

FORECASTING SANTA ANA WINDS

Thesis by

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In Partial Fulfillment of the Requirements for the Degree of Master
of Science in Meteorology, California Institute of Technology,
Pasadena, California, 1944.

No definite irrefutable conclusions can be set forth for the absolutely infallible forecasting of Santa Ana winds from the results of the rather meager investigation conducted by the author. To set forth adequate inflexible rules to cover every case would require an analysis of many such winds over a long period of time. But from a perusal of the accompanying 37 charts, covering the 3-hourly temperatures, dewpoints, wind directions and wind velocities for two such occurrences, and the raobs for two nearby stations for one period, we may arrive at a few facts which seemingly would apply in every case. From these few conclusions, by studying the accompanying charts, and by extending the investigation to other incidents of like nature, undoubtedly an accurate basis can be established for forecasting within a matter of hours or even minutes the approach and occurrence of Santa Ana winds.

As everyone knows, Santa Ana winds are caused primarily by a buildup of atmospheric pressure over the Great Basin, and when this pressure is great enough the air is naturally forced through the mountain passes into the valleys to the westward--provided of course that there is the necessary negative pressure gradient in those valleys. The Los Angeles Basin bears the brunt of this onslaught of high pressure winds because, while normally the center of the Thermal Low is in southern Nevada, a buildup of pressure in the Great Basin forces the center of that Low to migrate westward. In this way the pattern is arranged for the outflow of air from the Basin into a space which now has lower atmospheric pressure, though ordinarily it would show considerably higher pressure.

As a usual occurrence, the pressure gradient between Burbank or Mines Field and Las Vegas ranges between two and six millibars, with the lower pressure being of course at Las Vegas. During May and June in the periods of foggy weather this differential may even reach ten millibars or more. However, when Santa Ana winds occur it is noted that a very slight rise of pressure at Las Vegas or Kingston above that at Burbank or Mines Field is enough to start the air pouring through the mountain passes into the Los Angeles Basin. A pressure differential in this direction of only one to two millibars is all that is required to bring winds of Beaufort Force six to nine in the valleys.

As was stated above, the Thermal Low is centered over the Los Angeles Basin at this time instead of close to the Arizona-Nevada-California boundary. As a result, it is observed that on the afternoon of the day preceding the strong winds, abnormally high temperatures prevail throughout the Los Angeles Basin. The dew point continues fairly steady and relatively high through the period of maximum temperature. Then it is observed that from two to six hours after the highest temperature is reached the dew point begins to drop sharply, and continues a downward trend until six to nine hours before the high winds subside, from which the trend is gradually upward, with a surge upward as soon as lighter winds prevail. The strong winds arrive from six to nine hours after the dew point begins to fall, placing their appearance approximately twelve hours after the time of maximum temperature.

East of the passes, however, it is noted that the great wind increase is begun shortly after the maximum temperature is reached. At Kingston the wind force becomes high from one to three hours after the maximum temperature is reached, and at Las Vegas the winds rise from three to six hours after the temperature begins to decline.

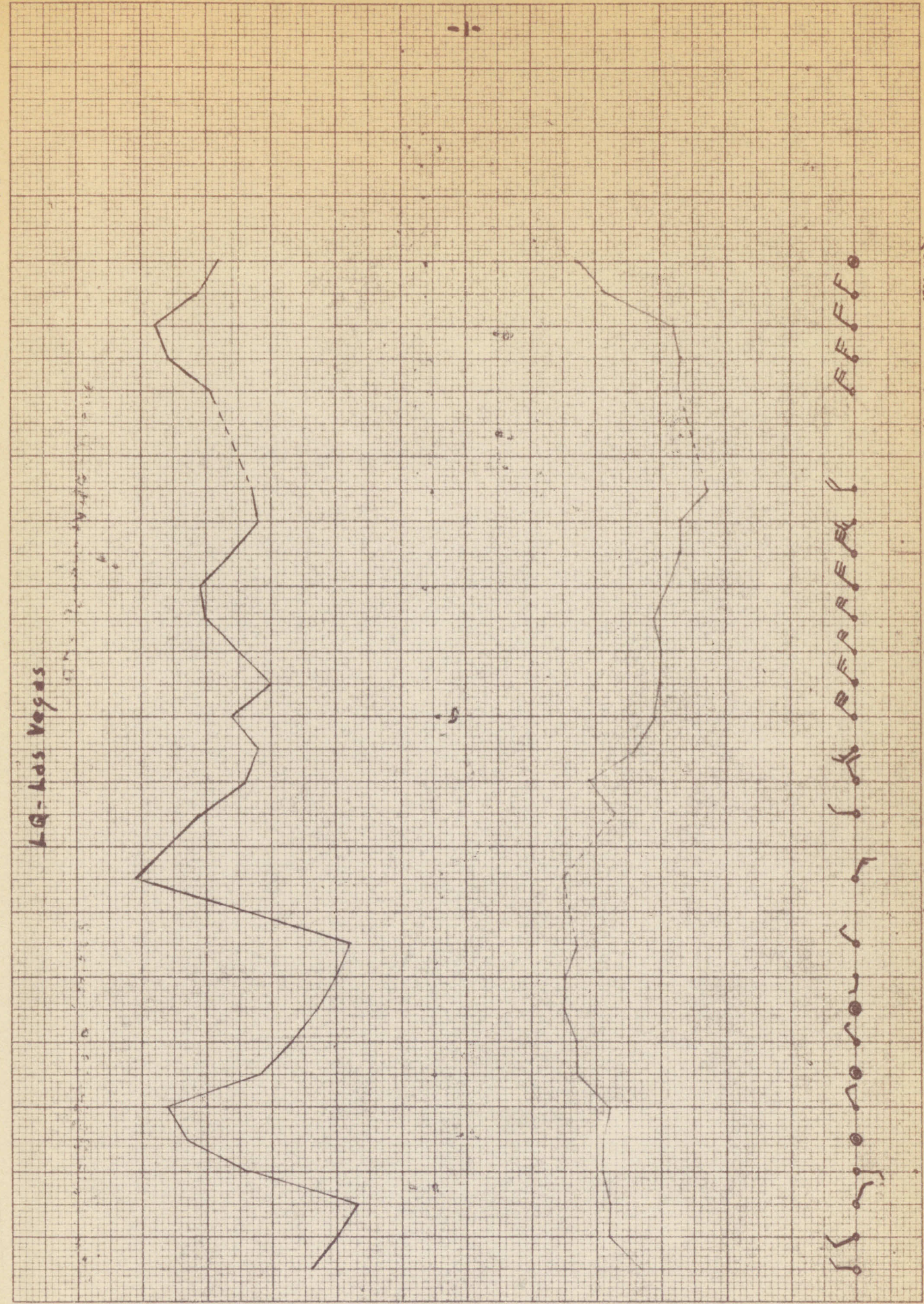
It appears that the high winds reach the lower parts of the Los Angeles Basin about twelve hours after they begin blowing at Kingston, and about nine hours after their increase at Las Vegas. They seem to reach their highest velocities in the lower portion of the San Fernando Valley. Bakersfield and San Diego appear to be situated at the northern and southern perimeter of the high wind area, being less affected by extremes of temperature and dew point, as well as by high winds.

During the passage of the high winds, higher than normal temperatures prevail, but without extreme maximums or minimums occurring.

To conclude, the following basic requirements are necessary for the occurrence of Santa Ana Winds, and their presence should first be ascertained in the preparation of a forecast of these winds:

1. High atmospheric buildup over the Great Basin.
2. Thermal Low over the Los Angeles Basin area.
3. Pressure gradient of one to two millibars from Las Vegas or Kingston to Eurbank or Mines Field.
4. Extremely high maximum temperatures in the Los Angeles Basin on the afternoon before the high winds begin.
5. Falling dew points from two to six hours after time of maximum temperatures and from six to nine hours before high winds begin.
6. Extremely low W-values in raob at North Island for twentyfour hours before high winds begin and during the passage of the strong winds; also relatively low W-values and subsidence indicated in raobs at Oakland.

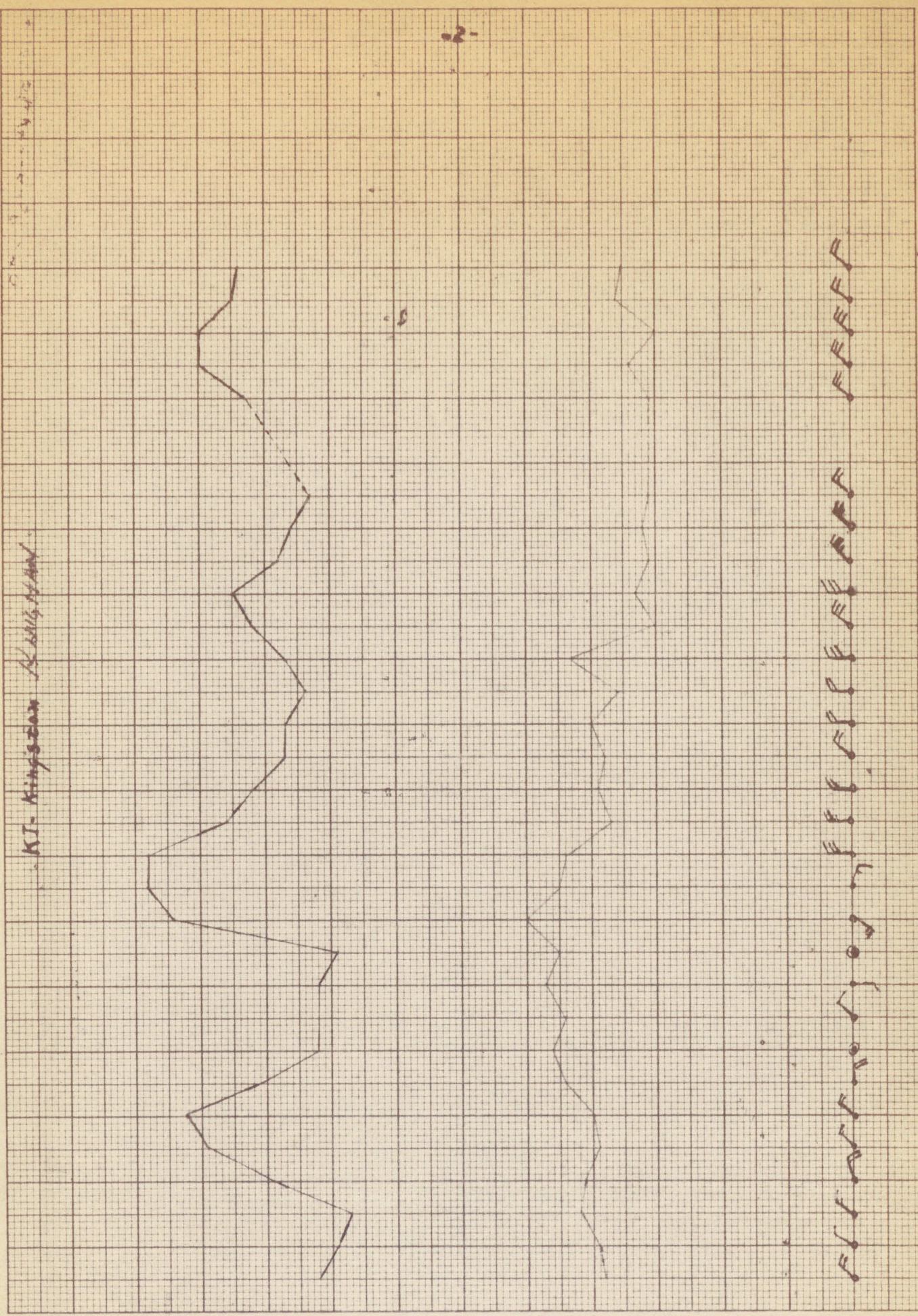
LQ-Las Vegas



Feb 17 1939

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KEUFFEL & ESSER CO., N. Y. NO. 389-11
 10 x 10 to the half inch, 5th lined accentuated.
 Engraving, 7 x 10 in.
 MADE IN U. S. A.



