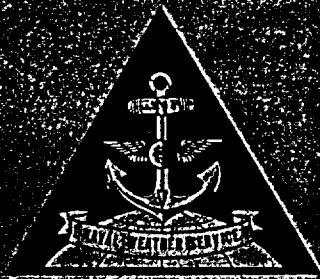
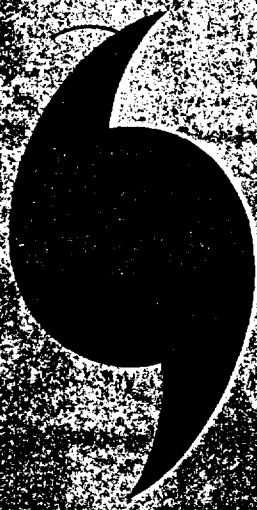


JTWC DIRECTOR

# ANNUAL TYPHOON REPORT



1959



FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER

Guam, Mariana Islands

U. S. FLEET WEATHER CENTRAL/  
JOINT TYPHOON WARNING CENTER  
COMNAVMARIANAS BOX 12  
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COMMANDING

1959

ANNUAL TYPHOON REPORT

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DIRECTOR, JOINT TYPHOON WARNING CENTER

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SECTION I

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**SECTION II**

**INTRODUCTION**

SECTION II  
INTRODUCTION

This report is primarily a summarization of Western North Pacific typhoons and Central North Pacific hurricanes (one) which occurred during the calendar year 1959.

Section III is a general summary of the 1959 Typhoon Season and pertains to the number of typhoons, areas of formation and development, physical characteristics, movement, etc. Section IV contains a discussion and evaluation of procedures for the detection of tropical cyclones, and techniques used both in preparing forecasts and in typhoon reconnaissance. Section V contains a short narrative of each typhoon, in chronological order, with post-analysis charts showing best track, eye position fixes, speed of movement, intensity and forecast positions. Also included are tables containing position verification data, and reconnaissance aircraft fixes. Section VI treats of destructive effects of the 1959 typhoons. This information is by no means complete, but merely touches on known losses, using only reports which were readily available to this Command.

Worthy of mention is the fact that this is the first Annual Typhoon Report published by Fleet Weather Central/Joint Typhoon Warning Center, Guam. Effective on 1 May 1959, CINCPAC, through CINCPACFLT, redesignated Fleet Weather Central, Guam as Fleet Weather Central/Joint Typhoon Warning Center (FWC/JTWC), Guam. The new entity was assigned the following additional responsibilities:

1. To provide warnings to U.S. Government agencies for all tropical cyclones west of 180 degrees longitude.

2. To determine typhoon reconnaissance requirements and priorities.

3. To conduct investigative and post analysis programs including the preparation of annual typhoon summaries.

4. To conduct forecasting and detection research as practicable.

Tokyo Weather Central, assisted as necessary by Fleet Weather Facility Yokosuka, was designated as alternate JTWC in case of failure of FWC/JTWC, Guam. Responsible for the issuance of tropical warnings for the Central North Pacific, east of 180 degrees, is the Joint Hurricane Warning Center in Hawaii, a coordinated agency composed of the U.S. Weather Bureau, Honolulu, the Air Force Kunia Weather Center, and Fleet Weather Central, Pearl Harbor. In practice, coordinated tropical warnings are issued both by the U.S. Weather Bureau, Honolulu and Fleet Weather Central, Pearl Harbor.

The JTWC, which is an integral section of FWC/JTWC, Guam, is staffed by two Air Force and two Navy meteorologists, and three enlisted men from each service. The senior Air Force Officer has been designated as the Director, JTWC.

Prior to the activation of FWC/JTWC, the Air Force and Navy both had various weather units in the Northwest Pacific assigned the responsibility of issuing tropical warnings. It can be easily understood that coordination of tropical warnings between widely

separated Air Force and Navy units was at times difficult or impossible due to communications problems. Thus it was not uncommon for uncoordinated warnings to be issued. For this reason, a single but joint unit, coordinating directly with the reconnaissance unit is believed to be the most efficient method of providing tropical warnings to all U.S. Government agencies in the Northwest Pacific.

Throughout this report, the word "miles" should be construed to mean "nautical miles" unless other wise indicated.



SECTION III

SUMMARY OF THE 1959 TYPHOON SEASON

### SECTION III

#### SUMMARY OF THE 1959 TYPHOON SEASON

##### A. NUMBER OF TYPHOONS

In 1959 a total of 65 tropical disturbances occurred over the Pacific Ocean west of 140 degrees west and north of the Equator (See page 11 entitled "Tropical Cyclones of 1959"). Of these, 59 were assigned cyclone numbers and 33 were named. Tropical disturbances existed on 177 different calendar days, which is higher than the past 50-year average of 147 days. The maximum period between successive disturbances was 48 days. This period occurred from 11 May to 28 June. However, August had 26 days and September 30 days with tropical disturbances. This is consistent with historically observed peaks of tropical cyclone activity.

Of the 65 tropical disturbances, 17 became typhoons, which is less than the normal yearly average of 19. The typhoons, in order of occurrence, were: TILDA, BILLIE, ELLEN, GEORGIA, IRIS, JOAN, LOUISE, PATSY, SARAH, VERA, AMY, CHARLOTTE, DINAH, EMMA, FRED A, GILDA and HARRIET. In addition, 9 other tropical disturbances, namely RUEY, SALLY, WILDA, CLARA, KATE, NORA, OPAL, WANDA and BABS, never exceeded tropical storm intensity. There was also one hurricane, Hurricane DOT, which occurred over the Central Pacific in August.

For a composite chart showing the tracks of all typhoons of the 1959 season, refer to page 13. Typhoon tracks for each month having one or more typhoons are included on pages 14 through 20.

##### B. AREA OF FORMATION AND DEVELOPMENT

As in the past, the tropical disturbances of 1959 were observed

to form within the normal typhoon spawning grounds of the tropical and subtropical western North Pacific. These disturbances were noted to have developed from vortices which, in general, were associated originally with easterly waves or the Intertropical Convergence Zone. Exceptions to this were ELLEN and GEORGIA which were formed as a result of the fracturing of polar troughs which extended to tropical latitudes.

Five of the 17 typhoons were first detected within 300 miles of Guam. They were, in order of occurrence, typhoons ELLEN, JOAN, LOUISE, SARAH and VERA. One disturbance, Typhoon PATSY, formed in the vicinity of 180 degrees longitude and spent her entire life oscillating northward about this meridian. Three of the typhoons LOUISE, SARAH and EMMA, were noted to have reached typhoon intensity at an abnormally slow rate, while another three, GEORGIA, IRIS and FREDA, developed to full typhoon intensity in a matter of hours.

#### C. SIZE AND INTENSITY OF TYPHOONS

Typhoons of the 1959 season were observed to be generally widespread in extent as compared with those of previous years. Only four typhoons, BILLIE, IRIS, PATSY and AMY, were noted to be of small areal extent, while typhoons JOAN, SARAH and VERA developed to very large dimensions and individually became the dominant feature of the Western Pacific circulation. It was the latter three which caused the greatest destruction and damage. For details of the damage caused, see SECTION VI, "Destructive Effects of Typhoons."

The two largest and most intense typhoons of 1959 were JOAN and VERA. Winds estimated by reconnaissance aircraft observers were 200

knots in JOAN and 175 knots in VERA. Both had sea level pressures below 900 millibars; JOAN's minimum central pressure was 891 millibars and VERA went as low as 896 millibars. For a comparison of the various significant parameters associated with each typhoon of 1959 see page 21, entitled "Typhoon Summation Data Sheet."

#### D. MOVEMENT OF TYPHOONS

Weather reconnaissance aircraft fixes supplemented by auxiliary charts and detailed map analyses provided sufficient information for determining, with reasonable accuracy, the tracks of the typhoons.

During their incipient stages the storms were observed to generally move in a westerly to west-northwesterly direction at average speeds of 8 to 12 knots. Three of the more important exceptions were typhoons ELLEN, GEORGIA and PATSY. All three originated north of 17 degrees and moved in a more northerly direction than the rest.

Thirteen of the typhoons recurved into the higher latitudes and subsequently became extra-tropical systems. Three late-season typhoons, CHARLOTTE, EMMA and FREDa, recurved fairly sharply, while the remainder recurved more gradually. Two typhoons, GILDA and HARRIET, showed little evidence of recurvature, and HARRIET actually moved south of west while passing through the central Philippine Islands. IRIS and JOAN showed evidence of recurvature but both dissipated after entering the China Coast.

Of those typhoons which recurved, eight showed a definite deceleration before recurvature and acceleration after recurvature, while typhoons, VERA, AMY and FREDa showed no noticeable deceleration prior to recurvature.

