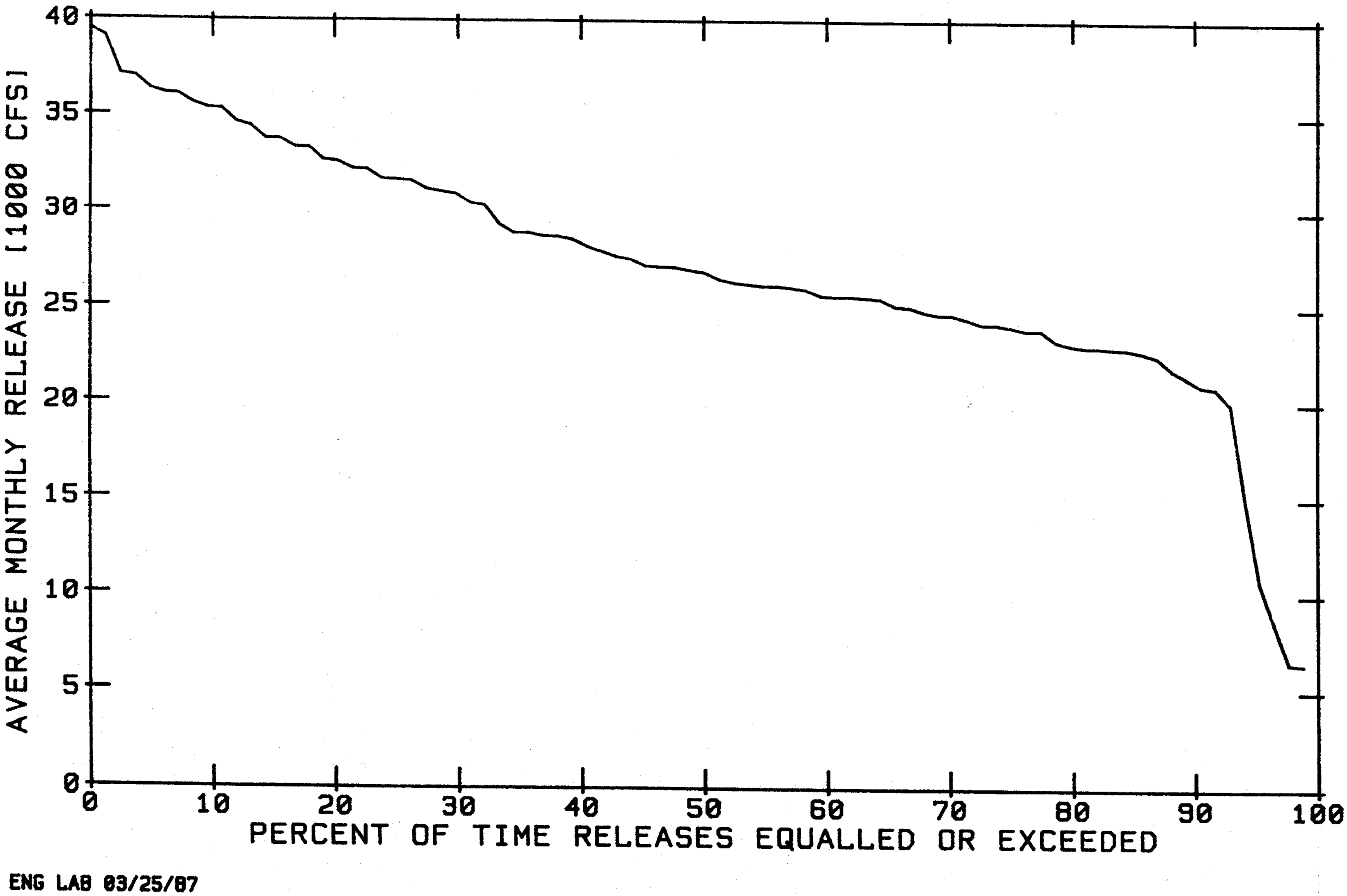

Figure 19. Average Monthly Release Frequency During July and August at Chickamauga Dam (1945-1986).

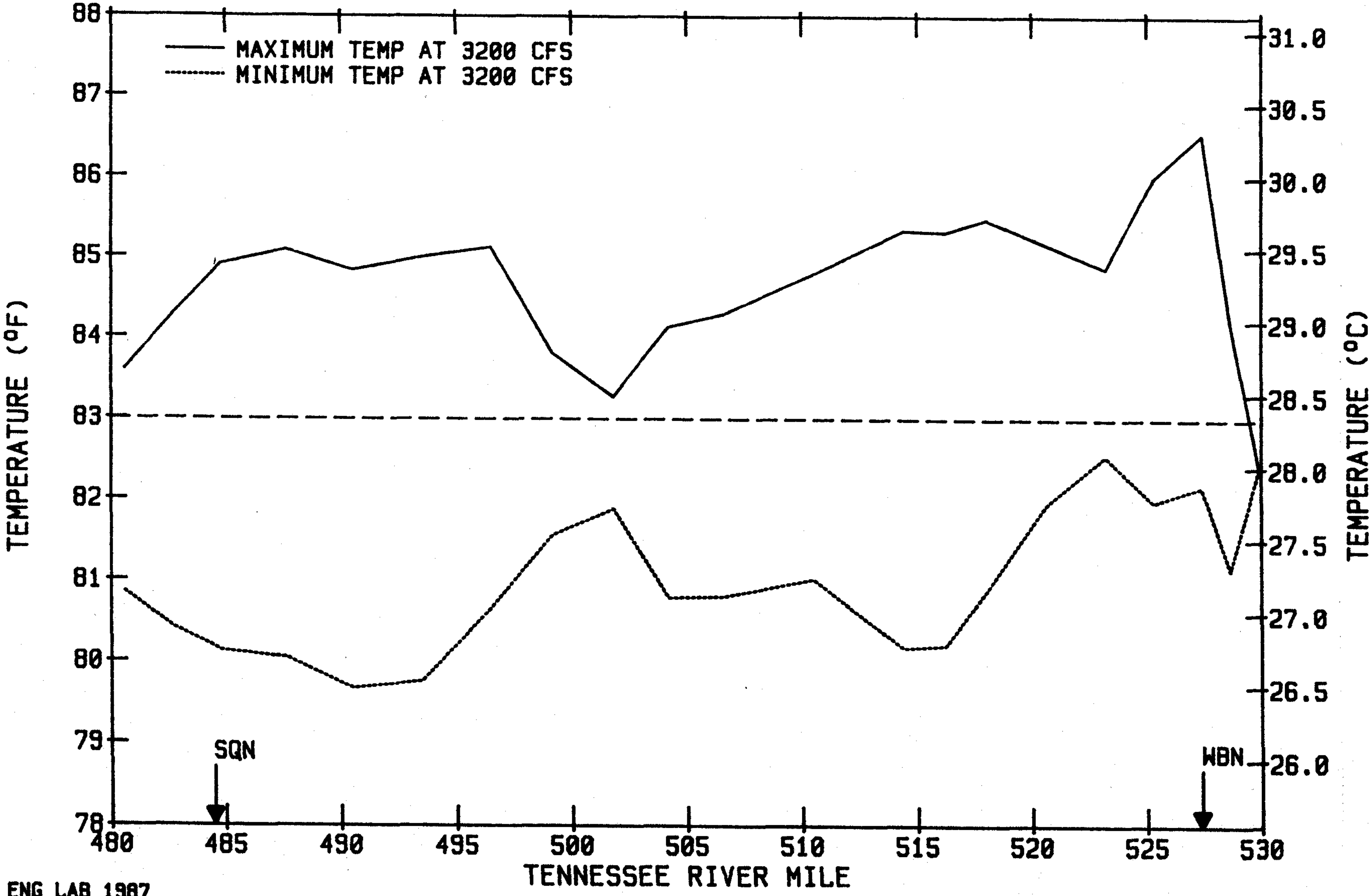

Figure 20. Longitudinal Daily Maximum and Minimum Temperature Distributions for a Riverflow of 3,200 cfs.