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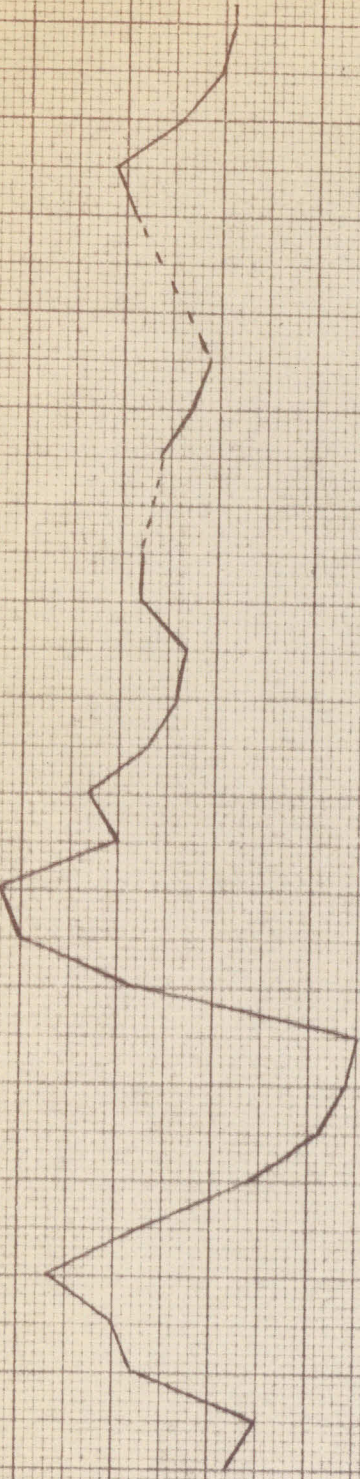
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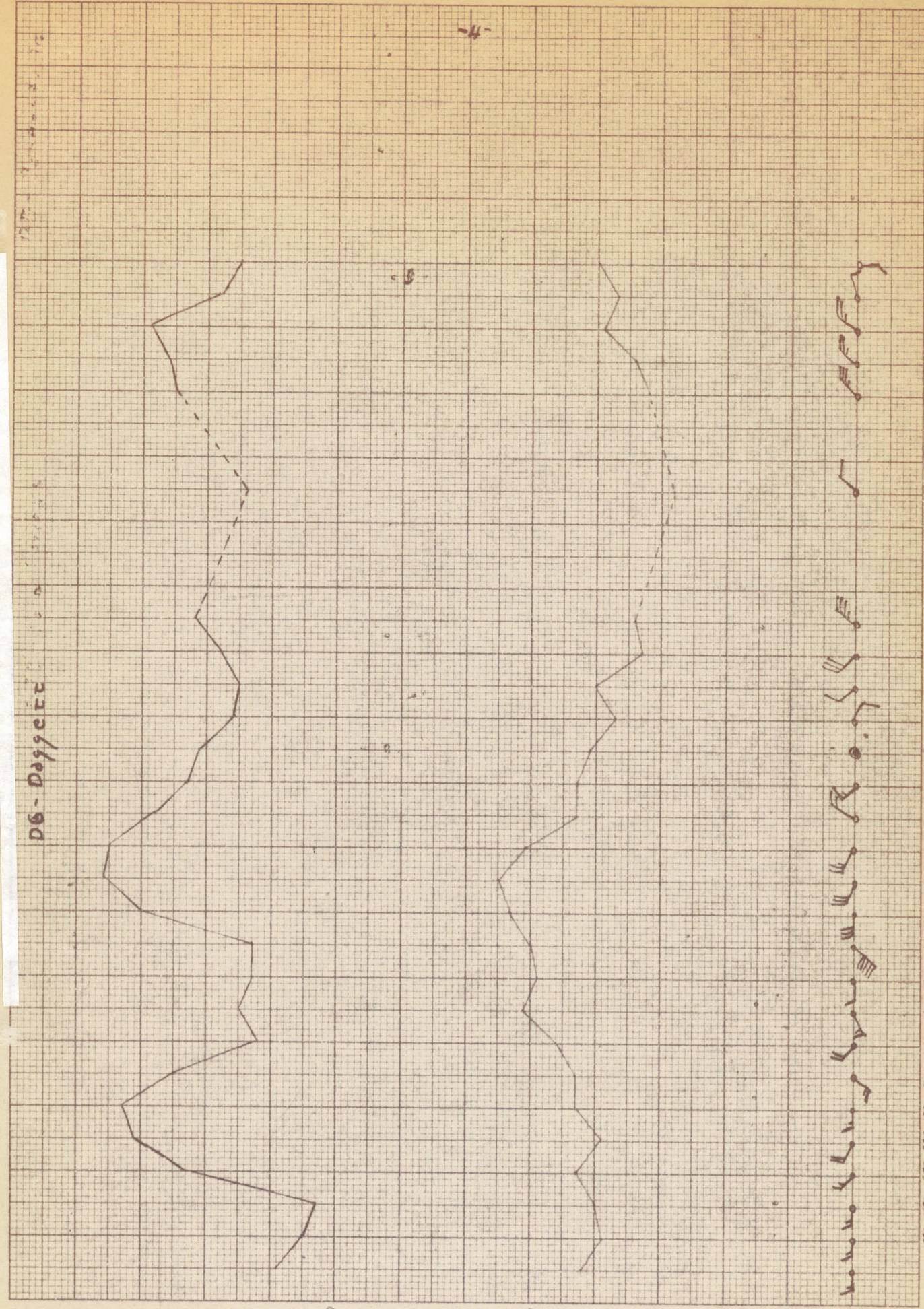
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KEUFFEL & ESSER CO., N. Y. NO. 363-11
 10 x 10 to the half inch, 24 lines across.
 Engraving 7 x 10 in.
 MADE IN U.S.A.

DG-Daggett



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 0330 0630 0930 1230 1530 1830 2130 2430

Feb 14/1939

Feb 15/1939

Feb 16/1939

Feb 17/1939

TWT - Beaufort

°F

80

70

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50

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30

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Dew Point

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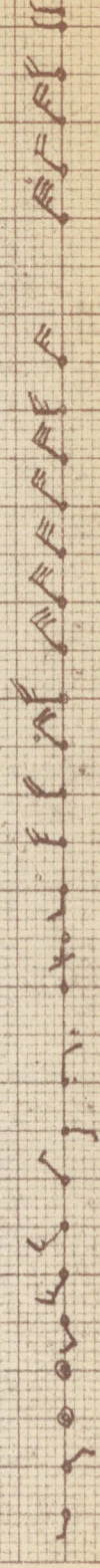
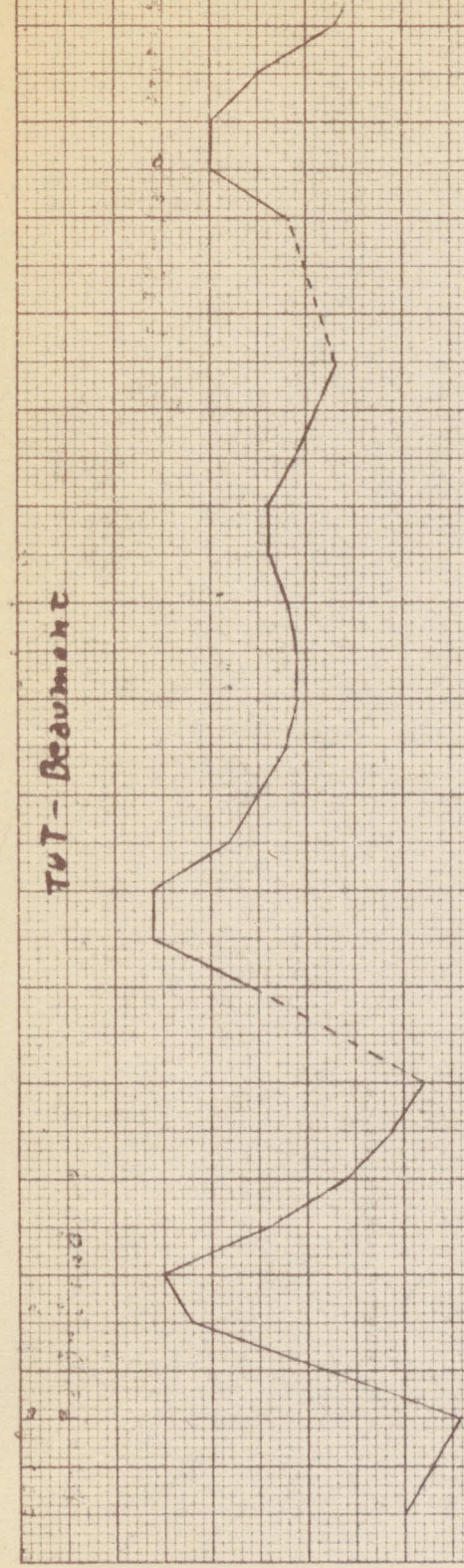
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Feb 14, 1939