TROPICAL CYCLONES OF 1959

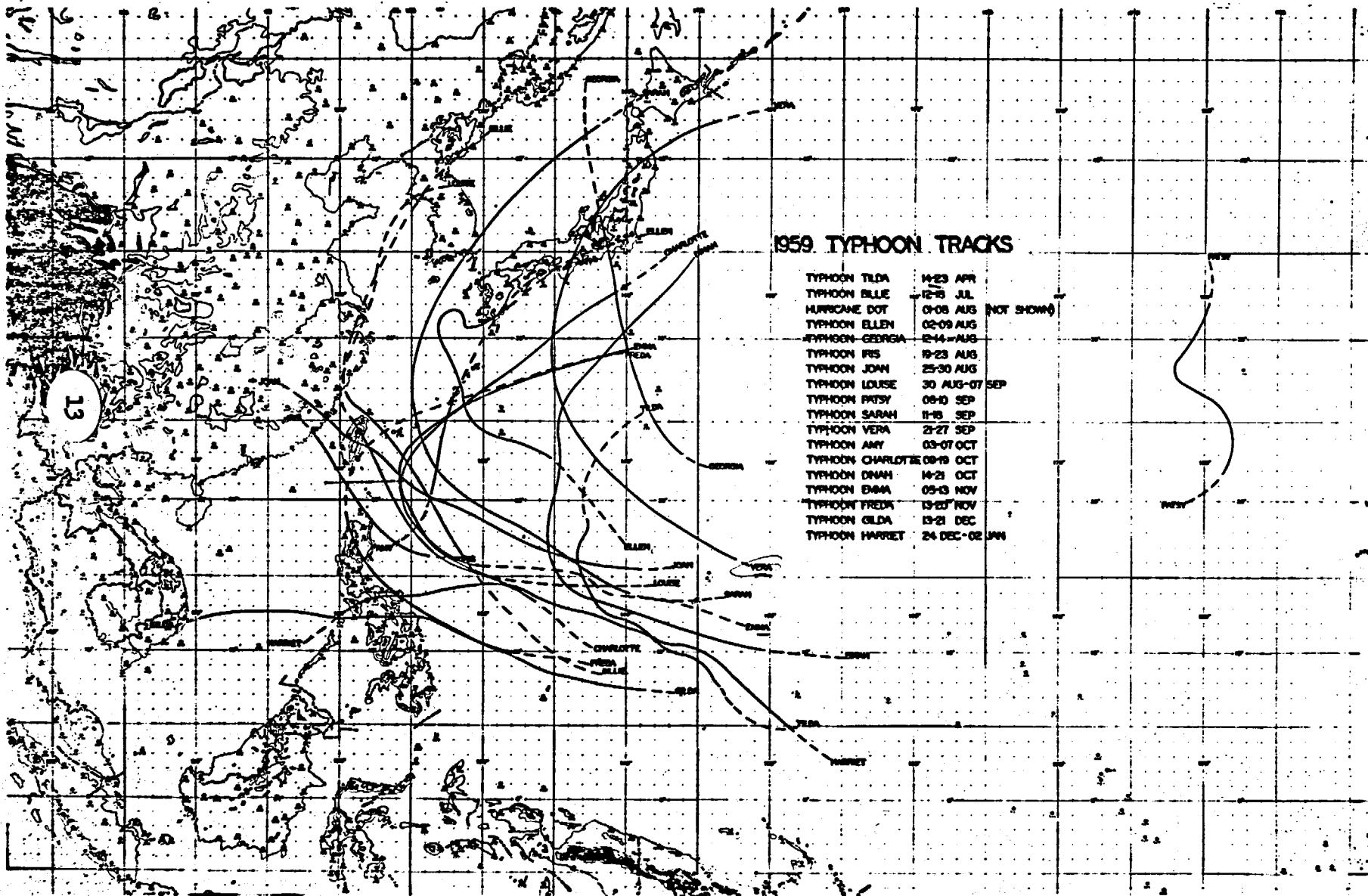
| CYCLONE                           | PERIOD                     |
|-----------------------------------|----------------------------|
| 01. Investigation                 | 24 Feb                     |
| 02. Tropical Storm RUBY (3)       | 27 Feb - 01 Mar            |
| 03. Tropical Storm SALLY (10)     | 04 Mar - 13 Mar            |
| 04. Typhoon TILDA                 | 14 Apr - 23 Apr            |
| 05. Investigation                 | 01 May                     |
| 06. Investigation                 | <del>11 May</del>          |
| * Tropical Depression VIOLET (2)  | 28 Jun - 29 Jun            |
| * Tropical Storm WILDA (3)        | 04 Jul - 06 Jul            |
| 07. Tropical Depression ANITA (3) | 05 Jul - 07 Jul            |
| 08. Typhoon BILLIE                | <del>09 Jul - 18 Jul</del> |
| ** Tropical Storm CLARA (7)       | 16 Jul - 22 Jul            |
| 09. Investigation                 | 17 Jul                     |
| 10. Investigation                 | 20 Jul                     |
| 11. Investigation                 | 25 Jul                     |
| <del>** Hurricane DOT</del>       | <del>01 Aug - 08 Aug</del> |
| 12. Typhoon ELLEN                 | 31 Jul - 09 Aug            |
| 13. Tropical Depression FRAN (2)  | 11 Aug - 12 Aug            |
| 14. Typhoon GEORGIA               | 12 Aug - 14 Aug            |
| 15. Tropical Depression HOPE (3)  | 17 Aug - 19 Aug            |
| 16. Investigation                 | 17 Aug                     |
| 17. Investigation                 | 19 Aug - 20 Aug            |
| 18. Typhoon IRIS                  | 20 Aug - 23 Aug            |
| 19. Investigation                 | 20 Aug                     |
| 20. Tropical Storm KATE (4)       | 24 Aug - 27 Aug            |
| 21. Typhoon JOAN                  | 25 Aug - 30 Aug            |
| 22. Typhoon LOUISE                | 29 Aug - 07 Sep            |
| 23. Investigation                 | 31 Aug - 01 Sep            |
| 24. Investigation                 | Cancelled                  |
| * Tropical Depression MARGE (2) ✓ | 02 Sep - 03 Sep            |
| 25. Investigation                 | 04 Sep                     |
| 26. Tropical Storm NORA (3)       | 05 Sep - 12 Sep            |
| 27. Tropical Storm OPAL (2)       | 05 Sep - 06 Sep            |
| 28. Investigation                 | 06 Sep                     |
| 29. Typhoon PATSY                 | 06 Sep - 10 Sep            |
| 30. Investigation                 | 07 Sep                     |

TROPICAL CYCLONES IN 1959 - CONTINUED

| CYCLONE                            | PERIOD                     |
|------------------------------------|----------------------------|
| 31. Tropical Depression RUTH (3)   | 08 Sep - 10 Sep            |
| 32. Investigation                  | 10 Sep                     |
| 33. Typhoon SARAH                  | 10 Sep - 18 Sep            |
| 34. Investigation                  | 14 Sep                     |
| 35. Investigation                  | 14 Sep                     |
| 36. Tropical Depression THELMA (2) | 18 Sep - 19 Sep            |
| 37. Investigation                  | 19 Sep                     |
| 38. Investigation                  | 20 Sep                     |
| 39. Typhoon VERA                   | 21 Sep - 27 Sep            |
| ** Tropical Storm WANDA (2)        | 26 Sep - 27 Sep            |
| 40. Typhoon AMY                    | 27 Sep - 07 Oct            |
| 41. Tropical Storm BABS (4)        | <del>05 Oct - 10 Oct</del> |
| 42. Typhoon CHARLOTTE              | 08 Oct - 19 Oct            |
| 43. Typhoon DINAH                  | 15 Oct - 21 Oct            |
| 44. Investigation                  | 23 Oct - 25 Oct            |
| 45. Investigation                  | 26 Oct                     |
| 46. Typhoon EMMA                   | 01 Nov - 13 Nov            |
| 47. Investigation                  | 01 Nov                     |
| 48. Typhoon FREDA                  | 13 Nov - 20 Nov            |
| 49. Investigation                  | 14 Nov - 15 Nov            |
| 50. Investigation                  | 19 Nov                     |
| 51. Investigation                  | 23 Nov - 25 Nov            |
| 52. Investigation                  | 27 Nov - 28 Nov            |
| 53. Investigation                  | 30 Nov                     |
| 54. Investigation                  | 05 Dec                     |
| 55. Investigation                  | 08 Dec                     |
| 56. Typhoon GILDA                  | 11 Dec - 21 Dec            |
| 57. Investigation                  | 18 Dec                     |
| 58. Typhoon HARRIET                | 21 Dec - 02 Jan            |
| 59. Investigation                  | 22 Dec                     |

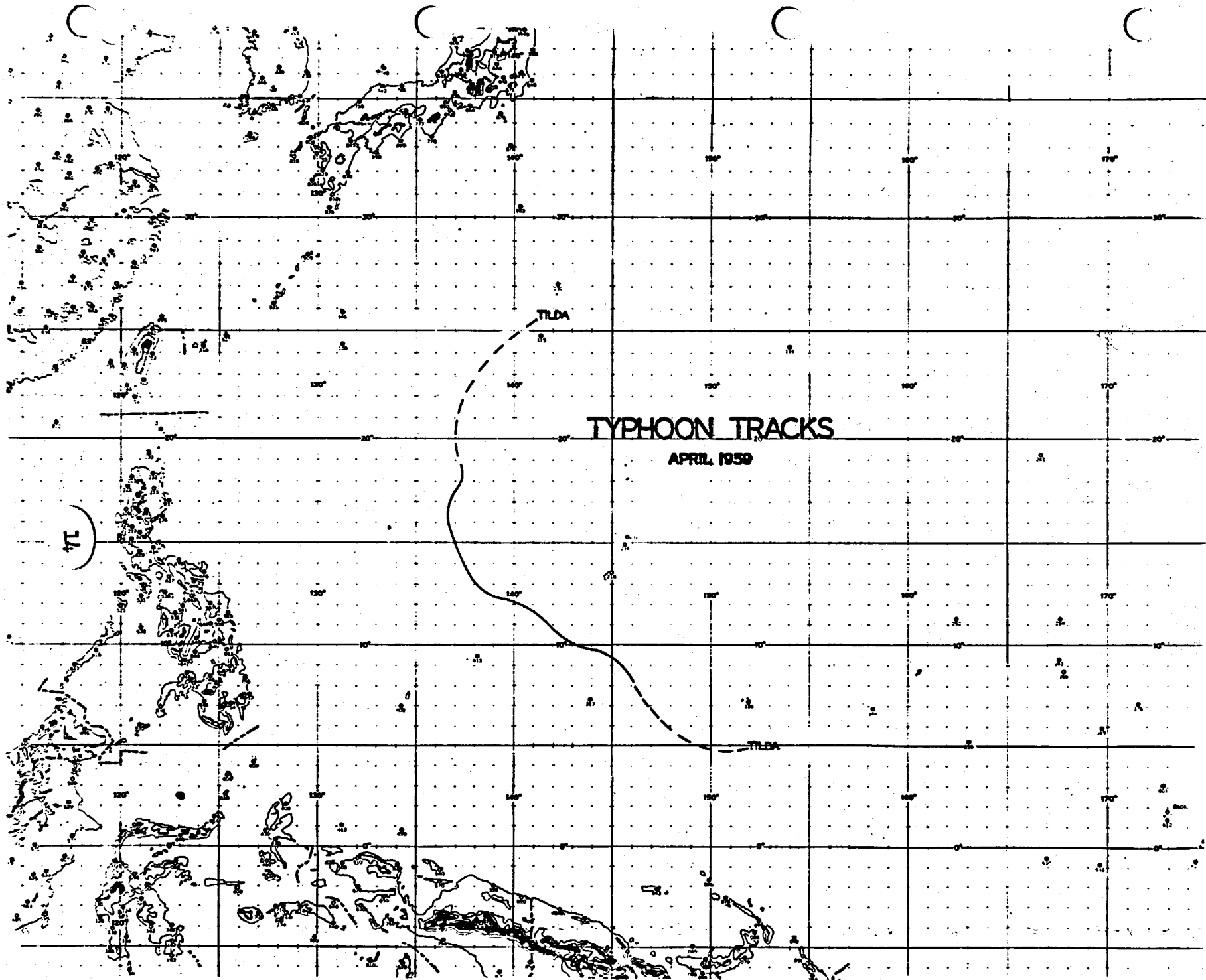
\* No reconnaissance performed, therefore no cyclone number assigned.