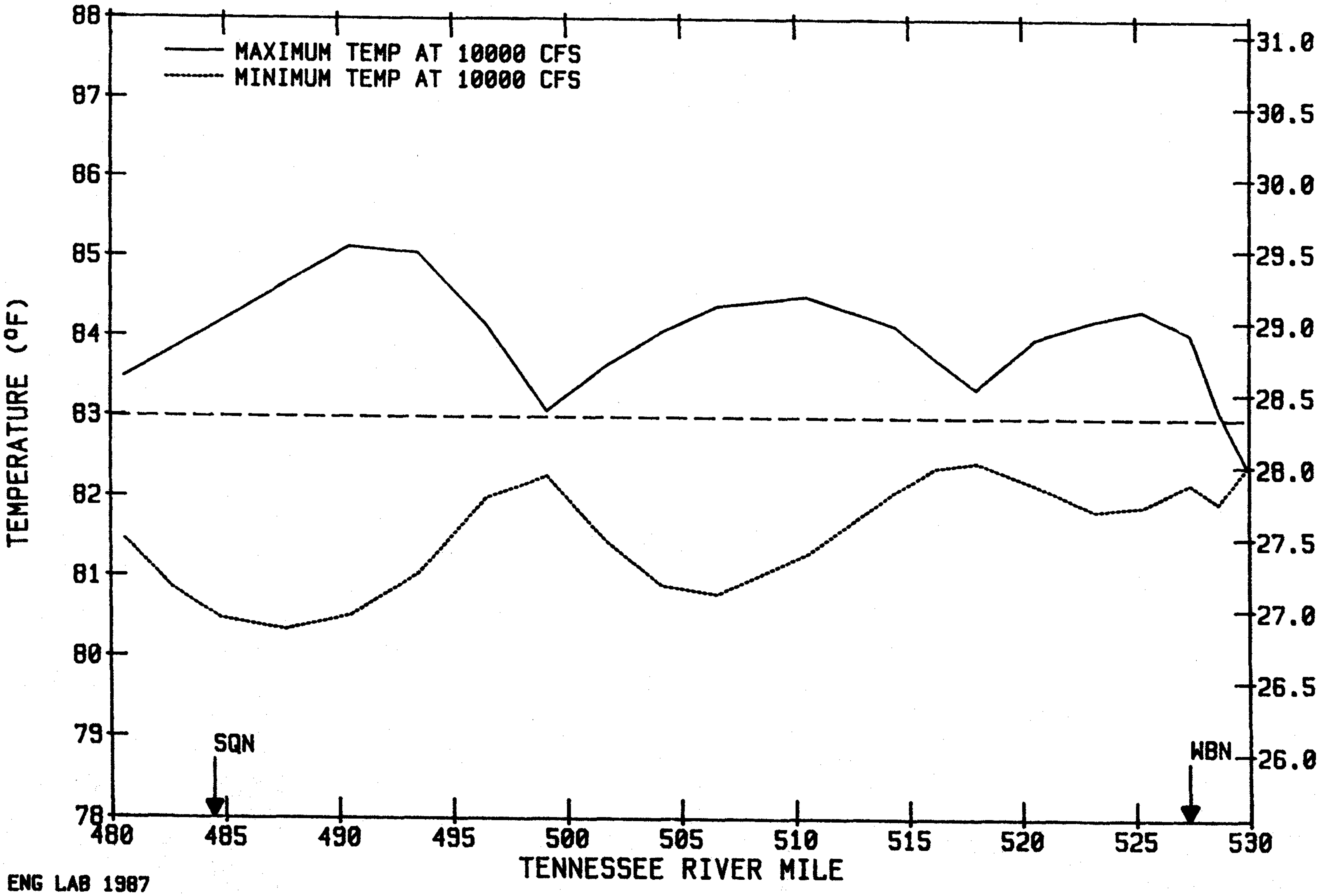

Figure 21. Longitudinal Daily Maximum and Minimum Temperature Distributions for a Riverflow of 10,000 cfs.