Feb 15, 1939

Feb 16, 1939

Feb 17, 1939

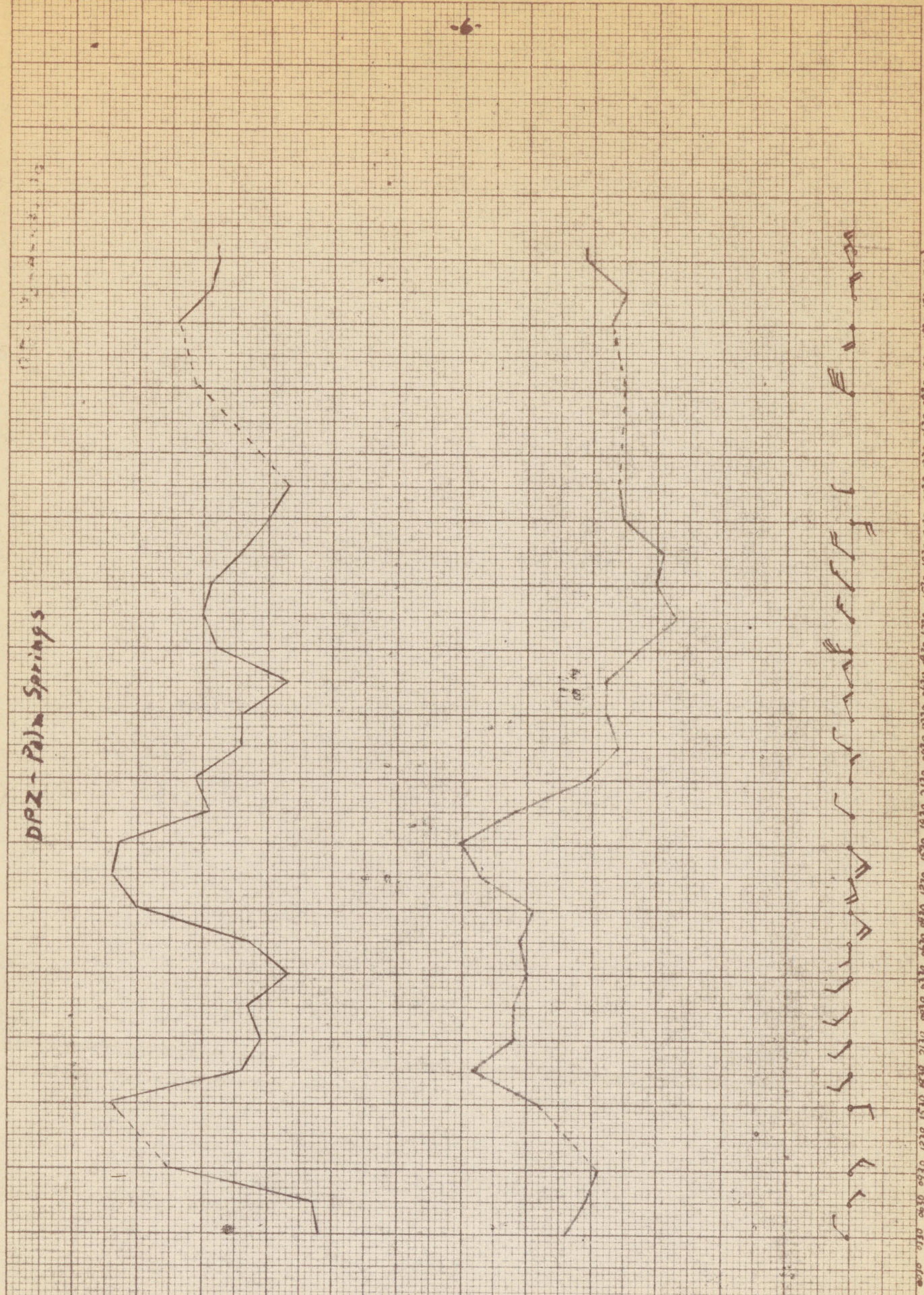
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 Engraving, 7 x 10 in.
 MADE IN U. S. A.

DPZ - Palm Springs

Temp

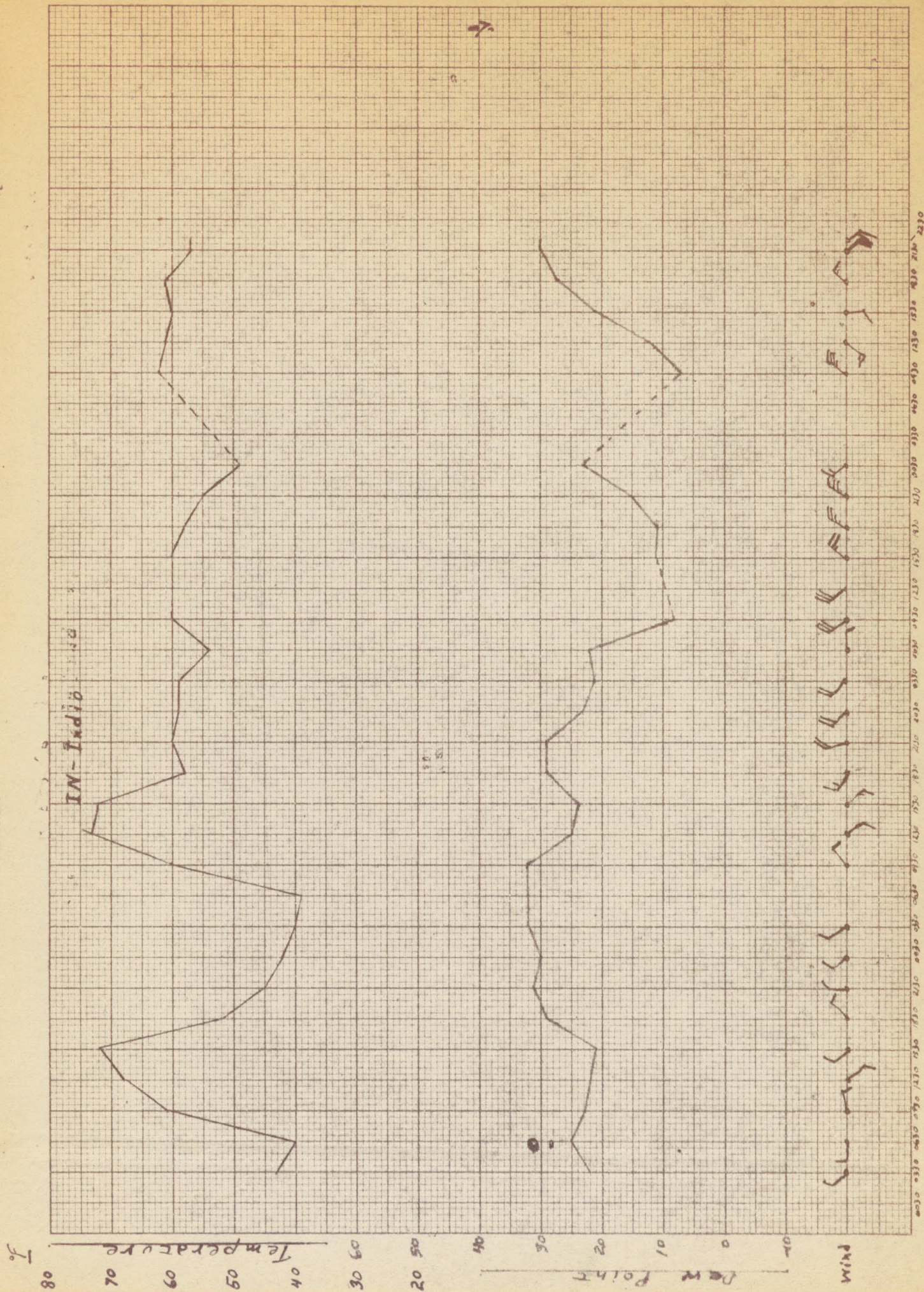
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Wind

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Feb. 14/1939 Feb. 15/1939 Feb. 16/1939 Feb. 17/1939



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Temperature

Dew Point

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Wind

Wind direction and speed (handwritten symbols)

Time (handwritten: 0000, 0100, 0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000, 2100, 2200, 2300, 2400)

Feb. 14, 1939

Feb. 15, 1939

Feb. 16, 1939

Feb. 17, 1939



Feb 14, 1939

Feb 15, 1939

Feb 16, 1939

Feb 17, 1939

T20-Sandberg

°F

Temperatures

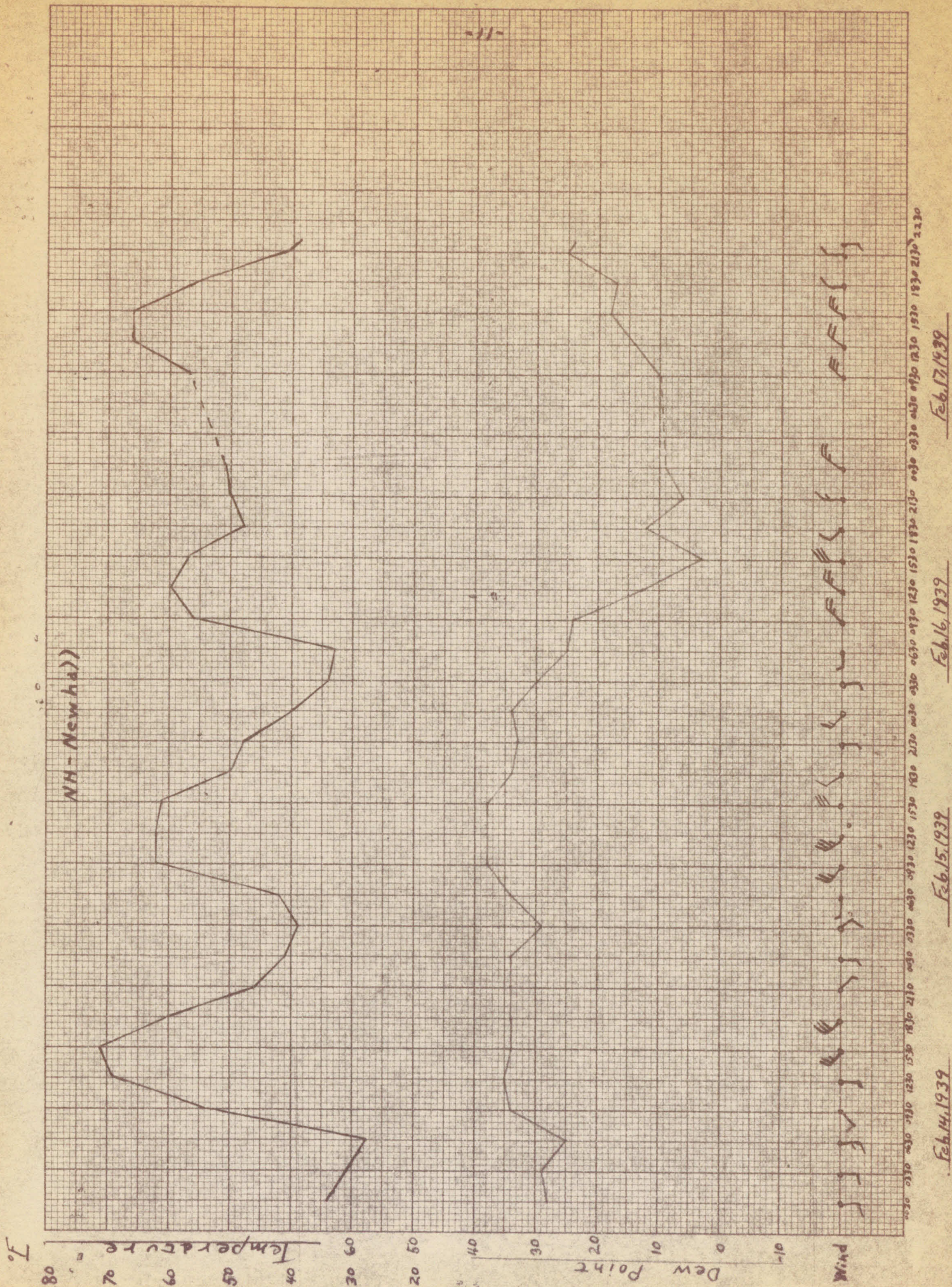


Feb. 14, 1939

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Feb. 17, 1939



KEUFFEL & ESSER CO., N. Y. NO. 389-11
 10 x 10 to the half inch, 5th lines acented.
 Engraving, 7 x 10 in.
 MADE IN U. S. A.