\*\* Forecast responsibility FWC Pearl and USWB Honolulu; no cyclone number assigned.

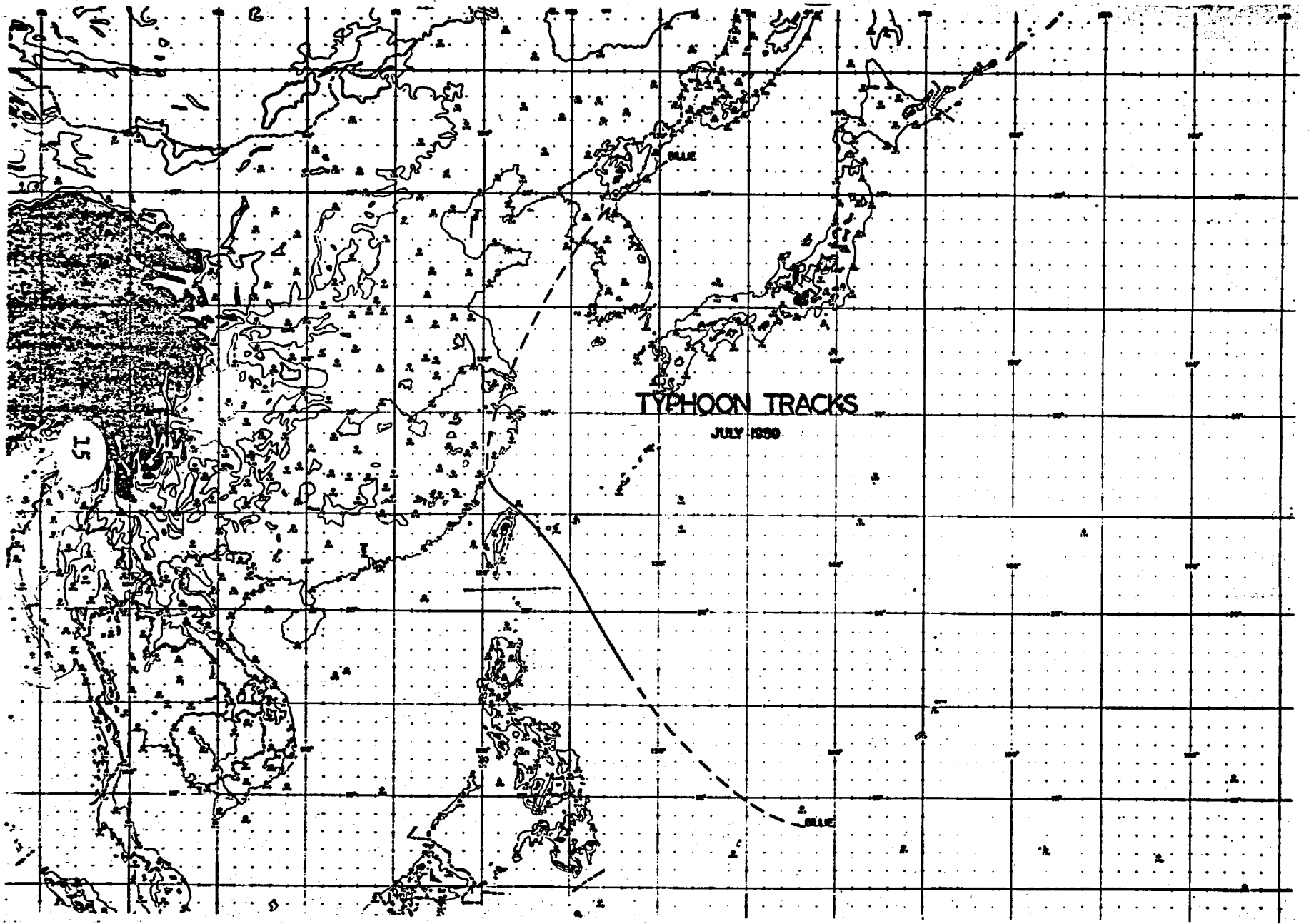


### 1959 TYPHOON TRACKS

|                   |                       |
|-------------------|-----------------------|
| TYPHOON TILDA     | 14-23 APR             |
| TYPHOON BILLIE    | 12-16 JUL             |
| HURRICANE DOT     | 01-08 AUG (NOT SHOWN) |
| TYPHOON ELLEN     | 02-09 AUG             |
| TYPHOON GEORGIA   | 12-14 AUG             |
| TYPHOON IRIS      | 19-23 AUG             |
| TYPHOON JOAN      | 25-30 AUG             |
| TYPHOON LOUISE    | 30 AUG-07 SEP         |
| TYPHOON PATSY     | 08-10 SEP             |
| TYPHOON SARAH     | 11-15 SEP             |
| TYPHOON VERA      | 21-27 SEP             |
| TYPHOON AMY       | 03-07 OCT             |
| TYPHOON CHARLOTTE | 08-19 OCT             |
| TYPHOON DIANAH    | 14-21 OCT             |
| TYPHOON EMA       | 05-13 NOV             |
| TYPHOON FREDA     | 13-20 NOV             |
| TYPHOON GILDA     | 13-21 DEC             |
| TYPHOON HARRIET   | 24 DEC-02 JAN         |