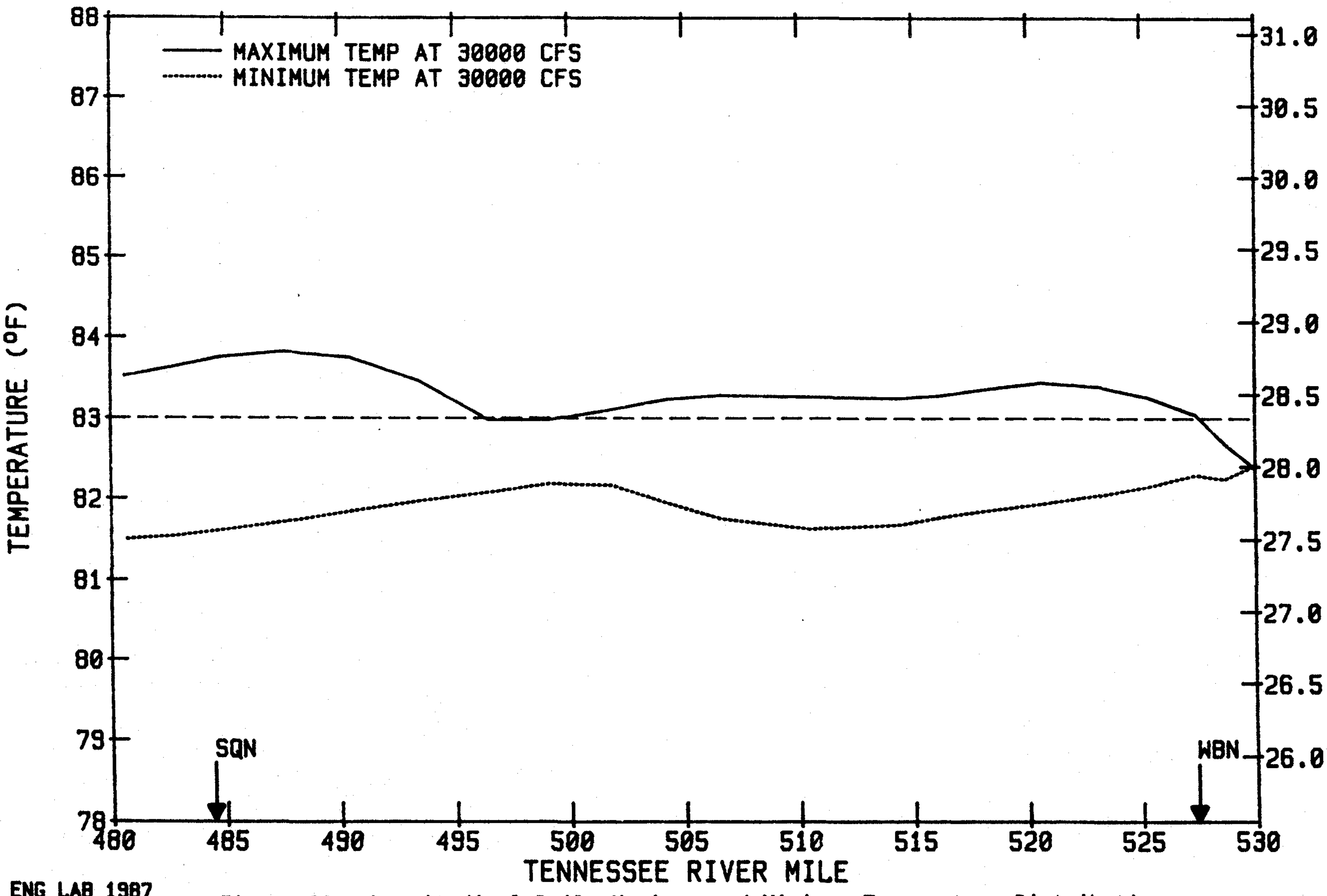

Figure 22. Longitudinal Daily Maximum and Minimum Temperature Distributions for a Riverflow of 30,000 cfs.

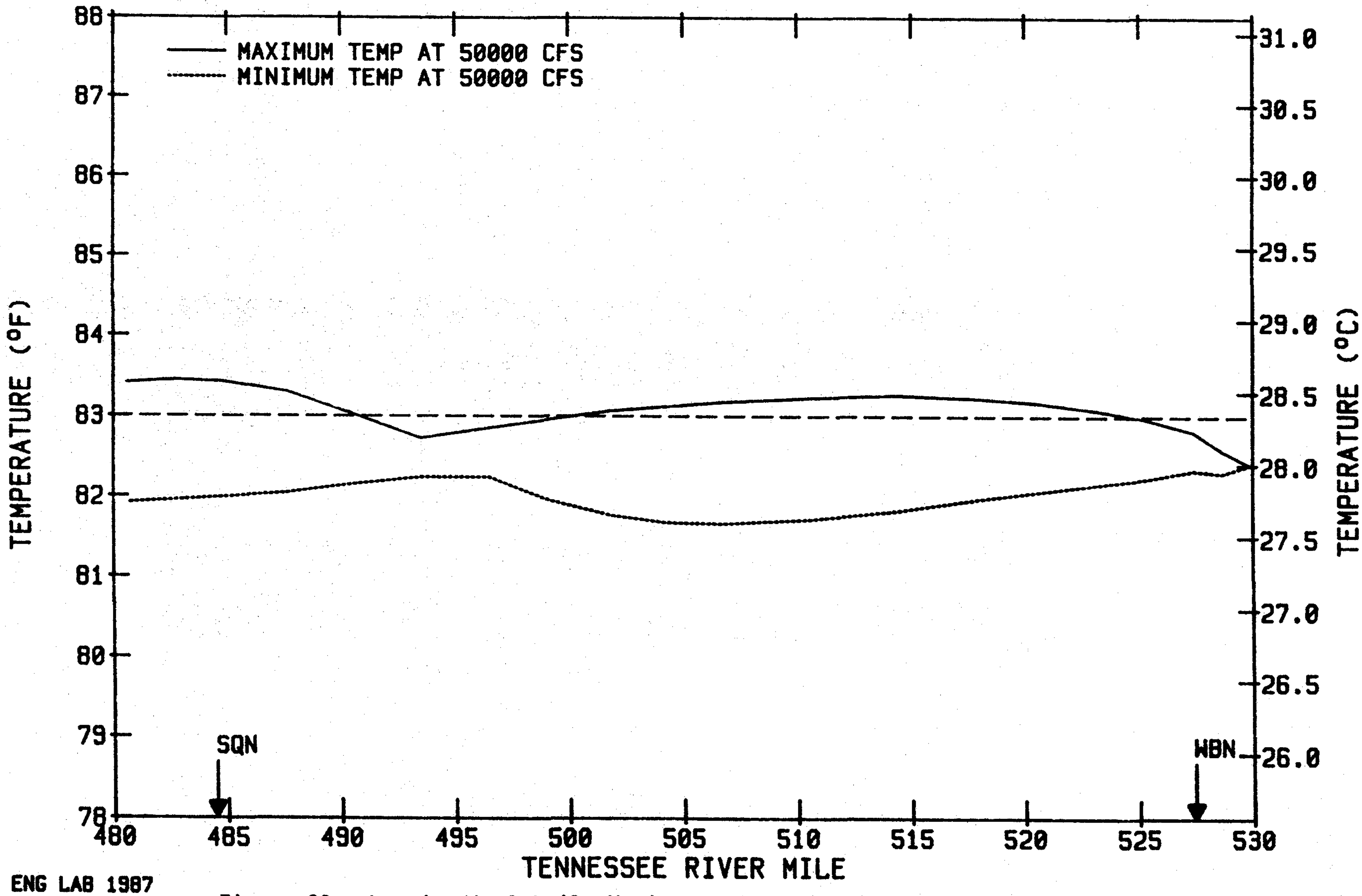

Figure 23. Longitudinal Daily Maximum and Minimum Temperature Distributions for a Riverflow of 50,000 cfs.