-12-

LA-Los Angeles

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KEUFFEL & ESSER CO., N. Y. NO. 350-11
 10 x 10 to the half inch, 5th lines accented.
 Beginning, 7 x 10 in.
 MADE IN U. S. A.

59 - San Diego

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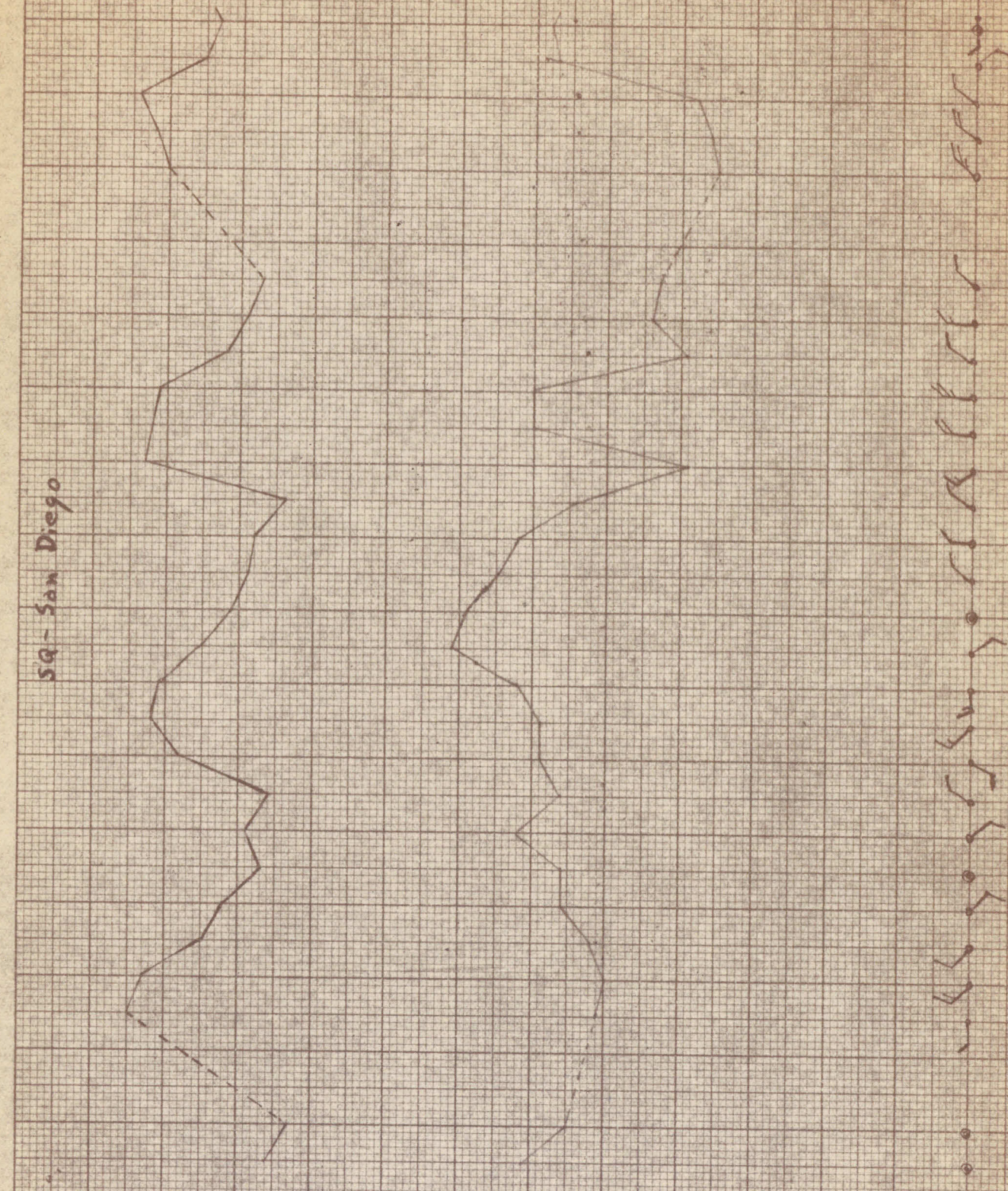
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Temperature



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 Feb 14, 1939
 Feb 15, 1939
 Feb 16, 1939
 Feb 17, 1939

LQ - Las Vegas

Temp

Temperature

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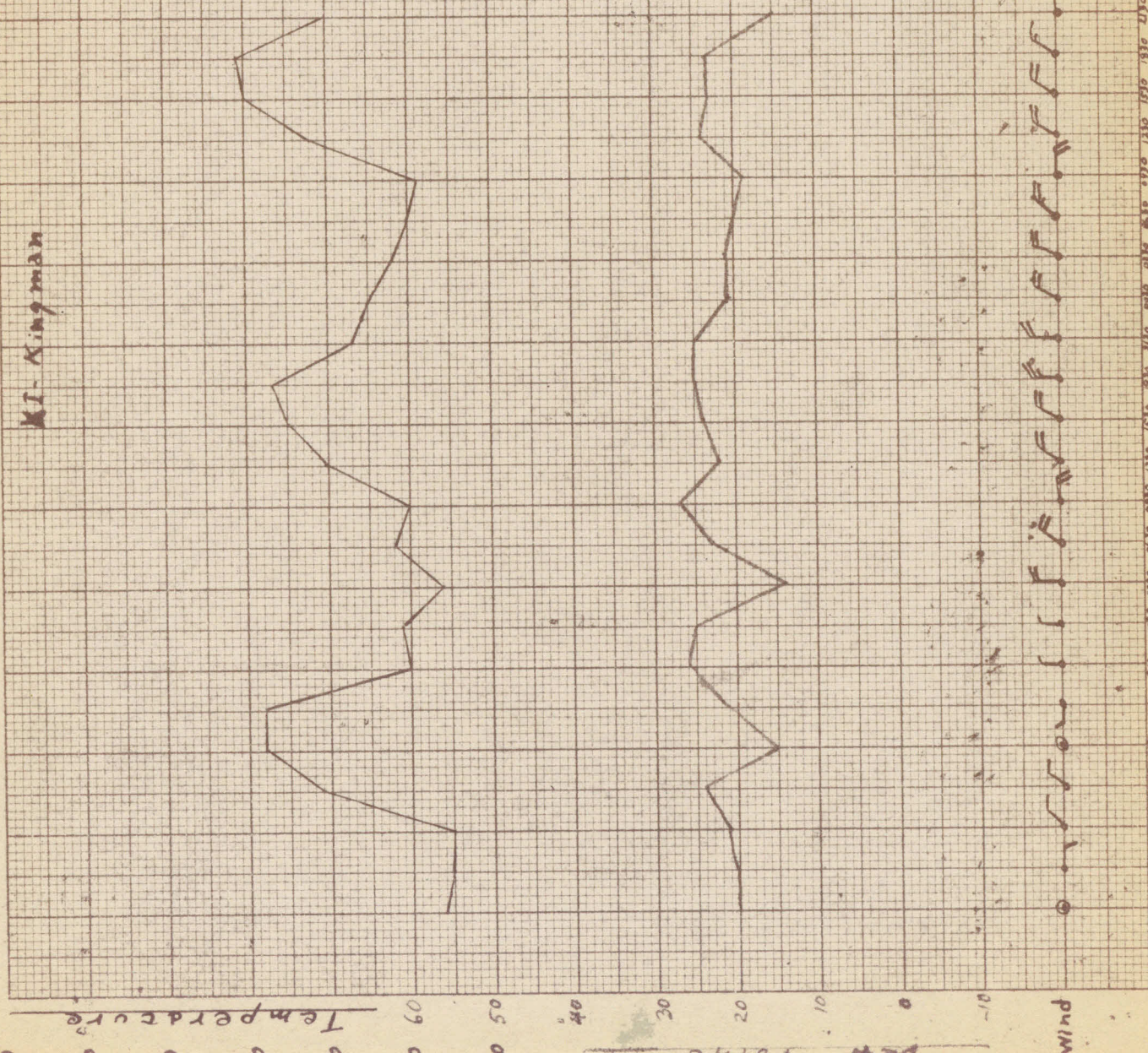
-16-

50000

KI-Kingman

KEUFFEL & ESSER CO., N. Y. NO. 389-11
10 x 10 to the half inch, 5th lines accented.
Engraving, 7 x 10 in.
MADE IN U.S.A.