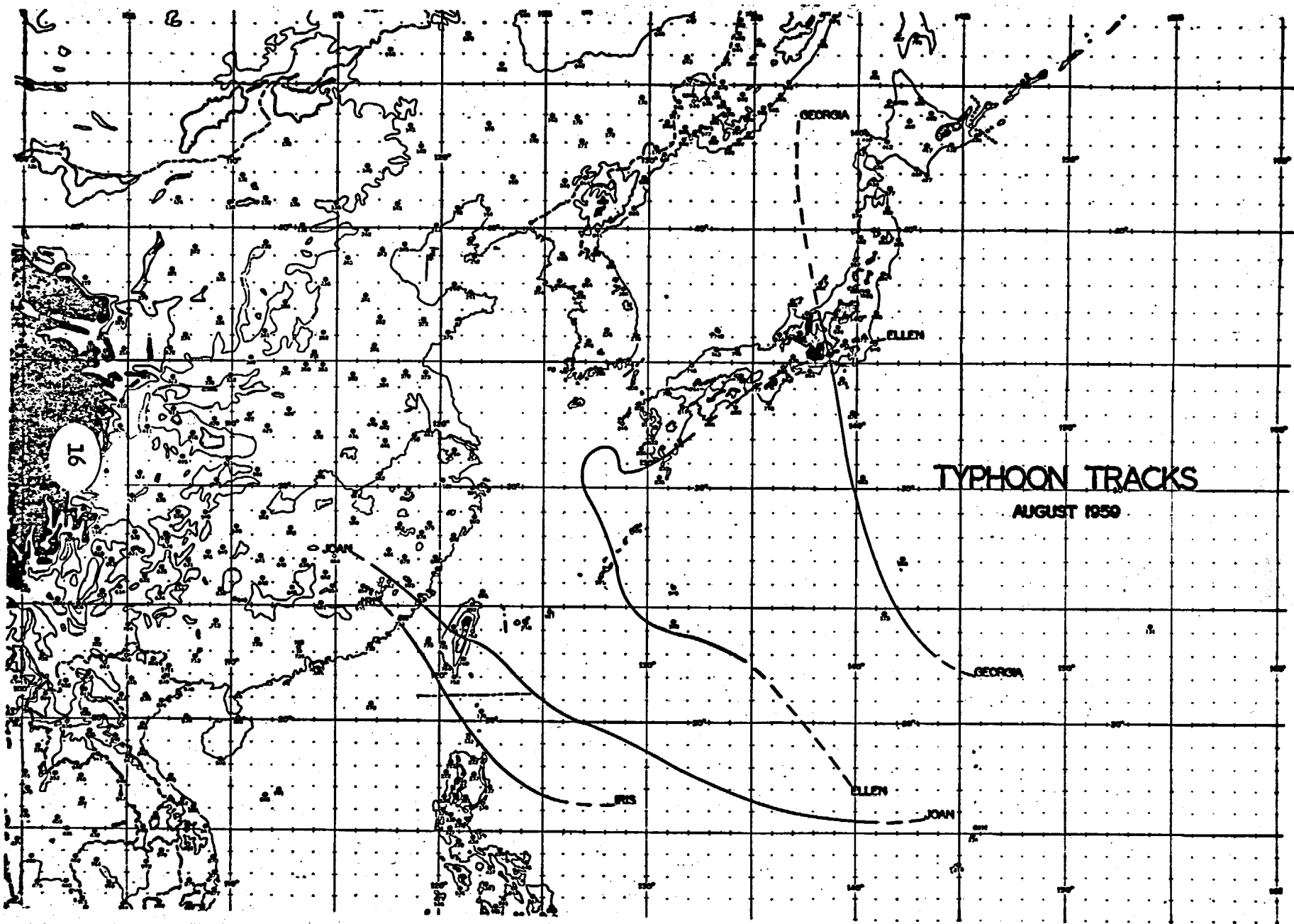






TYPHOON TRACKS  
JULY 1950

15



TYPHOON TRACKS

AUGUST 1950

16

GEORGIA

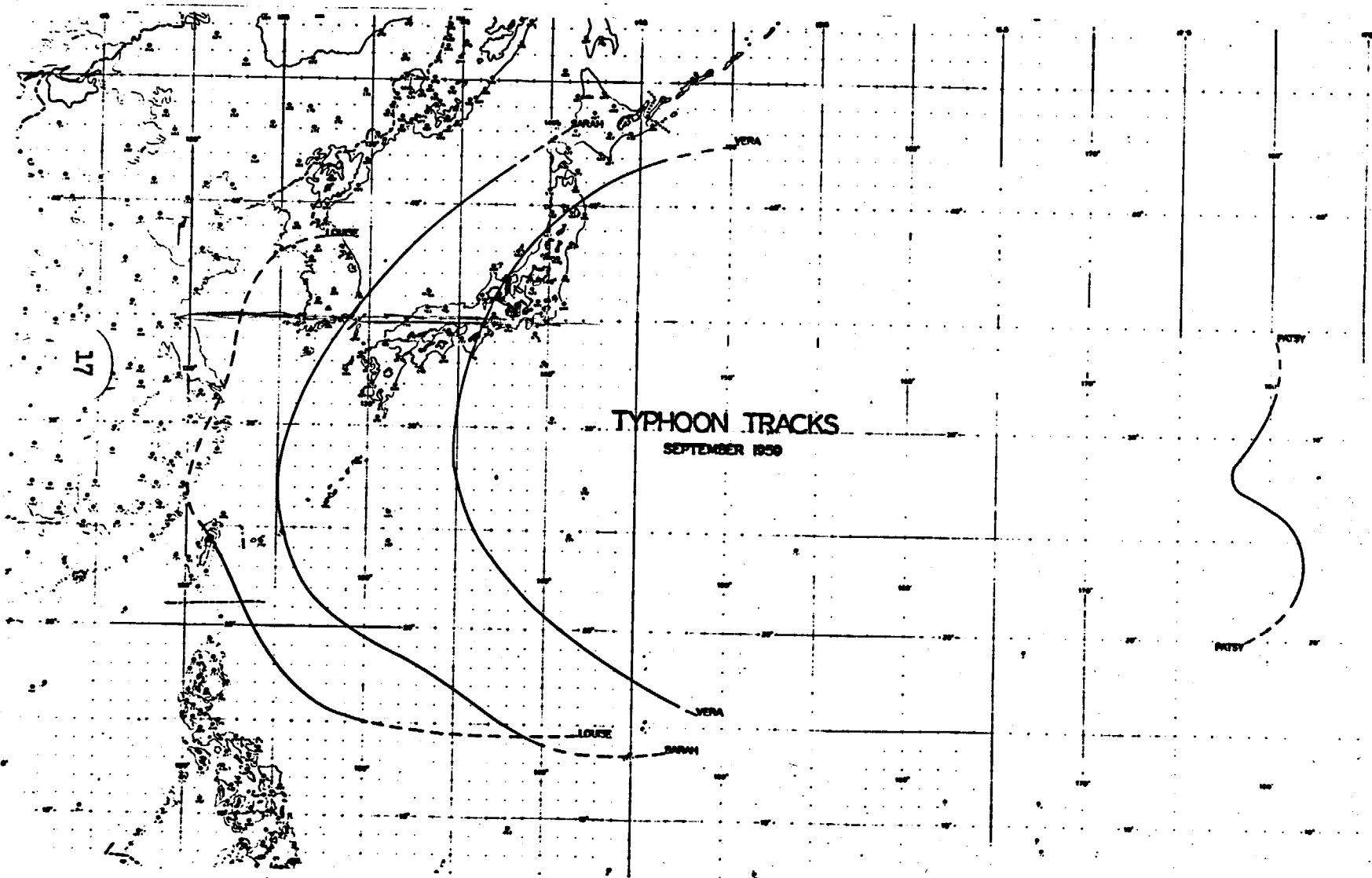
ELLEN

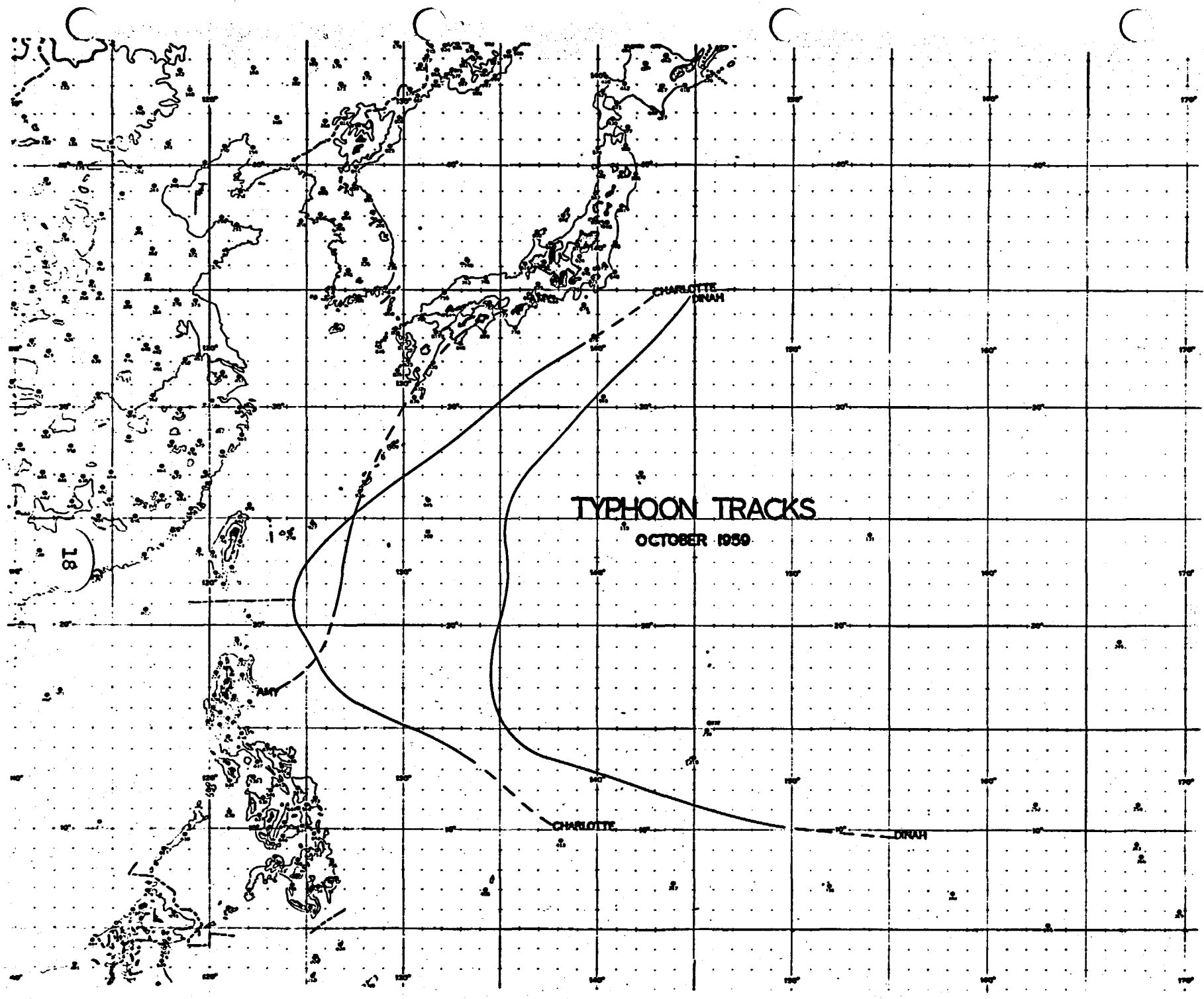
GEORGIA

RIS

ELLEN

JOAN





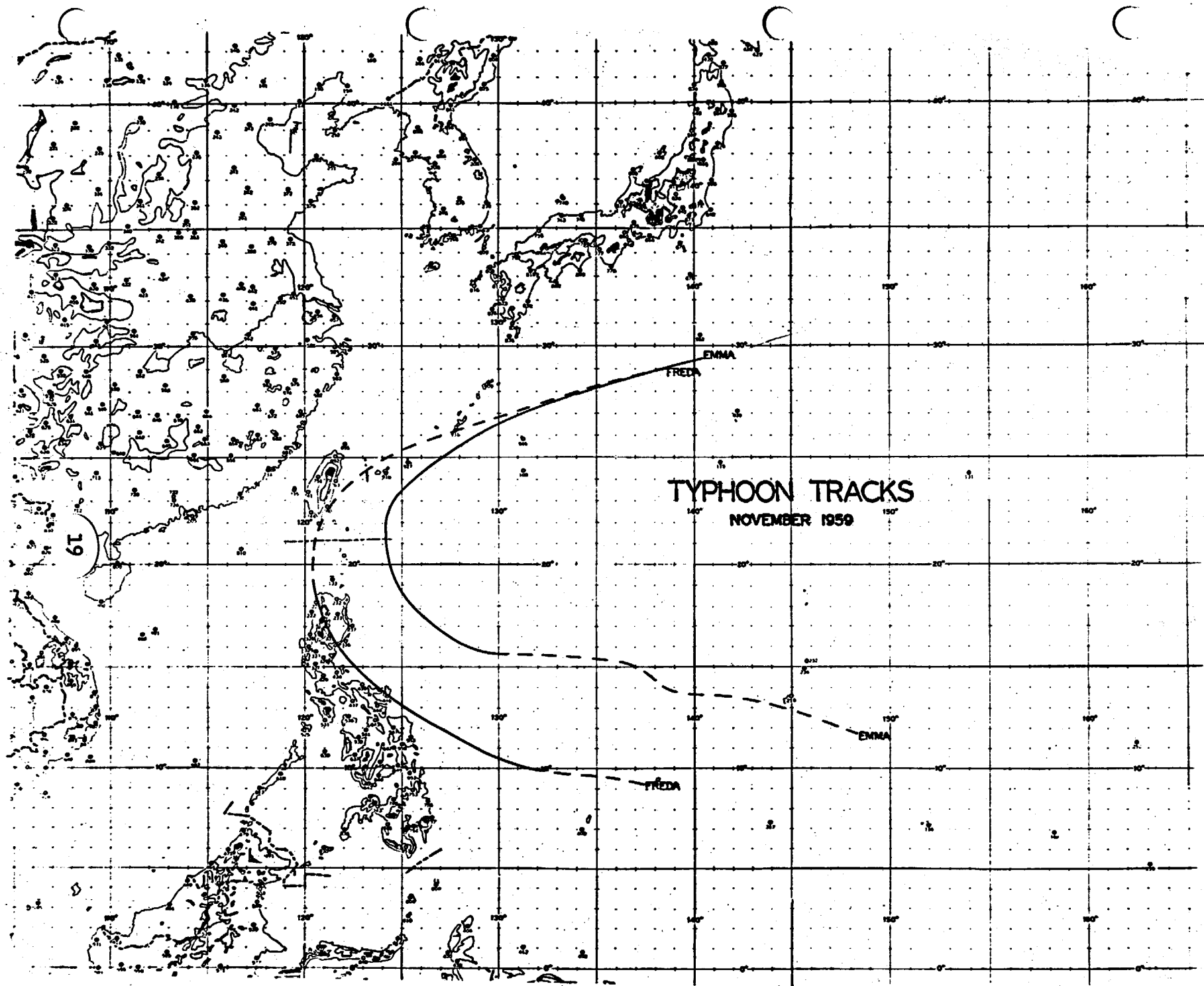
**TYPHOON TRACKS**  
OCTOBER 1959

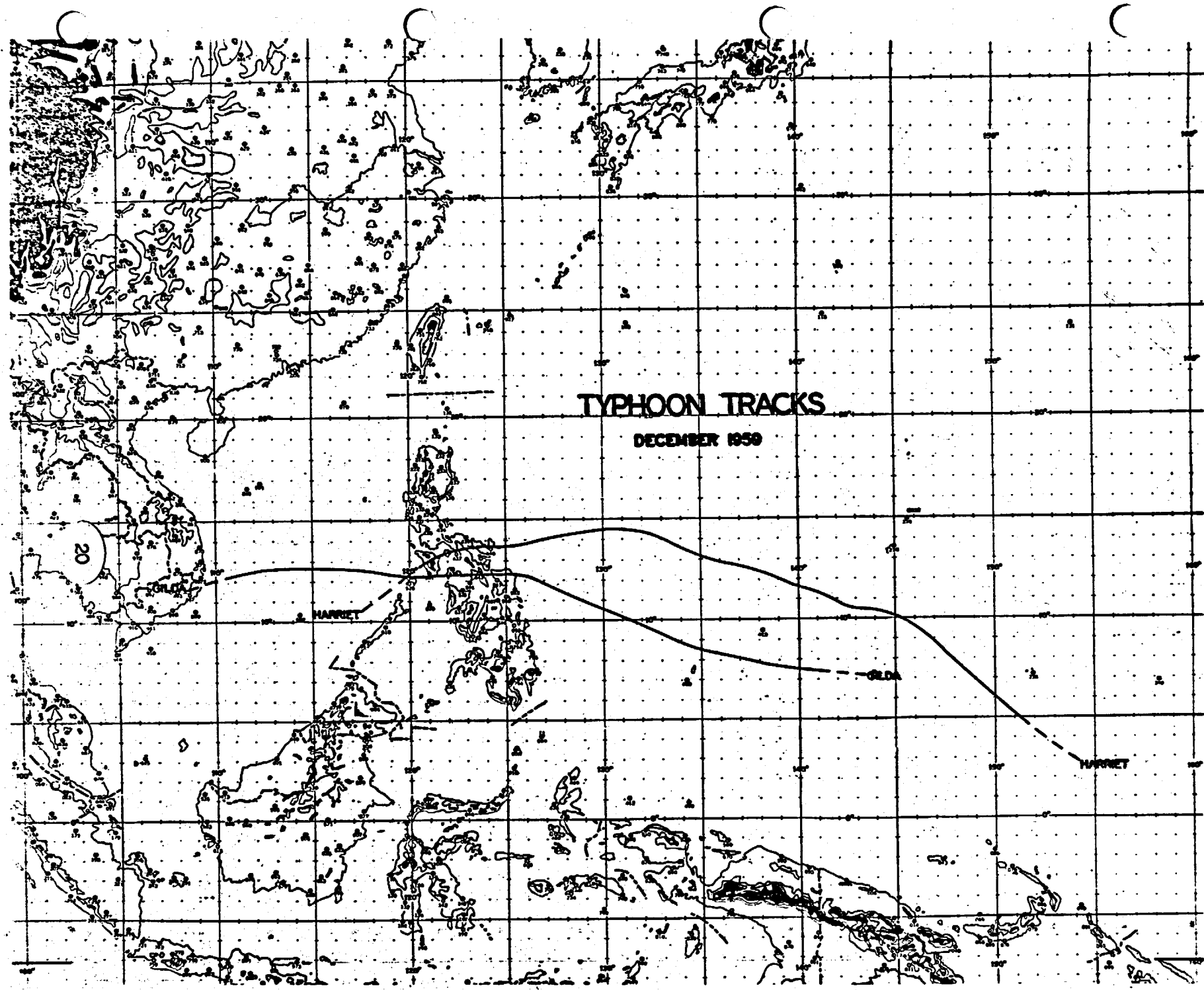
18

CHARLOTTE  
DINAH

CHARLOTTE

DINAH





# TYPHOON TRACKS

DECEMBER 1959

20

HARRIET

OLDA

HARRIET

TYPHOON SUMMATION DATA SHEET

| TYPHOON   | FROM RECON              | FROM WARNING BULLETIN |                            |                           | FROM RECON         |                  |                     |                     |
|-----------|-------------------------|-----------------------|----------------------------|---------------------------|--------------------|------------------|---------------------|---------------------|
|           | MAX<br>OBSVD<br>SFC WND | MAX<br>SFC<br>WND     | MAX<br>RADIUS<br>LOOKT WND | MAX<br>RADIUS<br>50KT WND | MAX<br>TEMP<br>(C) | MAX<br>DP<br>(C) | MIN<br>700MB<br>HGT | MIN<br>SLP<br>(MBS) |
| TILDA     | 175 (70)                | 130                   | —                          | 150                       | 23                 | 23               | 8080                | 964                 |
| HILLIE    | 100 (75)                | 80                    | —                          | 100                       | 27                 | 21               | 9270                | 968                 |
| ELLEN     | 110 (78)                | 100                   | —                          | 150                       | 20                 | 16               | 9120                | 964                 |
| GEORGIA   | 120 (88)                | 120                   | 20                         | 175                       | 20                 | 17               | 8960                | 953                 |
| IRIS      | 100 (77)                | 90                    | —                          | 100                       | 19                 | 11               | 9130                | 966                 |
| JOAN      | 200 (142)               | 170                   | 90                         | 300                       | 25                 | 16               | 6850                | 891                 |
| LOUISE    | 125 (78)                | 125                   | 60                         | 225                       | 24                 | 24               | 9120                | 964                 |
| PATSY     | 150 (82)                | 120                   | —                          | 60                        | 22                 | 15               | 9250                | 960                 |
| SARAH     | 170 (130)               | 165                   | 75                         | 225                       | 26                 | 15               | 7510                | 905                 |
| VERA      | 175 (137)               | 165                   | 75                         | 250                       | 30                 | 23               | 7180                | 896                 |