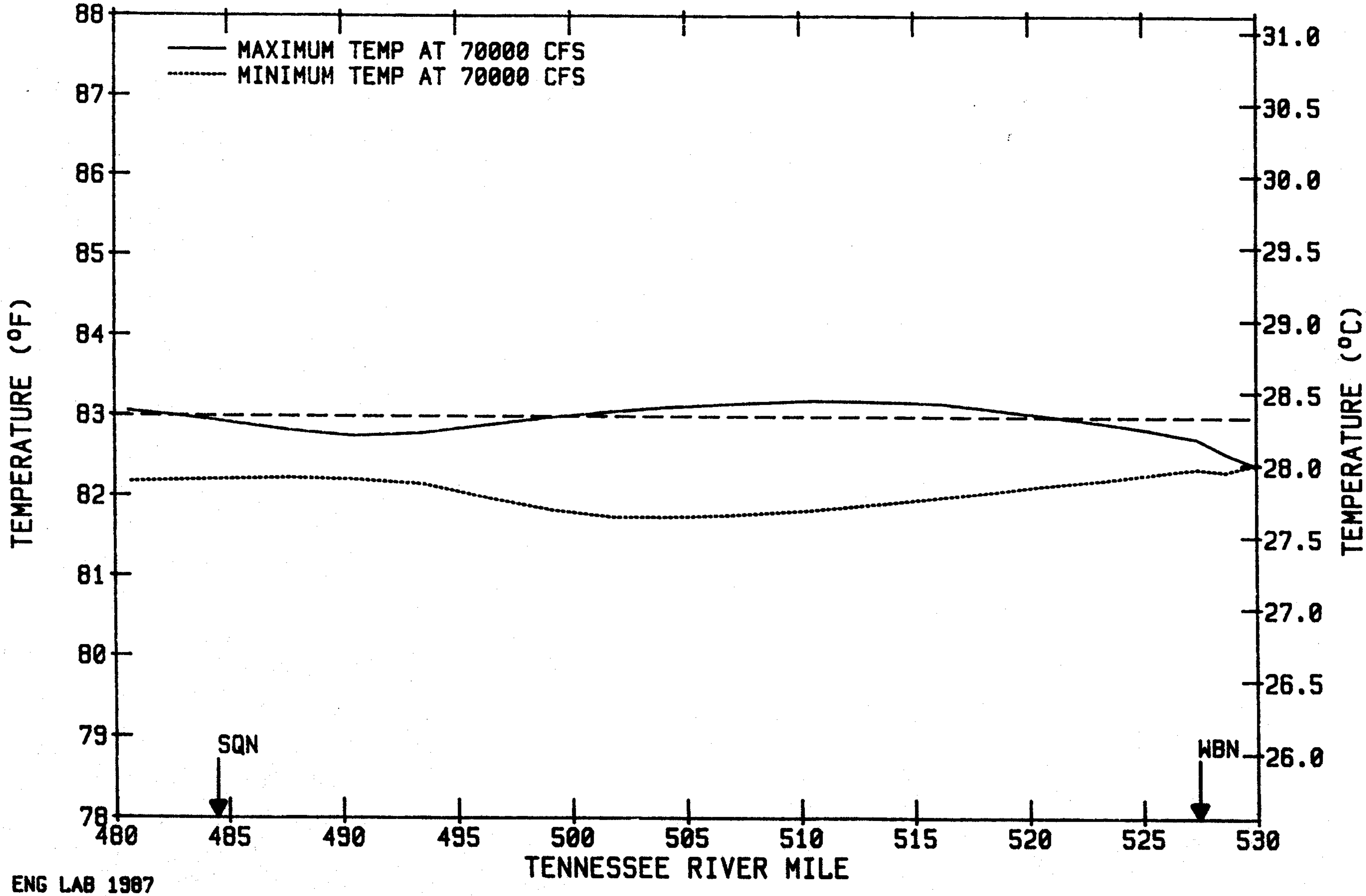

Figure 24. Longitudinal Daily Maximum and Minimum Temperature Distributions for a Riverflow of 70,000 cfs.

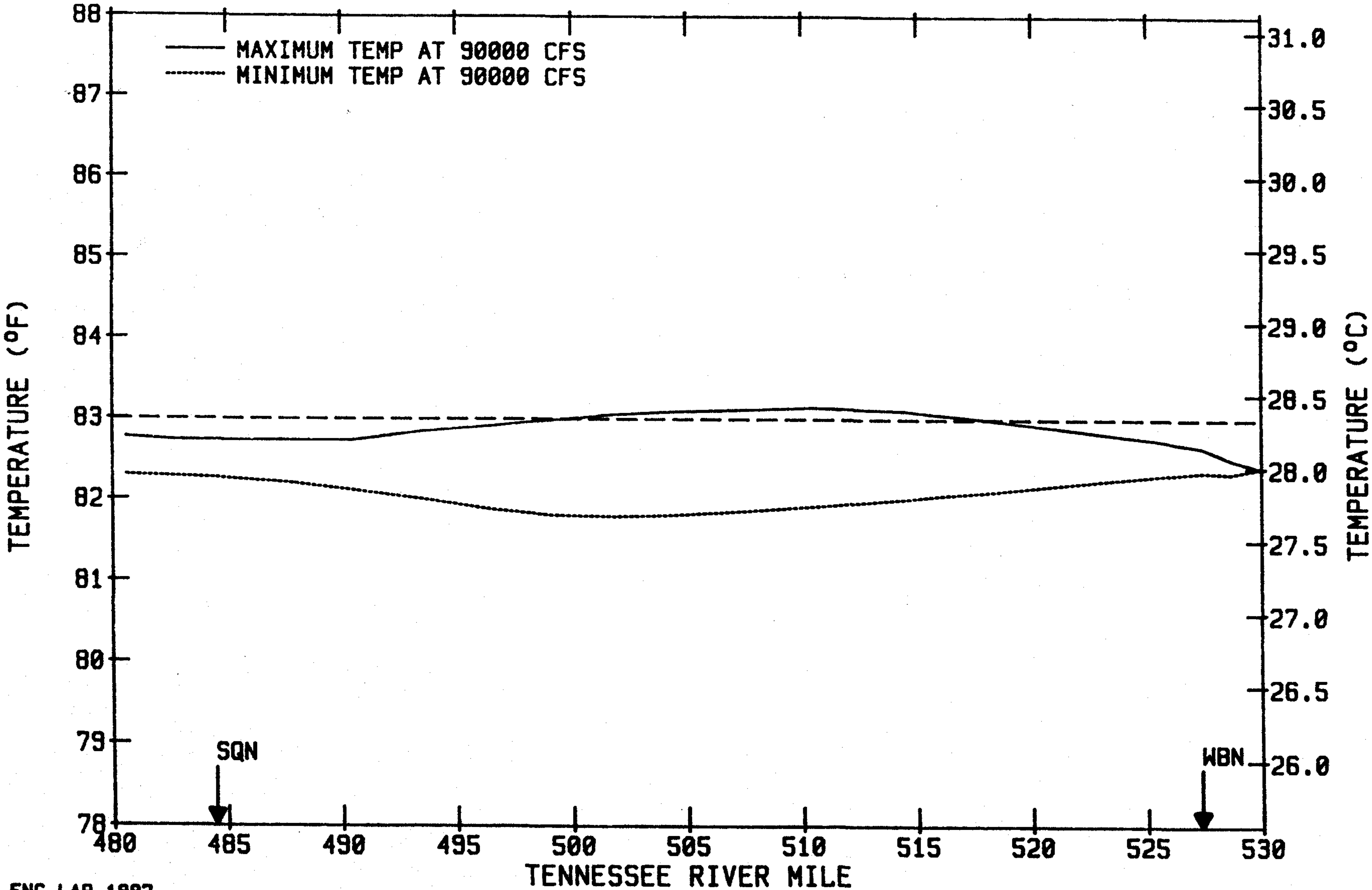

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Figure 25. Longitudinal Daily Maximum and Minimum Temperature Distributions for a Riverflow of 90,000 cfs.

TABLE 3

Monthly Average Releases from Hiwassee Dam for July and August from 1977 to 1986

Year	Hiwassee Release (cfs) July	Hiwassee Release (cfs) August
1977	2238	2366
1978	1058	1653
1979	2289	2761
1980	2513	2553
1981	1385	1561
1982	1510	1512
1983	1043	760
1984	1662	1703
1985	1085	1367
1986	341	360
AVERAGE	1512	1660

The daily maximum and minimum temperatures at each cross section are influenced primarily by the depth of channel which is a function of riverflow (i.e., release from Watts Bar Dam). To demonstrate the relationship, longitudinal depth profiles for flows of 3,200; 10,000; 50,000; and 90,000 cfs are presented in Figure 26. The deep pools at TRMs 523, 502, and 485 serve as thermal reservoirs and play an important role in reducing the impacts of diurnal heating/cooling on river temperature.