of



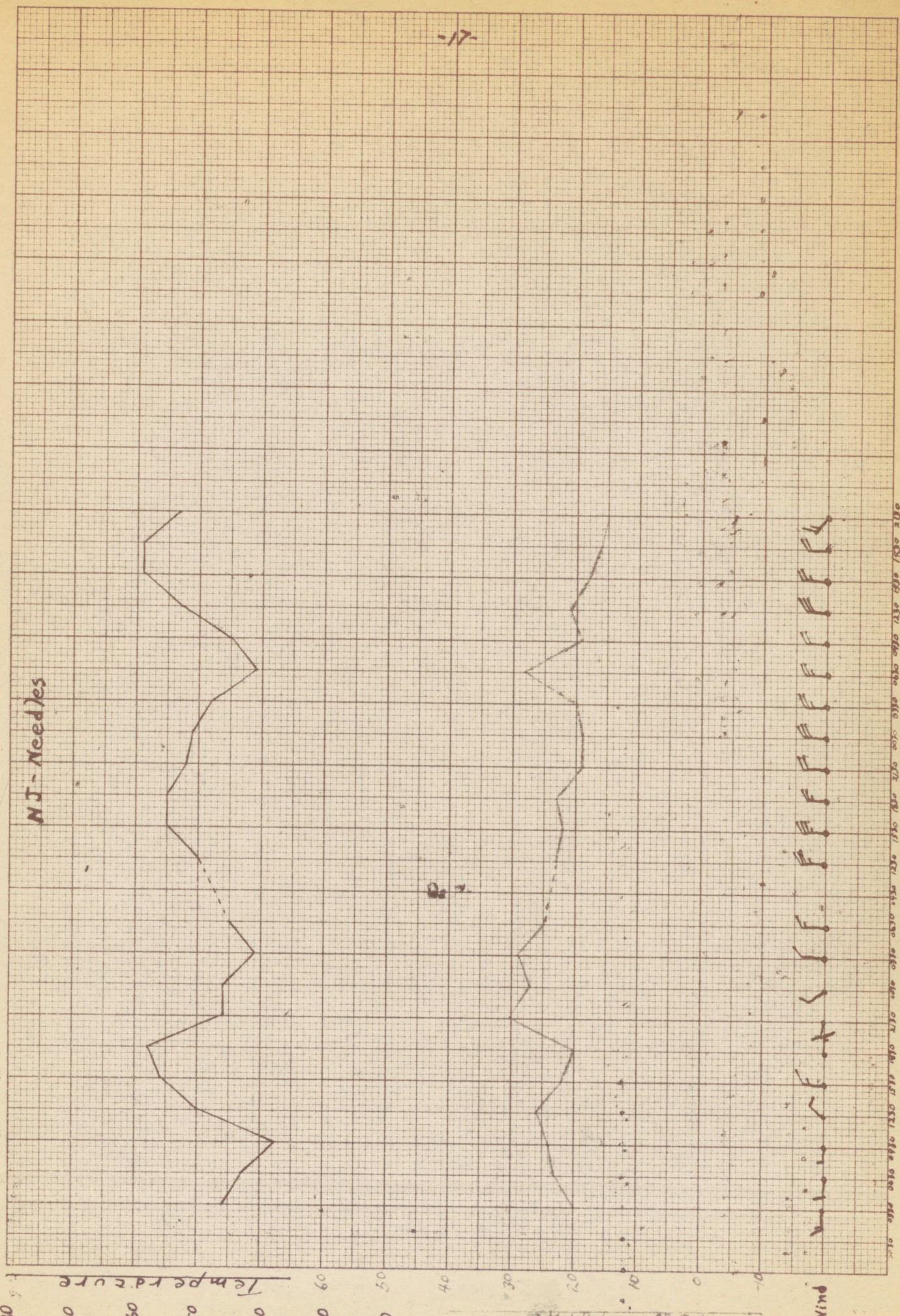
Nov. 20, 1941

Nov. 20, 1941

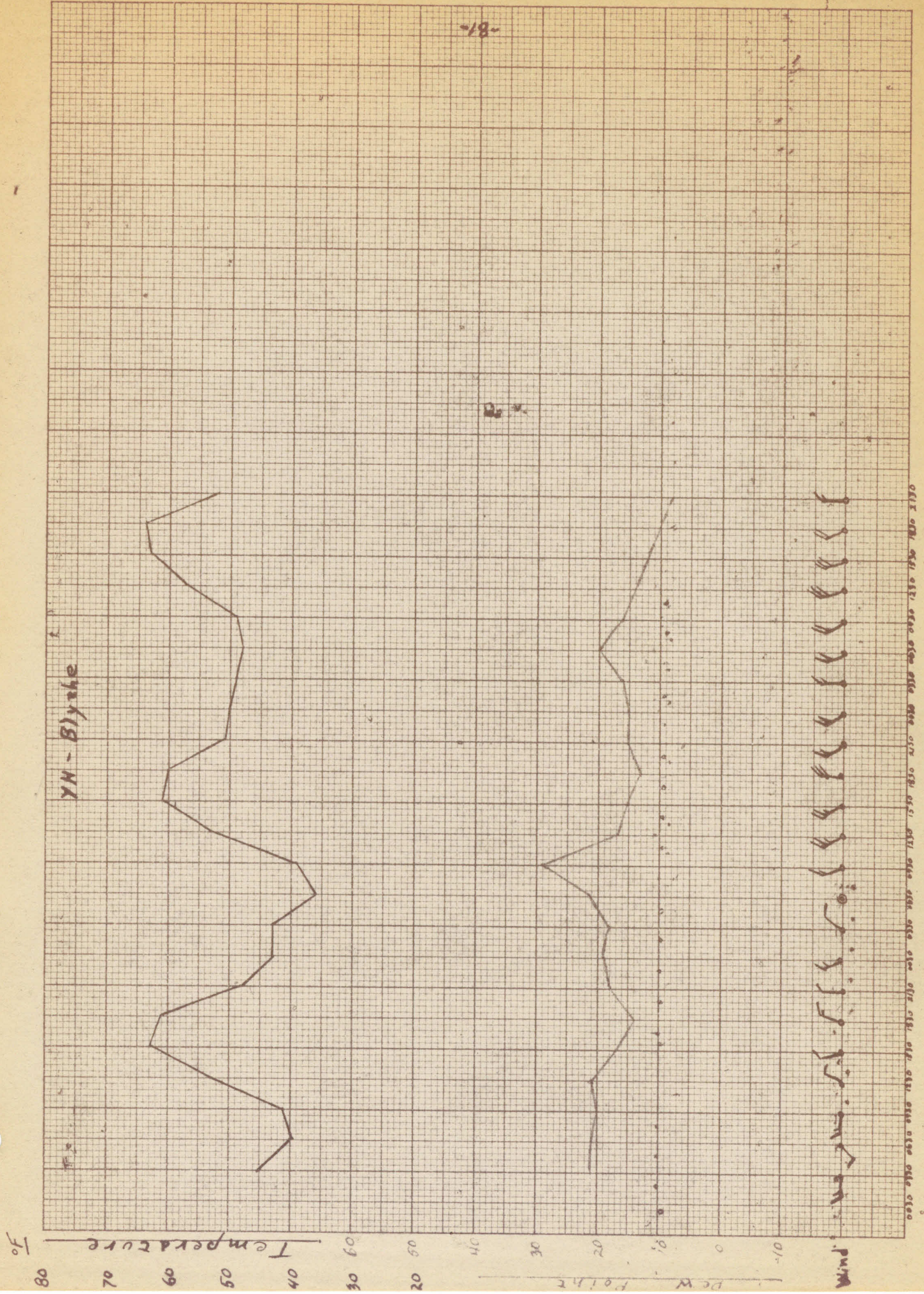
Nov. 19, 1941

-17-

NJ-Needles



Nov. 19, 1941 Nov. 20, 1941 Nov. 21, 1941



Nov. 21, 1941

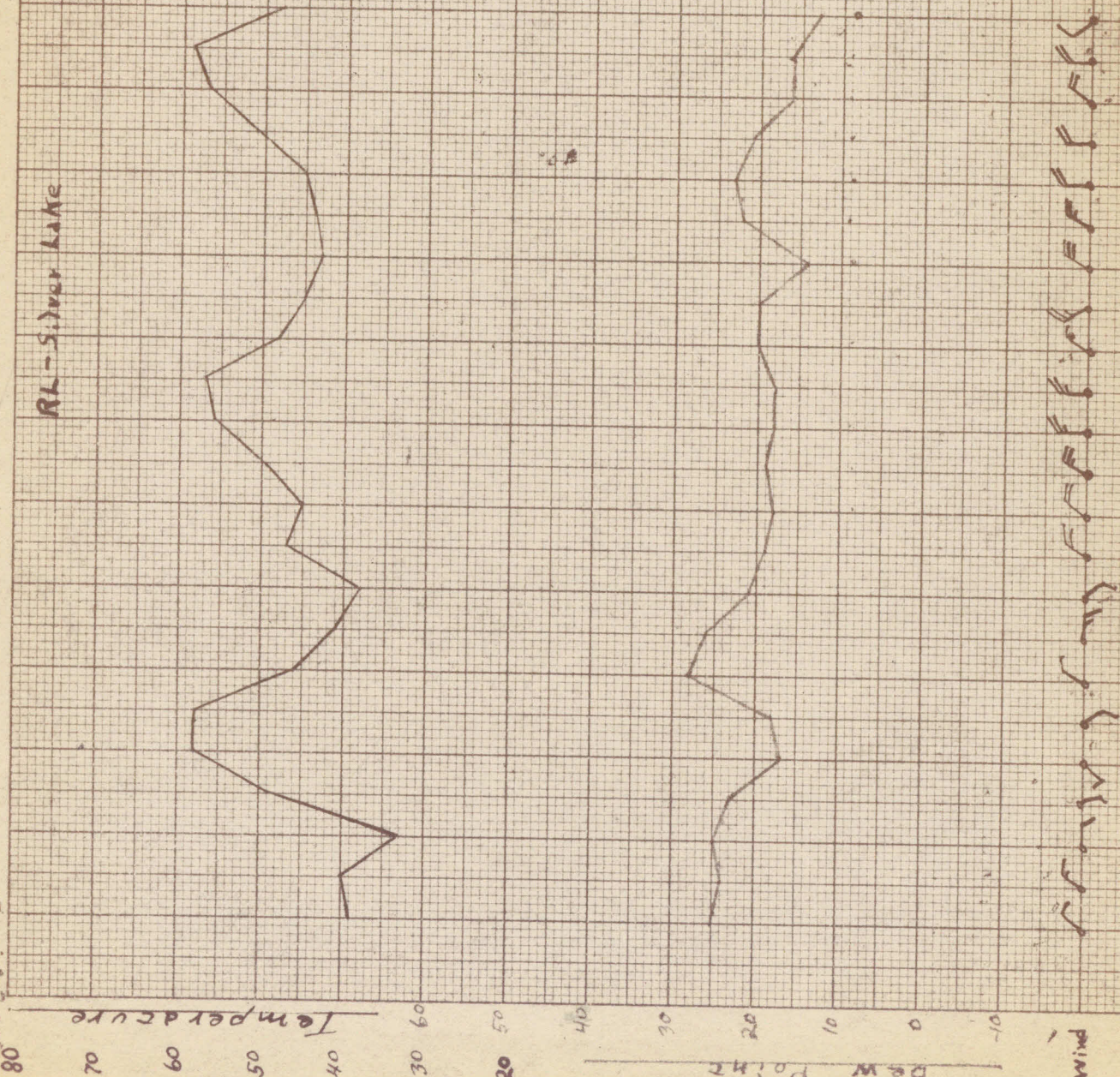
Nov. 20, 1941

Nov. 19, 1941

RL-Silver Lake

of 80

Temperature



0000 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500 2600 2700 2800 2900 3000