| AMY       | 95 (65)                 | 65                    | —                          | 60                        | 18                 | 16               | 9670                | 977                 |
| CHARLOTTE | 175 (130)               | 145                   | 75                         | 180                       | 22                 | 18               | 7320                | 905                 |
| DINAH     | 200 (122)               | 155                   | 50                         | 175                       | 21                 | 17               | 7600                | 913                 |
| EMMA      | 130 (83)                | 110                   | 75                         | 250                       | 25                 | 18               | 8980                | 959                 |
| FREDA     | 125 (102)               | 120                   | 75                         | 180                       | 20                 | 13               | 8530                | 936                 |
| GILDA     | 165 (122)               | 150                   | 50                         | 125                       | 22                 | 18               | 7540                | 914                 |
| HARRIET   | 150 (111)               | 130                   | 50                         | 150                       | 21                 | 19               | 8140                | 926                 |

**SECTION IV**  
**DISCUSSION AND EVALUATION**  
**OF INITIAL DETECTION,**  
**FORECAST TECHNIQUES EMPLOYED**  
**AND AIRCRAFT RECONNAISSANCE**



## SECTION IV

### DISCUSSION AND EVALUATION OF INITIAL DETECTION, FORECAST TECHNIQUES EMPLOYED AND AIRCRAFT RECONNAISSANCE

#### A. DETECTION TECHNIQUES

Extremely important to the JTWC in detecting tropical cyclones in the formative stages of development were the surface and upper air reports from the Trust Territory Islands and Guam. The importance of these reports can be readily understood since, during the 1959 Typhoon Season, 13 of a total of 17 typhoons were first detected in the area of the Trust Territory Islands. The Trust Territory Island reporting stations are shown on page 29. During the Typhoon Season very careful analyses were made of the area encompassing the Trust Territory Islands, both for the surface and upper air levels. These detailed analyses often gave the first indications of a tropical cyclone in the initial stages of development. Also, very valuable tools in first detecting tropical cyclone development were the Stidd Diagram and Time Cross-section of the Winds Aloft. A Stidd Diagram, an example of which is shown on page 30, is maintained continuously throughout the year, and includes all of the Trust Territory Islands transmitting surface reports. Time Cross-sections of the Winds Aloft, one of which is included on page 31, are also continuously maintained on all Trust Territory Island stations taking RAWIN or PIBAL observations. Weather Observations from the Vulture Lima reconnaissance track (shown on page 29), ship reports, and reports from scheduled and unscheduled aircraft also provided additional information from which the initial formation of tropical cyclones could first be detected. Normally, during

the Typhoon Season, the Vulture Lima track was flown at least every other day.