During low riverflow conditions (see Figure 20), the daily maximum temperature increases over shallow reaches and decreases with increasing channel depth; whereas, the daily minimum temperature is lower in shallow channels and higher in deep pools (as shown in Figure 26). As riverflow increases, the difference between the maximum and the minimum temperature becomes smaller and the peaks and valleys start moving downstream due to flushing effects. With even higher flow, all peaks and valleys disappear and the effects of diurnal heating/cooling on river temperature are reduced to less than 1F° (0.5C°). This relationship between flow and the daily maximum and minimum temperatures at SQN is shown in Figure 27.

The daily maximum and minimum temperatures and the number of hours that river temperatures exceed the maximum intake temperature limit (83°F) at SQN for each flow condition are presented in Table 4. To examine the effects of the WBN thermal discharge on river temperature at SQN, a blowdown rate of 85 cfs (Ungate and Howerton, 1977) and a discharge temperature of 95°F (35°C) (maximum NPDES permit limit) were used. A comparison of the daily maximum and minimum temperatures including WBN thermal discharge and those without the thermal discharge are provided in Table 4. Under these extreme environmental conditions, violations of the maximum intake cooling water temperature limit occur at all flows less than 70,000 cfs. At low flow conditions (<30,000 cfs), the thermal discharge from WBN causes no more than 0.1F° (0.06C°) increase in the daily maximum and minimum temperatures and no more than two hours increase to the hours of exceeding the 83°F (28.3°C) temperature limit. With higher flow, there is essentially no difference

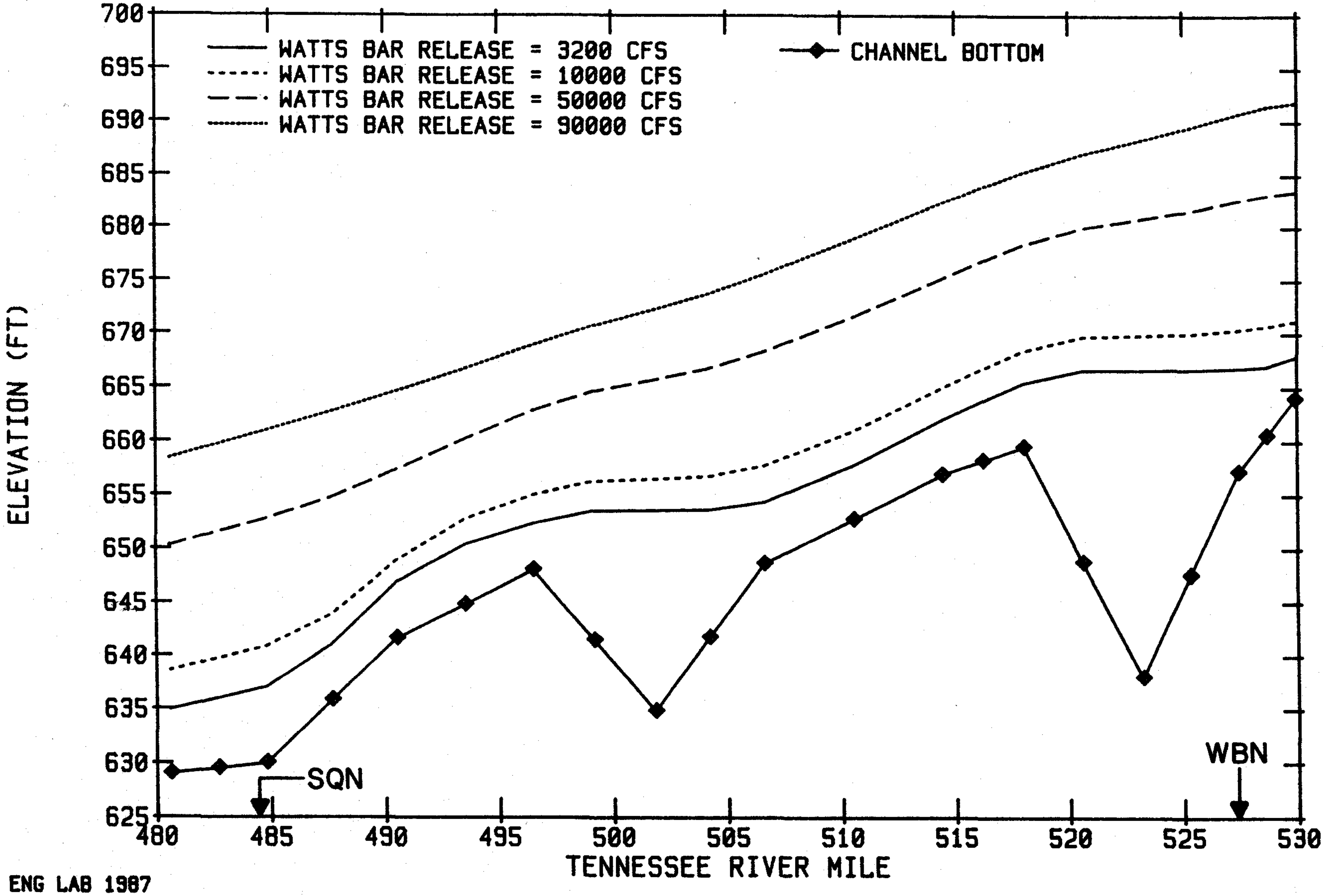

Figure 26. Longitudinal Channel Depth Profile From Watts Bar Dam to SQN.