Nov. 19, 1941

Nov. 20, 1941

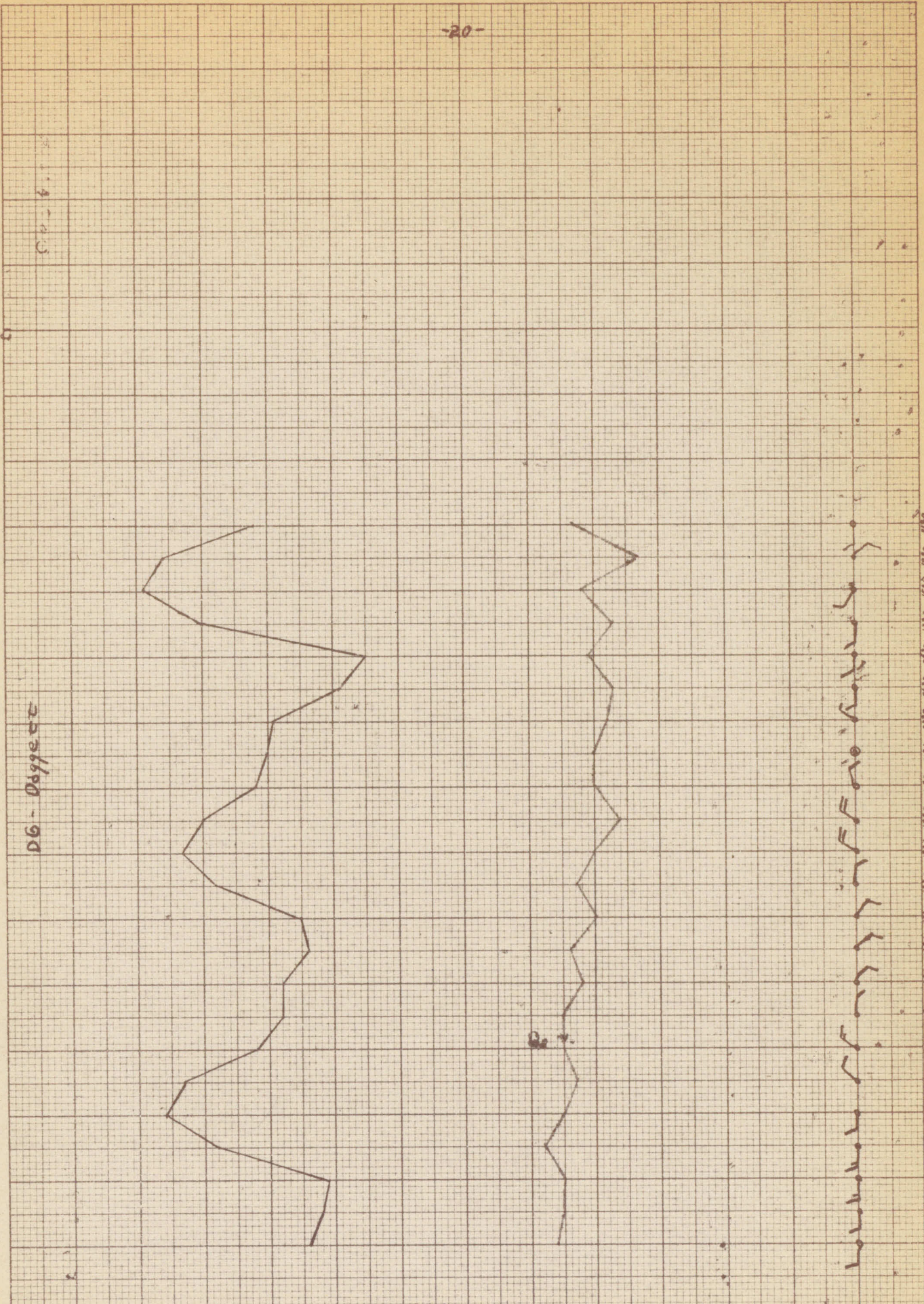
Nov. 21, 1941

Nov. 22, 1941

°F

Temperature

DG - Degree



DEQ - Victorville

Q. 2.

Nov. 21, 1941

Nov. 20, 1941

Nov 19 1941

-22-

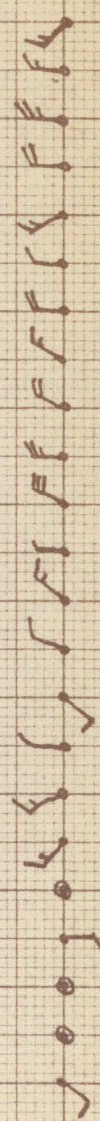
TUT-Beaumont

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Temperature

Dew Point

Wind



Nov. 19, 1941 Nov. 20, 1941 Nov. 21, 1941

-23-

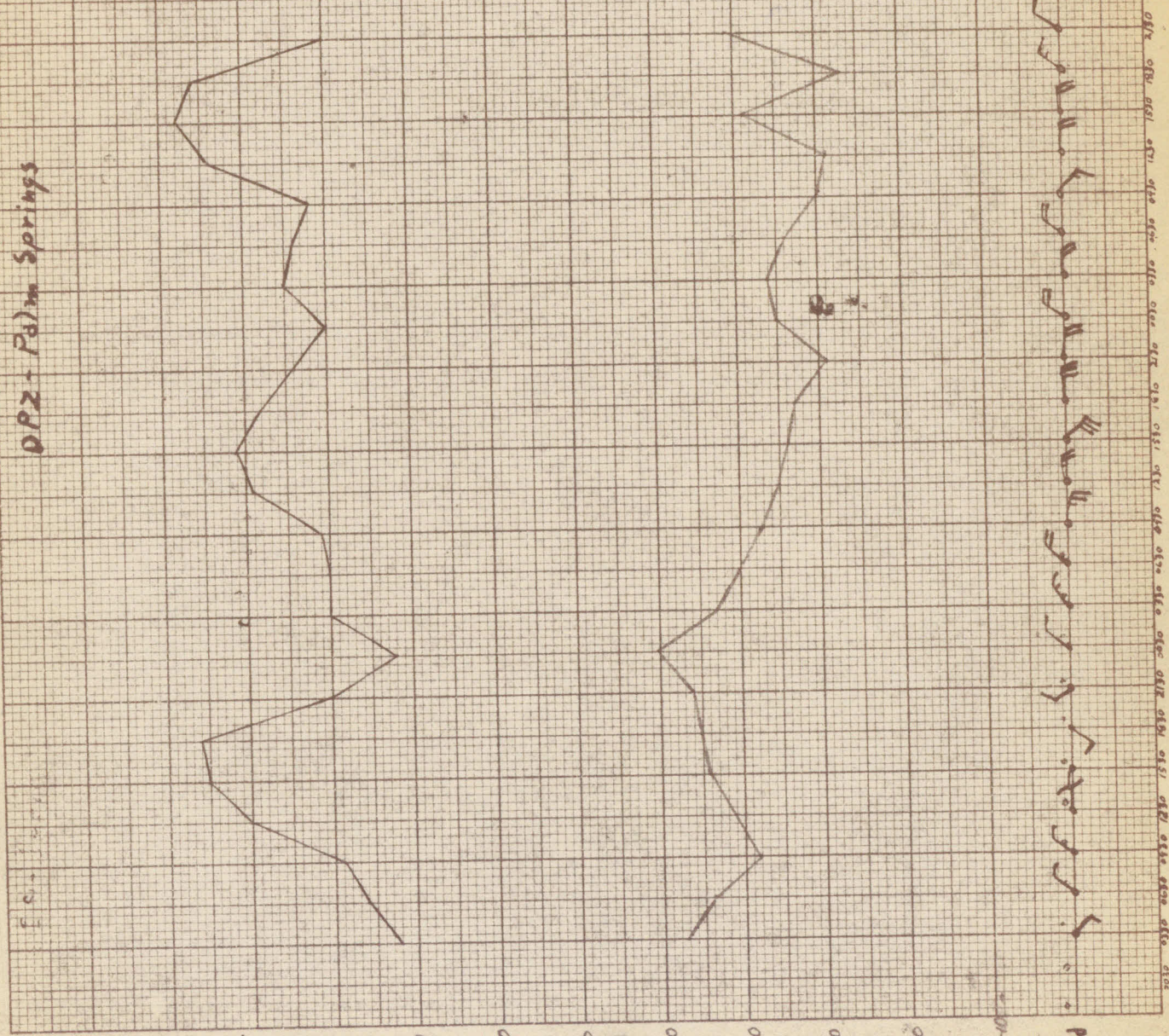
DPZ - Palm Springs

°F

Temperature

Dew Point

Wind



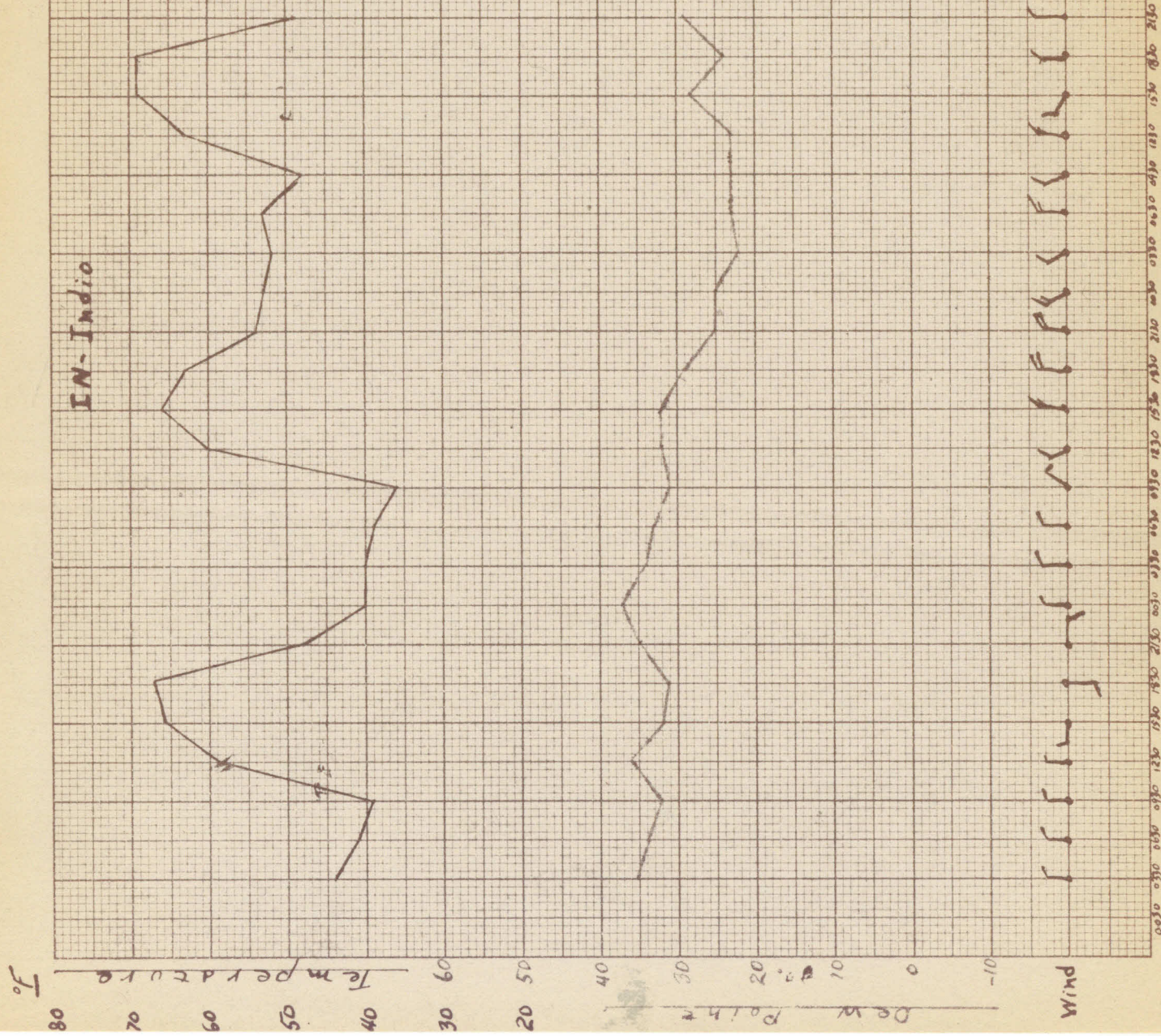
Nov. 24, 1941

Nov. 20, 1941

Nov. 19, 1941

-24-

IN-India



Nov. 26, 1941

Nov. 20, 1941

Nov. 19, 1941

BD - Baker's field

°F

Temperature

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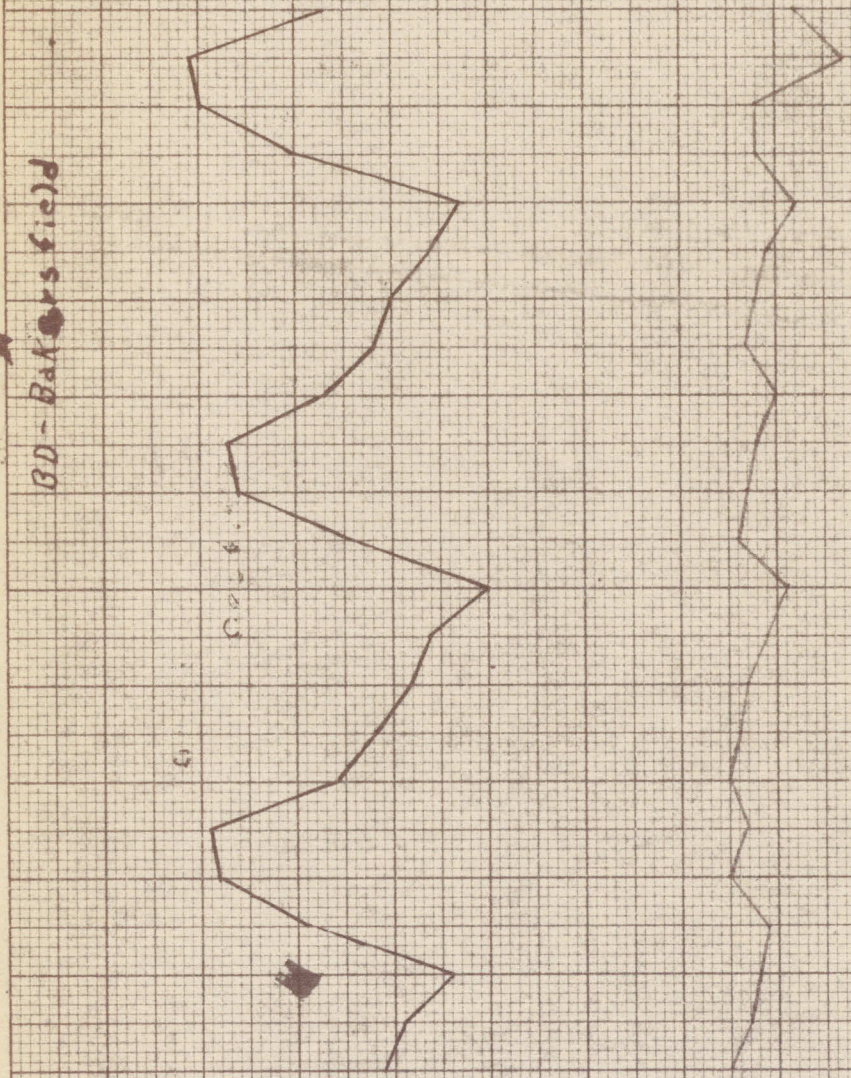
20