As soon as indications pointed to the development of a tropical cyclone, a reconnaissance aircraft was dispatched to the suspect area to confirm or deny the existence of a closed circulation on the surface. During the 1959 Typhoon Season, there were very few instances in which tropical cyclone warnings were issued prior to a reconnaissance aircraft confirming the existence of a closed surface circulation. It can be stated, without equivocation, that the existence of 95 percent of 1959 typhoons, tropical storms and depressions could not initially have been confirmed without aircraft reconnaissance. This is due to the sparsity of reporting stations in the tropical cyclone spawning area to the southeast of Guam.

#### B. FORECAST TECHNIQUES

For ease of operation in preparing tropical cyclone warnings, a basic chart plus three acetate overlays were used by the Typhoon Duty Officers. All reconnaissance and radar fixes were plotted on the basic chart. Forecast positions were plotted on the bottom overlay, warning positions on the second overlay, and the top overlay was utilized as a work sheet.

Once the existence of a tropical cyclone was confirmed, a track, based on climatology and the forecast high level flow, was projected forward on the work sheet through the recurvature point (if applicable). This long range forecast track was used as a guide, and was continually modified based on reconnaissance and changes in the upper air pattern.

Normally, a reconnaissance fix on all typhoons was received

approximately two hours before each warning was issued. Each fix was carefully evaluated by the Typhoon Duty Officer in terms of the type of fix, the reported accuracy of navigation, and the basis of navigation. Each fix was also evaluated in terms of previous fixes, the best track to date, and the high level flow. In preparing warnings, particular care was exercised not to be unduly influenced by short period fix to fix trends. Typhoons appear to have minor oscillations in movement, but it has been observed, in most instances, that the underlying or basic track is a straight line or smooth curve.

Warnings were based largely upon the information contained in completed Warning Forecast Worksheets, an example of which is included on page 32. Some of the more important features of the Warning Forecast Worksheet are:

1. Twenty-four hour forecast by Malone: Malone is an objective method of forecasting hurricane movement developed under the supervision of Doctor T. F. Malone of the Travelers Weather Research Center, Hartford, Connecticut. The method was adopted directly for forecasting typhoon movement in the Pacific. Since the method is based on the climatology of Atlantic hurricanes, it undoubtedly is not completely valid for forecasting typhoon movement. The JTWC computed typhoon movement using this method throughout the 1959 Typhoon Season, and found the forecasts to be 30 percent less accurate than the forecasts contained in the warnings prepared by the JTWC.

2. Speed of movement computations: The speeds between the last evaluated fix and the past five warning positions were computed. Likewise, the speeds between the last warning position and the pre-

vious four warning positions are computed. One advantage of this procedure is that acceleration and deceleration can be readily detected.

3. Upper air discussion: A somewhat detailed discussion of the high level flow, and its possible steering effects on the tropical cyclone, has proven very useful. The JTWC Typhoon Duty Officers are of the opinion that fully developed typhoons are usually (except during strong polar outbreaks) steered by the flow above the highest closed contour around the typhoon. Generally, the best steering flow has been found to be at the 200 or 150 millibar level. High level movement and intensity trends of the semi-permanent Pacific subtropical high were observed to be important indices with regard to the recurvature of typhoons. Post-analysis of the 1959 Typhoon Season has indicated that splitting of the subtropical high or ridge by eastward moving major troughs, and advective temperature effects on the intensity of the high or ridge, were invariably the determining factors as to when and where a typhoon would recurve. However, the complete lack of upper air data in the area of most frequent recurvature (the rectangle formed by Guam, Iwo-Jima, Taiwan and Clark Air Base) often precluded an accurate analysis in this critical area. For this reason, it is believed that forecasting typhoon recurvature will continue to be one of the major forecasting problems facing the JTWC.

It is appropriate to mention that typhoon forecasts provided by Tokyo Weather Central proved very useful. These forecasts, prepared using the space-mean technique, were transmitted to the JTWC twice daily whenever a typhoon had reached approximately 20 degrees north. In event the forecast differed significantly from that prepared by

the JTWC, coordination was effected by radiotelephone.

Forecast error data for the 1959 Typhoon Season has been compiled and is included on page 33. The following "ground rules" were used for verifying forecasts: Forecasts were verified only when the cyclone was of tropical storm or typhoon intensity, and no forecasts were verified when the actual position of the storm or typhoon was north of 35 degrees.

#### C. AIRCRAFT WEATHER RECONNAISSANCE

The tropical cyclone reconnaissance provided by the 54th Weather Reconnaissance Squadron during the 1959 Typhoon Season was outstanding. The cooperation of the commander, Lieutenant Colonel Dale D. Desper, and his entire organization was commendable. The spirit of cooperation which existed between the 54th Reconnaissance Squadron and the Fleet Weather Central/Joint Typhoon Warning Center is perhaps the major factor which contributed to the effectiveness of this joint organization during its first year of operation. Perusal of the chart on page 34 clearly shows that during the 1959 Typhoon Season the 54th Weather Reconnaissance Squadron efficiently discharged its assigned responsibility for typhoon reconnaissance in the Western Pacific. It should be noted that 98 percent of all fixes requested by the Joint Typhoon Warning Center were made.

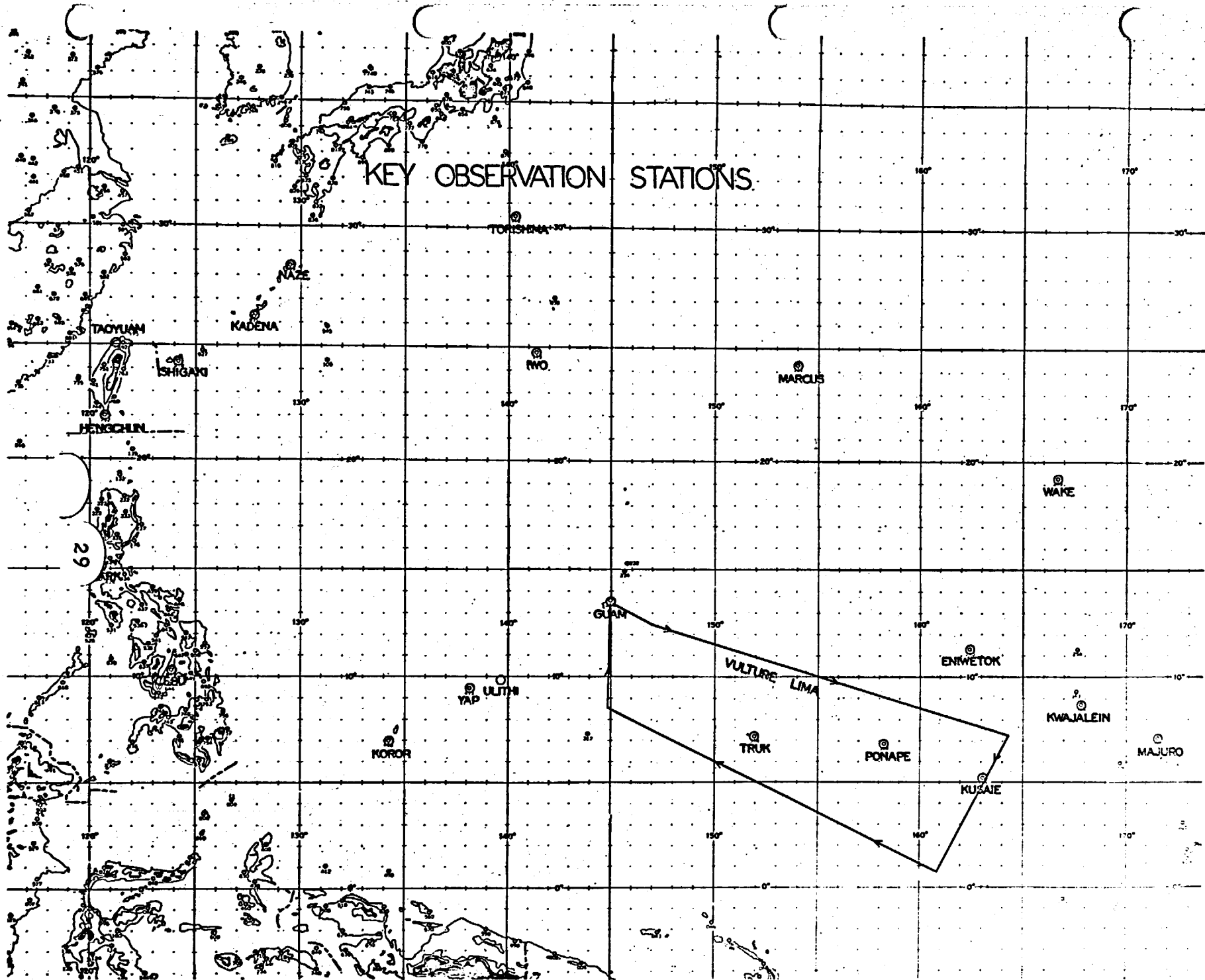
Additional units of the Air Force and Navy also provided the Joint Typhoon Warning Center with typhoon fixes which proved to be of invaluable assistance. The 56th Weather Reconnaissance Squadron made 21 fixes on diversions from fixed tracks; the 11th and 12th Tactical Reconnaissance Squadrons made 54 radar fixes; Navy BARPAC aircraft

made 3 fixes on Typhoon PATSY; and an aircraft of Navy W-3 Squadron made 3 fixes on Typhoon HARRIET.