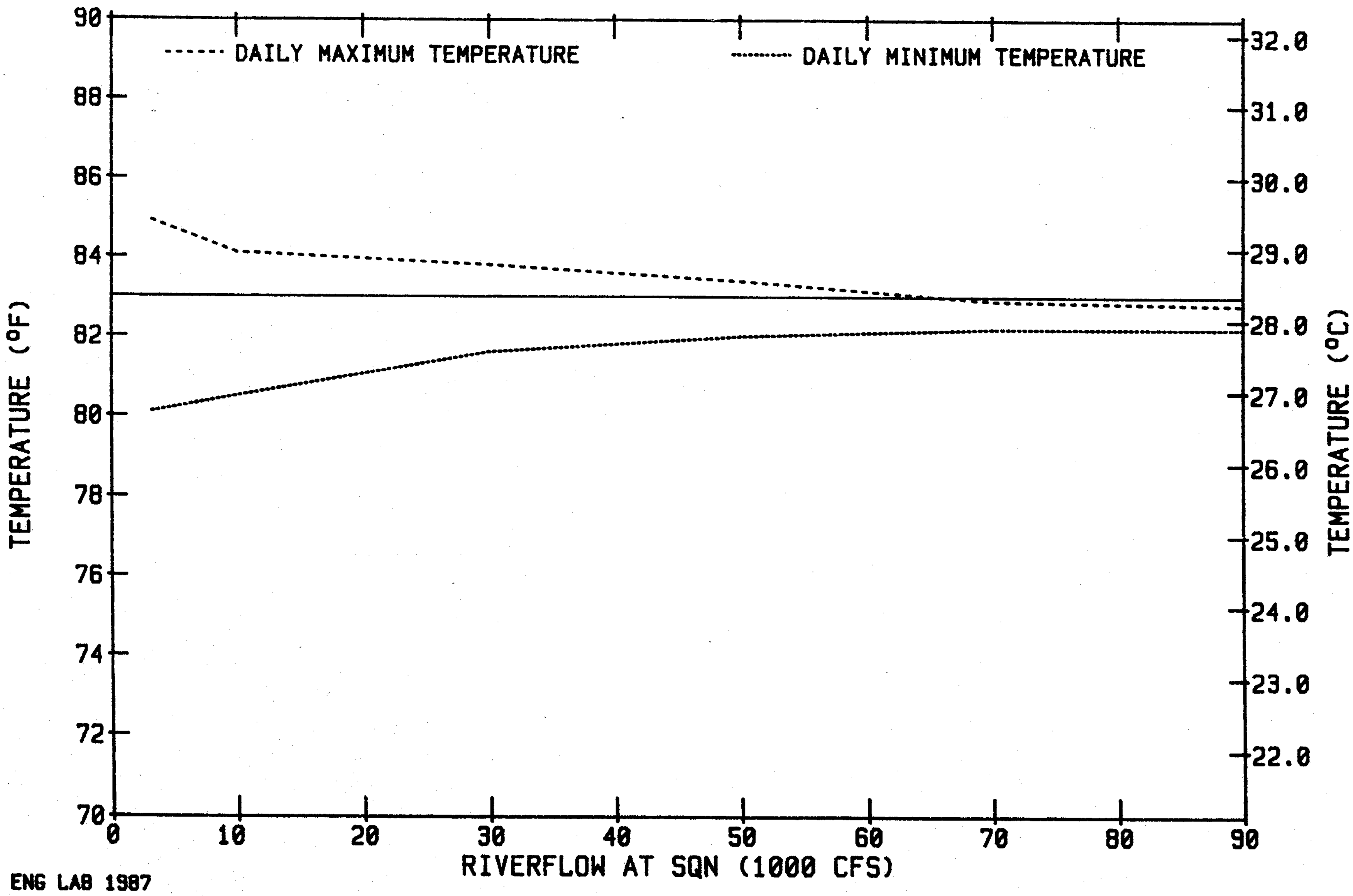

Figure 27. Relationship Between Riverflow and Daily Maximum and Minimum Temperatures at SQN.

TABLE 4

Watts Bar Nuclear Plant Thermal Discharge Effects
on Water Temperature at Sequoyah Nuclear Plant Intake

	With WBN Thermal Discharge			Without WBN Thermal Discharge		
Watts Bar Release (cfs)	Max. Temp (°F)	Min. Temp (°F)	No. of Hours Exceeding 83°F (hrs/day)	Max. Temp (°F)	Min. Temp (°F)	No. of Hours Exceeding 83°F (hrs/day)
3,200	84.9	80.1	10	84.9	80.1	10
10,000	84.1	80.5	12	84.1	80.4	10
30,000	83.8	81.6	9	83.7	81.3	8
50,000	83.4	82.0	5	83.4	81.9	5
70,000	82.9	82.2	0	82.9	82.2	0
90,000	82.8	82.2	0	82.8	82.2	0

between the two cases. It can be concluded that the WBN thermal discharge has only a minimum effect on river temperature at SQN.

Sensitivity Analyses

As previously stated, the water temperature at SQN is influenced by the effects of meteorology, riverflow, and Watts Bar Dam release temperature. The computations shown above used the worse case scenario, the 1980 extreme meteorology and the highest recorded Watts Bar release temperature. The probability of having these two conditions occur at the same time can be a small one. To gain a better understanding of the individual effect of meteorology and Watts Bar Dam release temperature on SQN intake temperature, a moderate summer meteorology and different (lower) Watts Bar Dam release temperatures were investigated.

To examine the effect of Watts Bar Dam release temperature on SQN intake temperature, river temperatures for a riverflow of 3,200 cfs were computed using three different dam release temperatures, 82.4°F (28°C), 68°F (20°C), and 50°F (10°C). The same 1980 extreme meteorology was used in all three cases. Shown in Figure 28 are the computed longitudinal (daily) maximum temperature profiles for the three cases which converge near the site of SQN. An examination of the daily maximum and minimum temperatures at SQN shown in Table 5 indicates that temperatures at SQN for the three cases are essentially the same despite the large differences in Watts Bar Dam release temperature. Low riverflow (long travel time) and the extreme meteorology (driving force), together, nullify the effect of lower Watts Bar Dam release temperature on SQN intake temperature.

Increasing the riverflow to 10,000 cfs, however, resulted in a significant drop in the daily maximum temperature at SQN. As shown in Figure 29, the warming of the longitudinal maximum temperature profile is considerably slower than that with a riverflow of 3,200 cfs. The computed daily maximum and minimum temperatures at SQN (see Table 6) indicate that, with a riverflow of 10,000 cfs, the maximum intake temperature limit (83°F) at SQN can be met with a Watts Bar Dam release temperature of 75.2°F (24°C) even when the 1980 extreme meteorology is applied.