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-10

Wind

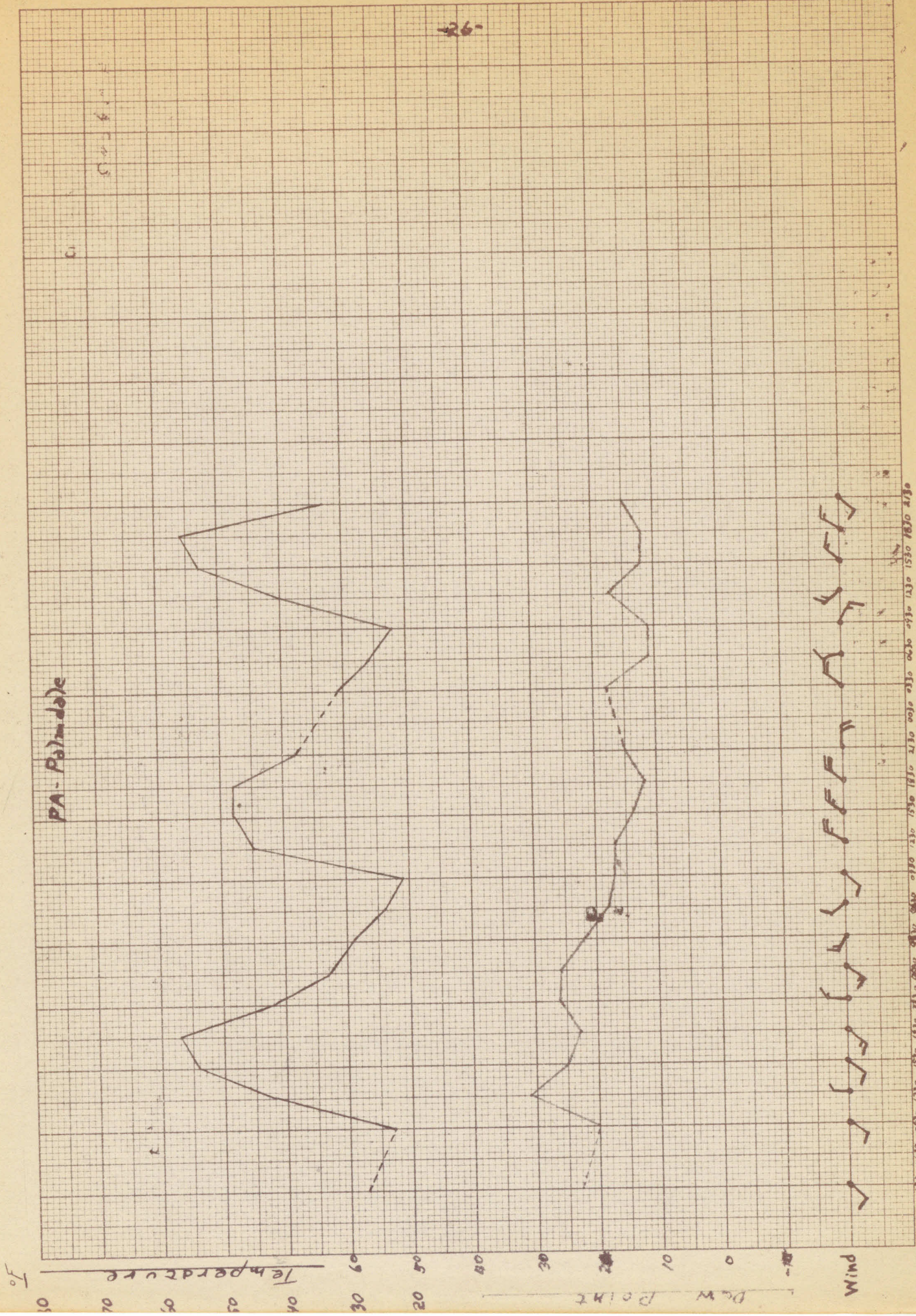


Nov 19 1941

Nov 24 1941

Nov 20 1941

Nov 19 1941



T2B - Sandberg

°F

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Temperature

Dew Point

Wind

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Nov. 19, 1941 Nov. 20, 1941 Nov. 21, 1941

Nov. 21, 1941

Nov. 20, 1941

Nov. 19, 1941

NH - New Haven

°F

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-30

-40

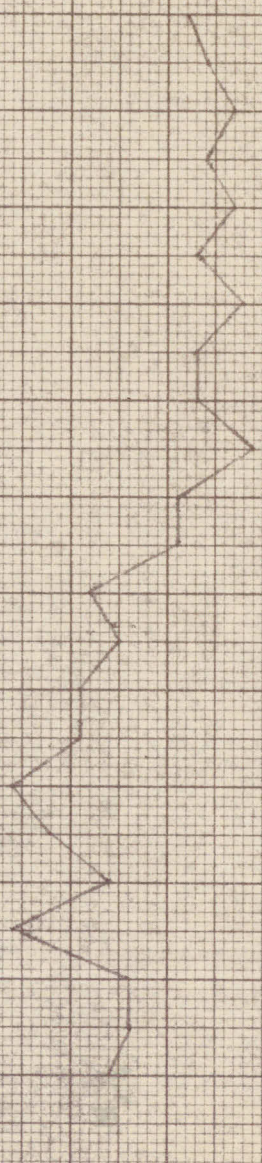
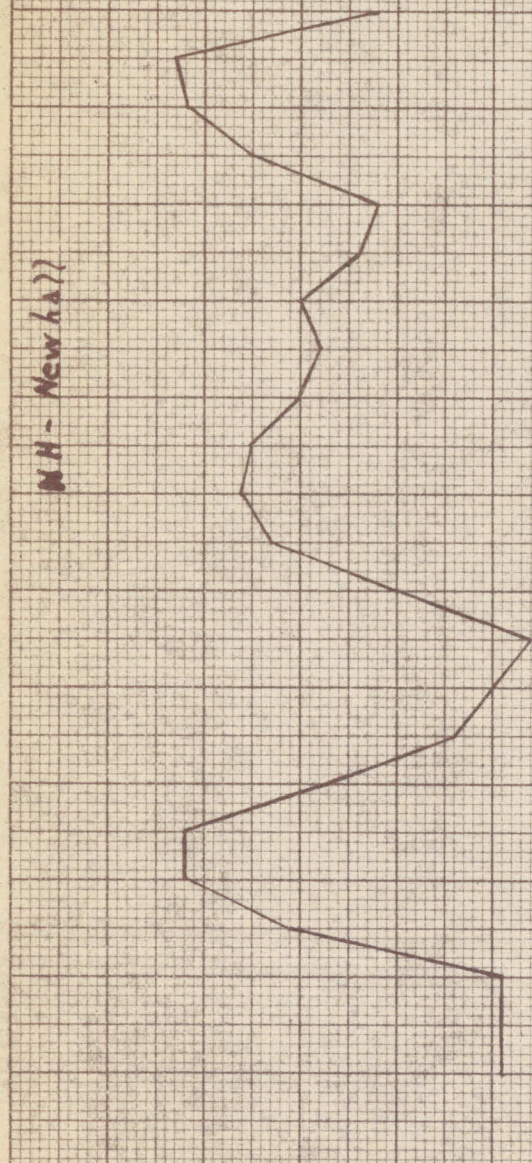
-50

-60

Temperature

Point

Wind



Nov. 21, 1941

Nov. 20, 1941

Nov. 19, 1941

KEUFFEL & ESSER CO., N. Y. NO. 389-11
 10 x 10 to the half inch, 5th lines accented.
 Engraving, 7 x 10 in.
 MADE IN U. S. A.