The method used by the 54th Weather Reconnaissance Squadron wherein typhoons were penetrated at the 700 millibar level was found to be completely satisfactory. Occasional penetrations at the 500 millibar level were found to be less reliable for several reasons: (1) Difficulty was encountered in locating the eye. (2) Cloud cover often made it impossible to observe the surface, thus precluding a determination of the wind speed in the immediate vicinity of the typhoon center. (3) When observed, estimates of surface wind speeds tended to be less accurate than those made at the 700 millibar level.

There appears to be a high degree of correlation between the maximum wind speed reported by reconnaissance at the 700 millibar level in the vicinity of a fully developed typhoon and the maximum reported surface wind speed. In most cases, the maximum surface wind speed appears to be approximately 15 to 25 percent higher than the wind speed at the 700 millibar level. However, the foregoing statements are based on an incomplete investigation, and a more detailed study will be undertaken during the coming months. If a definite correlation can be established, a marked improvement should result in the accuracy of existing maximum wind speeds, as reported in issued typhoon warnings. It should be mentioned that the flight level wind measuring equipment, with which B-50 weather reconnaissance aircraft are now equipped, is extremely accurate. Winds measured with this equipment (APN/82, Doppler Navigation Equipment) are generally accurate to plus or minus one degree in direction, and plus or minus 5 knots in speed.

# KEY OBSERVATION STATIONS.



# STIDD DIAGRAM

(FIRST INDICATIONS OF DINAH)

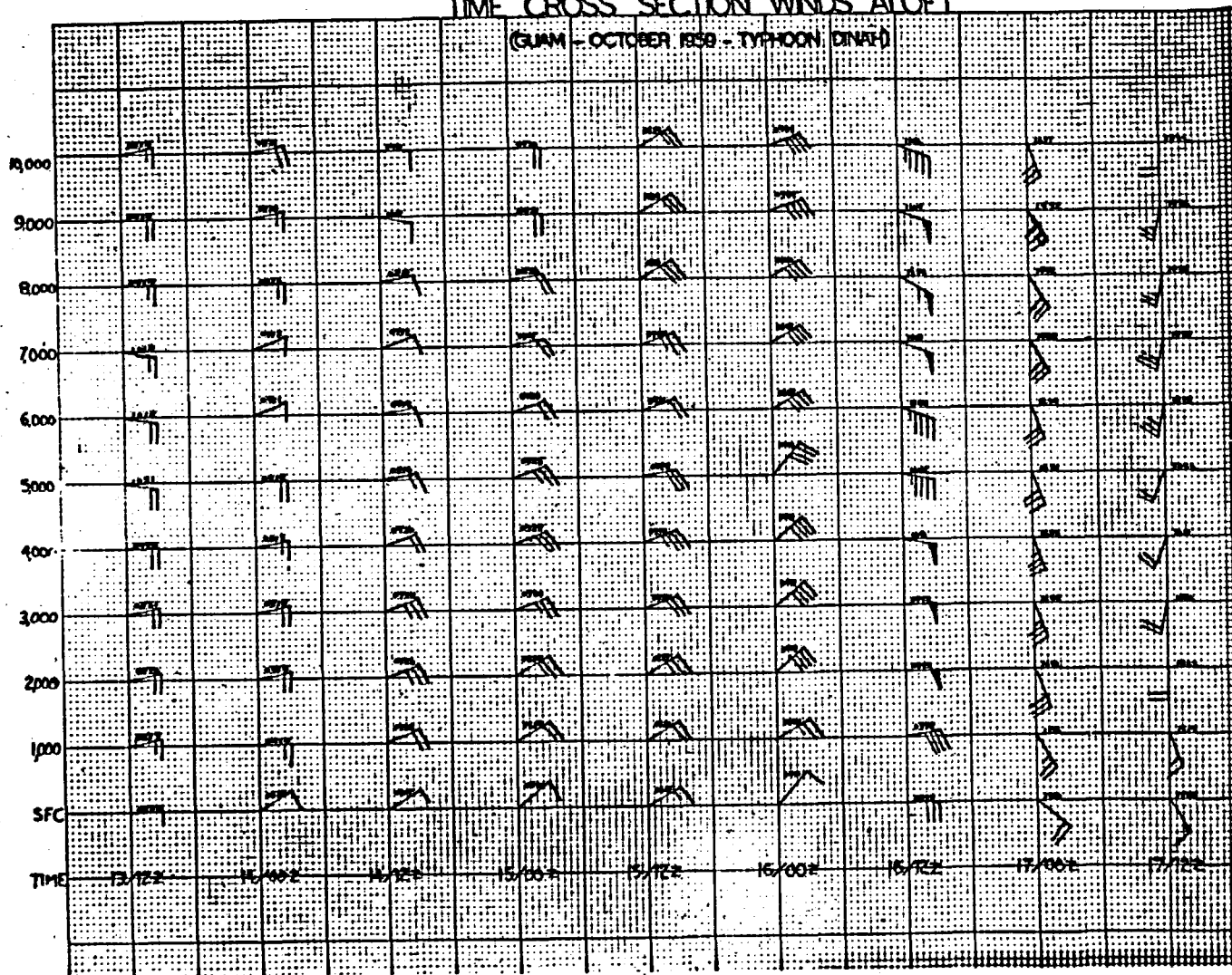
OCTOBER 1959

| TIME   | GUAM 212                             | TRUK 334                             | PONAPE 348                           | ENIWETOK 250                         |
|--------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| 13/18Z | 77 091<br>12 0 -12V<br>75 8 1<br>-16 | 76 081<br>15 0 -05V<br>76 8 1<br>-10 | 75 054<br>15 0 -12V<br>74 8 2<br>-48 | 82 064<br>10 0 -20V<br>77 8 2<br>-27 |
| 13/21Z | 79 102<br>15 0 +10V<br>75 8 1<br>-11 | 78 088<br>15 0 +07V<br>77 8 2<br>-17 | 79 075<br>15 0 +10V<br>75 8 1<br>-40 | 84 075<br>10 0 +10V<br>77 8 2<br>-28 |
| 14/00Z | 81 110<br>15 0 +07V<br>77 8 2<br>-11 | 86 081<br>15 0 -07V<br>77 8 2<br>-27 | 85 078<br>15 0 +03A<br>76 8 2<br>-34 | 79 081<br>10 0 +08V<br>77 8 2<br>-27 |
| 14/03Z | 86 095<br>15 0 +11V<br>75 8 2<br>+8  | 87 058<br>15 0 -21V<br>78 8 2<br>-33 | 80 047<br>15 0 -32V<br>75 8 2<br>-34 | ○ NODAT ○                            |
| 14/06Z | 83 079<br>15 0 -17V<br>75 8 2<br>±0  | 86 054<br>15 0 -05V<br>79 8 2<br>-27 | 77 047<br>10 0 -00V<br>74 8 2<br>-34 | 82 064<br>10 0 +20V<br>77 8 2<br>-7  |
| 14/09Z | 79 082<br>10 0 +05V<br>76 8 2<br>-9  | 83 064<br>18 0 +10V<br>78 8 2<br>-31 | 75 058<br>15 0 +12V<br>74 8 2<br>-33 | ○ NODAT ○                            |
| 14/12Z | 79 097<br>15 0 +15V<br>75 8 2<br>-13 | 89 085<br>15 0 +19V<br>88 8 2<br>-20 | 74 064<br>12 0 +06A<br>74 8 2<br>-31 | 83 081<br>10 0 +05A<br>76 8 2<br>-4  |
| 14/15Z | 60 084<br>12 0<br>76 8 2<br>-11      | 80 054<br>15 0 -29V<br>77 8 2<br>-34 | 75 044<br>15 0 -20V<br>74 8 2<br>-34 | 81 068<br>10 0 -14V<br>76 8 2<br>-3  |
| 14/18Z | 79 069<br>12 0 -18V<br>77 8 2<br>-22 | 81 044<br>15 0 -12V<br>76 8 2<br>-37 | 76 047<br>15 0 -02V<br>74 8 2<br>-9  | 82 054<br>10 0 -14V<br>75 8 2<br>-10 |
| 14/21Z | 80 076<br>15 0 +08V<br>76 8 2<br>-26 | 80 047<br>15 0 +03V<br>77 8 2<br>-41 | 78 061<br>15 0 +19V<br>74 8 2<br>-14 | 83 075<br>10 0 +20V<br>78 8 2<br>±0  |
| 15/00Z | 82 087<br>15 0 +10V<br>76 8 2<br>-23 | 84 054<br>15 0 +07V<br>79 8 2<br>-27 | 84 077<br>15 0 +08V<br>76 8 2<br>-7  | 83 088<br>10 0 +14V<br>77 8 2<br>+7  |
| 15/03Z | 86 069<br>15 0 -19V<br>75 8 2<br>-26 | 80 037<br>15 0 -19V<br>76 8 2<br>-21 | 82 051<br>15 0 -20V<br>75 8 2<br>+4  | 84 061<br>10 0 -29V<br>76 8 2<br>○   |
| 15/06Z | 85 055<br>15 0 -12V<br>74 8 2<br>-24 | 82 018<br>15 0 -17V<br>76 8 2<br>-36 | ○ NODAT ○                            | 81 051<br>10 0 -10V<br>75 8 2<br>-13 |
| 15/09Z | 82 064<br>12 0 +07V<br>76 8 2<br>-18 | 81 024<br>15 0 +07V<br>76 8 2<br>-40 | 79 068<br>12 0 +17V<br>75 8 2<br>+10 | ○ NODAT ○                            |
| 15/12Z | 80 078<br>10 0 +13V<br>77 8 2<br>-19 | 79 044<br>15 0 +19V<br>76 8 2<br>-41 | 80 078<br>15 0 +10V<br>74 8 2<br>+14 | 82 078<br>10 0 +10A<br>76 8 2<br>-3  |



# TIME CROSS SECTION WINDS ALOFT

(GUAM - OCTOBER 1959 - TYPHOON DINAFI)