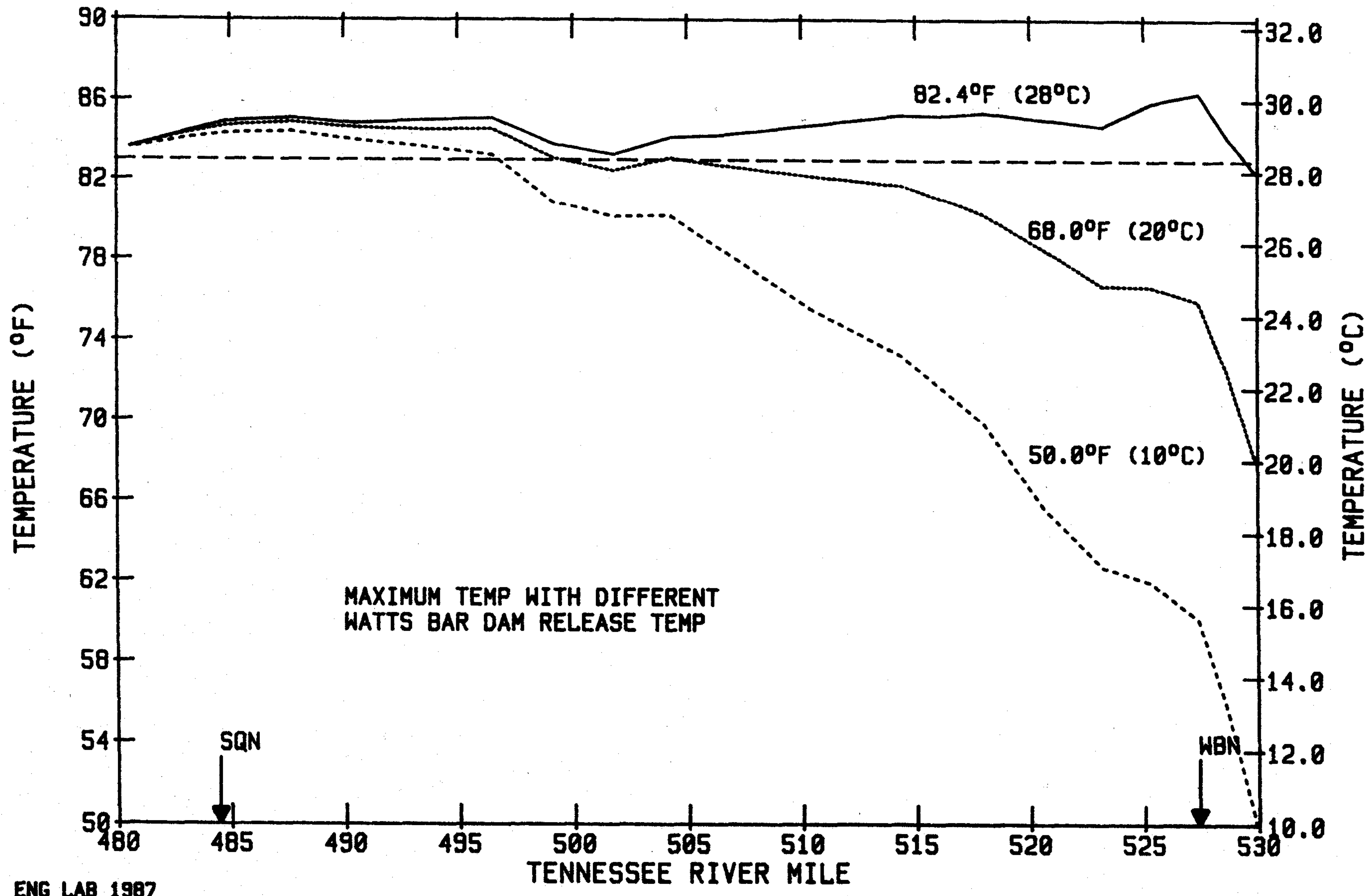

Figure 28. Longitudinal Daily Maximum Temperature Distribution for Different Watts Bar Dam Release Temperatures (Riverflow = 3,200 cfs).

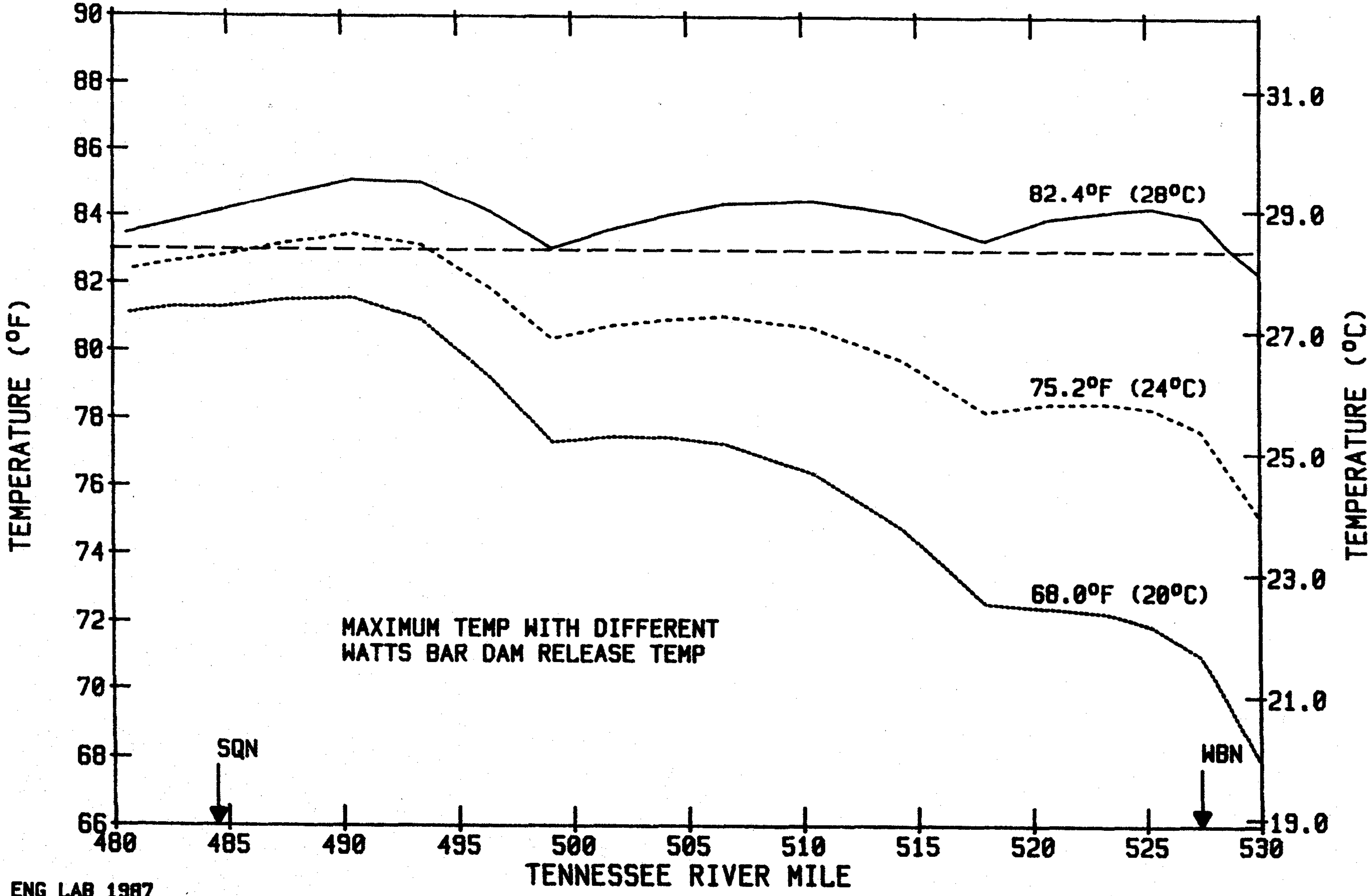

Figure 29. Longitudinal Daily Maximum Temperature Distribution for Different Watts Bar Dam Release Temperatures (Riverflow = 10,000 cfs).

TABLE 5

Water Temperature at SQN With Different
Watts Bar Dam Release Temperatures for a Riverflow of 3,200 cfs*

Watts Bar Release Temp (°F)	Max. Temp (°F)	Min. Temp (°F)	No. of Hours Exceeding 83°F (hrs/day)
82.4 (28°C)	84.9	80.1	10
68.0 (20°C)	84.7	80.1	9
50.0 (10°C)	84.3	80.1	8

*1980 extreme meteorology.

TABLE 6

Water Temperature at SQN With Different
Watts Bar Dam Release Temperatures for a Riverflow of 10,000 cfs*

Watts Bar Release Temp (°F)	Max. Temp (°F)	Min. Temp (°F)	No. of Hours Exceeding 83°F (hrs/day)
82.4 (28°C)	84.2	80.3	12
75.2 (24°C)	82.8	78.9	0
68.0 (20°C)	81.3	77.1	0

*1980 extreme meteorology.

The effect of meteorology on river temperature can best be demonstrated in a case when riverflow is low (for example, 3,200 cfs). The meteorology selected for this demonstration was a 5-day average of climatological data starting two days before the highest intake temperature at SQN was observed, (July 30 to August 3, 1986). The 1986 5-day average meteorology is shown in Table 7. The computed longitudinal maximum and minimum temperature profiles using the 1986 5-day average meteorology are plotted with the 1980 extreme meteorology in Figure 30. As shown in the figure, the effect of meteorology on river temperature is significant at low riverflow. The effect of using the 5-day average meteorology can also be seen in the computed daily maximum temperature, given in Table 8, which shows a dramatic reduction in the daily maximum temperature at SQN compared to that of the extreme 1980 meteorology.