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Bu - Burbank

°F

Temperature

80

70

60

50

40

30

20

10

0

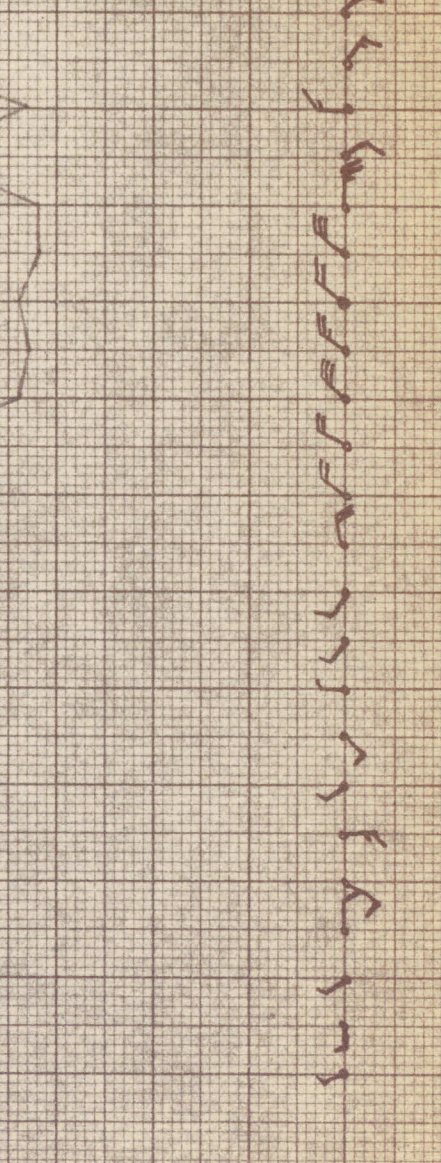
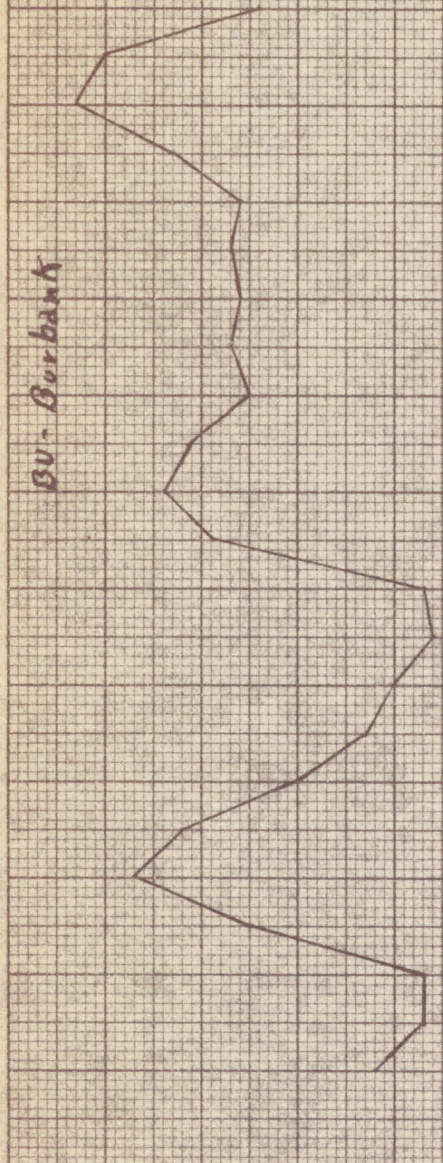
Wind

80

70

60

50



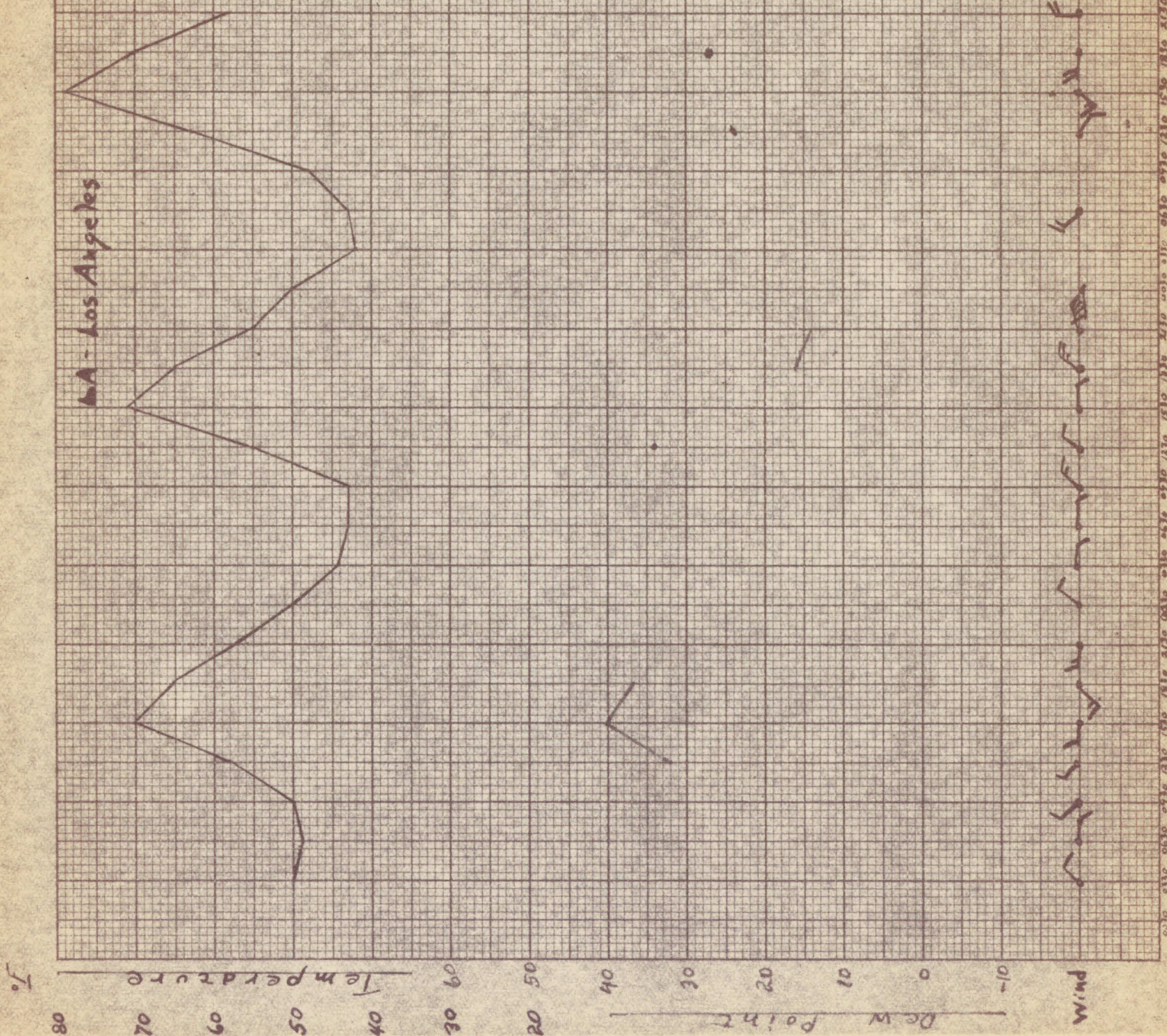
1930 1935 1940 1945 1950 1955 1960

Nov. 19, 1941

Nov. 20, 1941

Nov. 21, 1941

LA - Los Angeles



Nov. 19, 1941

Nov. 20, 1941

Nov. 21, 1941

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SQ - San Diego

Hand-drawn map of San Diego on grid paper. The map shows the coastline of San Diego, with a dashed line indicating a specific route or boundary. The coastline is irregular, with several bays and peninsulas. A dashed line runs from the northern tip of the peninsula down to the southern tip, following the general shape of the coastline. The map is drawn on a grid of small squares.

San Diego

Hand-drawn map of San Diego on grid paper. The map shows the coastline of San Diego, with a dashed line indicating a specific route or boundary. The coastline is irregular, with several bays and peninsulas. A dashed line runs from the northern tip of the peninsula down to the southern tip, following the general shape of the coastline. The map is drawn on a grid of small squares.

一、二、三、四、五、六、七、八、九、十、十一、十二、十三、十四、十五、十六、十七、十八、十九、二十、二十一、二十二、二十三、二十四、二十五、二十六、二十七、二十八、二十九、三十、三十一、三十二、三十三、三十四、三十五、三十六、三十七、三十八、三十九、四十、四十一、四十二、四十三、四十四、四十五、四十六、四十七、四十八、四十九、五十、五十一、五十二、五十三、五十四、五十五、五十六、五十七、五十八、五十九、六十、六十一、六十二、六十三、六十四、六十五、六十六、六十七、六十八、六十九、七十、七十一、七十二、七十三、七十四、七十五、七十六、七十七、七十八、七十九、八十、八十一、八十二、八十三、八十四、八十五、八十六、八十七、八十八、八十九、九十、九十一、九十二、九十三、九十四、九十五、九十六、九十七、九十八、九十九、一百。

[illegible]

Nov. 19, 1941

Nov. 20, 1941

Nov. 21, 1941

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