Overall, the analysis indicates that the effect of meteorology on river temperature is most important when riverflow is the lowest. However, the effect of Watts Bar Dam release temperature on SQN intake temperature becomes more pronounced with increased riverflow and eventually reduces the effect of meteorology on river temperature to a minimum.

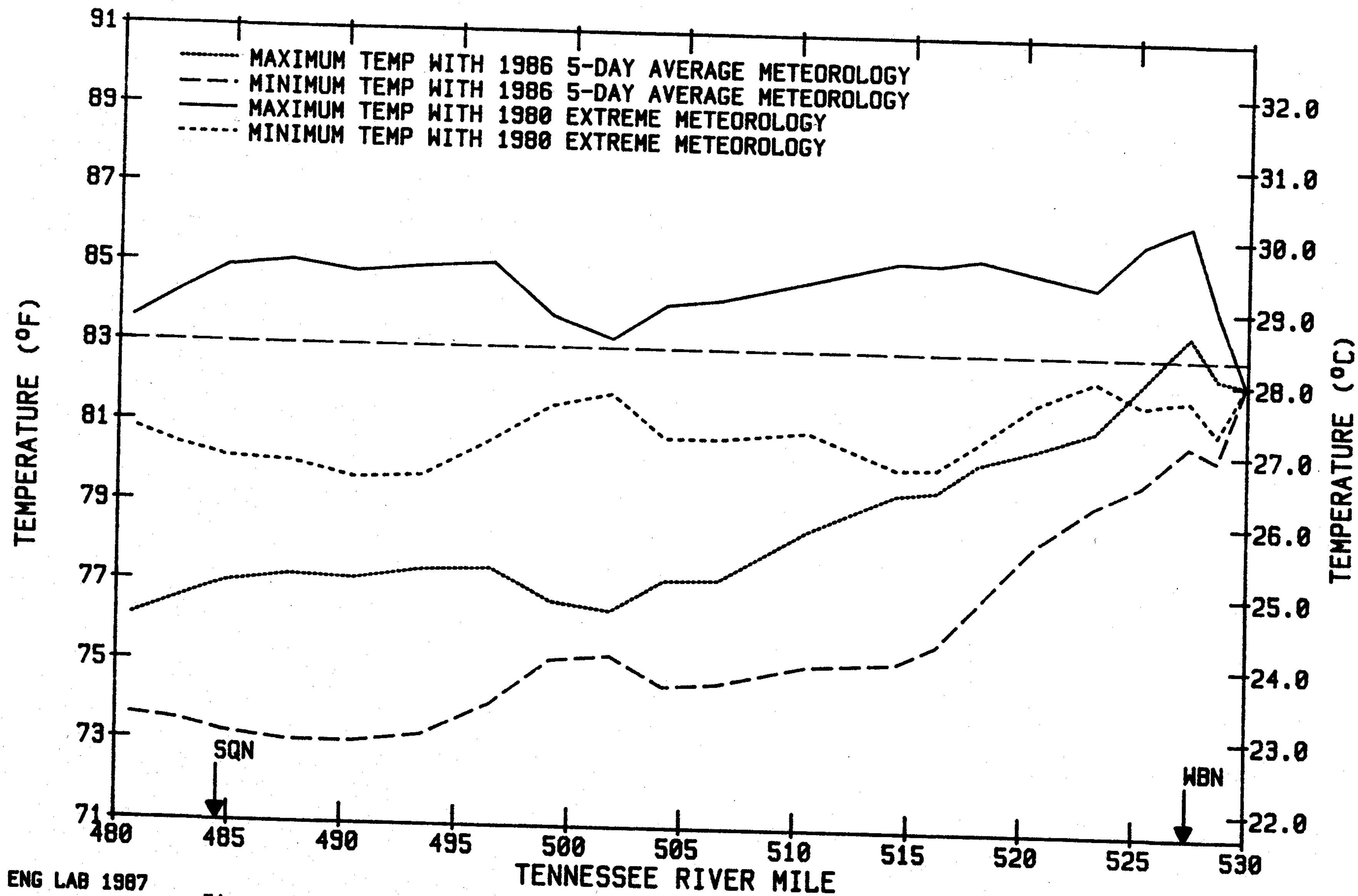

Figure 30. Longitudinal Daily Maximum and Minimum Temperature Distributions for Different Meteorologies (Riverflow = 3,200 cfs).

TABLE 7

1986 5-Day Average Meteorological Data at SQN
(July 30 to August 3, 1986)

Year	Julian Day	Hr	Air Temp (°C)	Air Temp (°F)	Dew Point Temp (°C)	Dew Point Temp (°F)	Atm. Press. (mb)	Wind Speed (ft/s)	RMS* Wind Speed (ft/s)	Solar Radiation (Btu/hr/ft²)
86	AVG	1	23.6	74.5	18.1	64.6	990	2.26	2.59	0.0
86	AVG	2	22.8	73.1	18.2	64.8	990	3.67	3.81	0.0
86	AVG	3	22.0	71.6	18.4	65.1	990	3.29	3.42	0.0
86	AVG	4	21.6	70.9	18.4	65.1	990	2.88	2.98	0.0
86	AVG	5	21.0	69.8	18.6	65.5	990	2.99	3.09	0.0
86	AVG	6	20.8	69.4	18.0	64.4	990	2.96	3.05	0.0
86	AVG	7	20.8	69.4	17.7	63.9	990	3.02	3.12	17.3
86	AVG	8	22.2	72.0	18.0	64.4	990	4.17	4.35	74.4
86	AVG	9	24.2	75.6	17.8	64.0	990	5.34	5.55	144.7
86	AVG	10	26.0	78.8	17.6	63.7	990	5.55	5.65	201.8
86	AVG	11	27.8	82.0	17.5	63.5	990	5.11	5.30	231.5
86	AVG	12	29.4	84.9	17.1	62.8	990	6.95	7.17	254.5
86	AVG	13	29.3	84.7	17.0	62.6	990	9.39	10.27	215.5
86	AVG	14	27.9	82.2	17.1	62.8	990	8.77	8.94	196.5
86	AVG	15	28.3	82.9	16.8	62.2	990	7.86	8.05	195.2
86	AVG	16	29.2	84.6	16.2	61.2	990	6.57	7.32	175.3
86	AVG	17	29.6	85.3	16.2	61.2	990	7.72	8.52	144.3
86	AVG	18	29.5	85.1	15.8	60.4	990	7.31	8.23	79.2
86	AVG	19	29.0	84.2	16.5	61.7	990	7.31	8.05	48.2
86	AVG	20	27.9	82.2	16.8	62.2	990	6.07	6.57	5.8
86	AVG	21	26.6	79.9	16.5	61.7	990	4.81	5.11	0.0
86	AVG	22	25.5	77.9	16.4	61.5	990	3.76	3.95	0.0
86	AVG	23	24.4	75.9	16.4	61.5	990	3.93	4.21	0.0
86	AVG	24	23.6	74.5	16.7	62.1	990	3.37	3.80	0.0

*Root mean square

TABLE 8

Water Temperature at SQN With Different Meteorologies for a Riverflow of 3,200 cfs*

Meteorology	Max. Temp (°F)	Min. Temp (°F)	No. of Hours Exceeding 83°F (hrs/day)
1980 Extreme	84.9	80.1	10
1986 5-day Average	77.0	73.2	0

*A Watts Bar Dam release temperature of 82.4°F (28°C) was used.

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