TYPHOON FORECASTS ERRORS

| TYPHOON   | 12 HR FORECASTS |                       | 24 HR FORECASTS |                       | 48 HR FORECASTS |                       |
|---|-----------------|-----------------------|-----------------|-----------------------|-----------------|-----------------------|
|   | NO. OF<br>CASES | MEAN<br>ERROR<br>(NM) | NO. OF<br>CASES | MEAN<br>ERROR<br>(NM) | NO. OF<br>CASES | MEAN<br>ERROR<br>(NM) |
| TILDA   | 34              | 43.9                  | 32              | 94.6                  | NONE MADE       |                       |
| BILLIE  | 16              | 64.1                  | 15              | 106.4                 | 13              | 247.9                 |
| ELLEN   | 24              | 74.7                  | 23              | 158.8                 | 19              | 290.8                 |
| GEORGIA   | 9               | 122.3                 | 7               | 236.0                 | 3               | 596.0                 |
| IRIS  | 11              | 47.5                  | 9               | 123.8                 | 5               | 309.4                 |
| JOAN  | 22              | 57.1                  | 20              | 105.7                 | 16              | 228.6                 |
| LOUISE  | 17              | 46.8                  | 16              | 114.6                 | 16              | 290.8                 |
| PATSY   | 16              | 113.4                 | 14              | 205.6                 | 4               | 360.8                 |
| SARAH   | 20              | 43.8                  | 18              | 105.4                 | 14              | 269.7                 |
| VERA  | 17              | 42.5                  | 15              | 87.3                  | 11              | 160.8                 |
| AMY   | 13              | 78.1                  | 11              | 176.8                 | 7               | 355.6                 |
| CHARLOTTE   | 34              | 48.0                  | 32              | 98.6                  | 28              | 310.3                 |
| DINAH   | 27              | 50.1                  | 25              | 97.7                  | 21              | 231.0                 |
| EMMA  | 27              | 69.1                  | 25              | 149.4                 | 21              | 335.7                 |
| FREDA   | 27              | 41.9                  | 25              | 97.8                  | 21              | 166.5                 |
| GILDA   | 30              | 35.1                  | 29              | 74.9                  | 25              | 178.2                 |
| HARRIET   | 35              | 46.5                  | 33              | 100.9                 | 29              | 272.7                 |
| AVERAGE ERROR - 12 HR FORECASTS (379 CASES) . . . . . |                 |                       |                 |                       |                 | 55.6                  |
| AVERAGE ERROR - 24 HR FORECASTS (349 CASES) . . . . . |                 |                       |                 |                       |                 | 115.5                 |
| AVERAGE ERROR - 48 HR FORECASTS (253 CASES) . . . . . |                 |                       |                 |                       |                 | 262.1                 |

54TH WEATHER RECONNAISSANCE SQUADRON TYPHOON DATA

| TYPHOON      | MISSIONS<br>FLOWN | TOTAL<br>OBS. | TOTAL<br>DROPS | FIXES<br>REQUESTED | FIXES<br>MADE | PENET<br>FIXES | OTHER<br>FIXES* |
|--------------|-------------------|---------------|----------------|--------------------|---------------|----------------|-----------------|
| TILDA        | 14                | 313           | 17             | 35                 | 32            | 25             | 7               |
| BILLIE       | 10                | 205           | 21             | 13                 | 12            | 9              | 3               |
| ELLEN        | 13                | 262           | 33             | 22                 | 21            | 18             | 4               |
| GEORGIA      | 5                 | 88            | 11             | 7                  | 7             | 5              | 2               |
| IRIS         | 6                 | 110           | 18             | 10                 | 10            | 10             | 3               |
| JOAN         | 9                 | 170           | 27             | 17                 | 17            | 15             | 5               |
| LOUISE       | 10                | 149           | 22             | 18                 | 17            | 13             | 5               |
| PATSY        | 4                 | 85            | 13             | 4                  | 4             | 4              | 0               |
| SARAH        | 11                | 200           | 28             | 20                 | 20            | 15             | 8               |
| VERA         | 10                | 159           | 29             | 18                 | 17            | 13             | 4               |
| AMY          | 12                | 218           | 32             | 15                 | 15            | 11             | 5               |
| CHARLOTTE    | 22                | 386           | 57             | 44                 | 44            | 28             | 16              |
| DINAH        | 19                | 228           | 31             | 30                 | 30            | 19             | 11              |
| EMMA         | 22                | 349           | 64             | 36                 | 36            | 27             | 9               |
| FREDA        | 12                | 215           | 30             | 23                 | 23            | 17             | 6               |
| GILDA        | 16                | 277           | 42             | 36                 | 36            | 23             | 10              |
| HARRIET      | 20                | 385           | 36             | 43                 | 41            | 28             | 15              |
| <b>TOTAL</b> | <b>215</b>        | <b>3799</b>   | <b>511</b>     | <b>391</b>         | <b>382</b>    | <b>280</b>     | <b>113</b>      |

\*Radar or Triangulation Fixes

**SECTION V**  
**INDIVIDUAL TROPICAL CYCLONE DATA**

## SECTION V

### INDIVIDUAL TYPHOON SUMMARIES

Each typhoon will be treated individually. This consists of the life history and characteristics; the Reconnaissance Aircraft Fix data; the Position and Forecast Verification data; and three charts showing Best Track, 12 and 24 hour Verification data.

The heading of the fifth column of each Reconnaissance Aircraft Fix tabulation is "\*Unit, Method & Accy." The asterisk was inserted to call attention to the following explanation of the terms used. The first term designates the unit making the fix: "54," "55" or "56" —54th, 55th or 56th Weather Reconnaissance Squadron. "12"—12th Tactical Reconnaissance Squadron. "VW"—Navy early warning aircraft. The second term is the method used to make the fix: "P"—penetration, "R"—radar and "T"—triangulation. The third term is the estimated accuracy of the fix in miles. A double asterisk in Column 5 indicates the fix was made by land-based radar.

Attention is called to the Forecast Verification data. The table is read from left to right with the information corresponding to the date-time group. For example, see the table with Typhoon TILDA 15-1200Z. The 12 hour forecast error, from a forecast made 12 hours previous, is 62 miles on a bearing 300 degrees from the Best Track position 07.6N 146.6E. The 24 hour error made on a forecast 24 hours previous is 95 miles on a bearing of 305 degrees from the same Best Track position. On Typhoons TILDA, BILLIE and ELLEN, the forecasts from the first fix positions were not for a full 12 or 24 hours, and although shown on the charts, the errors were not tabulated.

A. TYPHOON TILDA (14-23 APRIL 1959)

Surface map analyses on 12 April 1959 showed a possible closed cyclonic circulation on the Intertropical Convergence Zone south of Truk. Subsequent analyses showed the center moving slowly westward, while surface reports indicated intensification. The 54th Weather Reconnaissance Squadron was requested to investigate the suspect area. A fix made at 140123Z confirmed the existence of surface winds of tropical storm intensity and positioned Tropical Storm TILDA at 5.5N-148.2E.

Tropical Storm TILDA moved northwestward at 7.5 knots to a position near 7.5N - 146.6E where her speed decreased to 3 knots. At the same time the winds increased to typhoon intensity, having been observed by reconnaissance aircraft to be 80 knots in the northeast quadrant. Twelve hours later Typhoon TILDA resumed a northwesterly movement, with two minor oscillations, at an approximate speed of 7 knots. At 190000Z she began a northerly curvature moving at a speed of 9 knots. At 201200Z, near a point 18.7N - 137.5E, TILDA became quasi-stationary for approximately 30 hours. At the same time intensity decreased, and she was downgraded to a tropical storm in the 121800Z warning. During this 30 hour period the typhoon was fixed 6 times by reconnaissance aircraft with all fixes falling inside a circle 30 miles in diameter. A weak col area aloft apparently provided no push or steering and TILDA drifted aimlessly, unable to cross the ridge-line to the north. Weak troughing to the west of TILDA became evident after 220000Z and the rapidly weakening tropical storm moved northward picking up speed as she moved into the westerlies north of 20 degrees.

TILDA rapidly became extra-tropical and a final warning was issued at 230000Z, with the last position 130 miles southwest of Iwo Jima.

Typhoon TILDA reached her greatest intensity 400 miles west of Guam with maximum surface winds of 130 knots. She followed seasonal climatology quite well with the exception of the quasi-stationary period. Thirty-seven warnings were issued covering a period of 10 days.

Typhoon TILDA spent her fury over the open ocean and no damage was recorded.



RECONNAISSANCE AIRCRAFT FIXES - TYPHOON TILDA

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS  |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|----------------------|
| 1       | 140123Z | 05.5N | 148.2E | 54-P-10             | --          | 40          | 10050         | 38              | --              | --               |                      |
| 2       | 140732Z | 06.3N | 147.8E | 54-P-10             | --          | 60          | 9970          | 40              | 12              | 09               | CIRC DIA 30 MI       |
| 3       | 142030Z | 07.3N | 146.6E | 54-P-5              | 990         | 45          | 9920          | 55              | 10              | 07               | ELLIP MAJ AXIS 10 MI |
| 4       | 150200Z | 07.4N | 146.6E | 54-P-7              | --          | 50          | 9880          | 48              | 14              | 10               | ELLIP MAJ AXIS 20 MI |
| 5       | 150700Z | 07.6N | 146.6E | 54-P-3              | 987         | 75          | 9800          | 60              | 14              | 09               | CIRC DIA 30 MI       |
| 6       | 151400Z | 08.4N | 145.8E | 54-R-10             | --          | --          | --            | 50              | --              | --               | ELLIP 30X25 MI       |
| 39<br>7 | 152030Z | 08.8N | 145.7E | 54-P-5              | --          | 75          | 9380          | 70              | --              | --               | ELLIP 35X20 MI       |
| 8       | 160200Z | 09.5N | 145.2E | 54-P-5              | --          | 80          | 9110          | 50              | 19              | --               | CIRC DIA 20 MI       |
| 9       | 160640Z | 09.7N | 144.4E | VW-R--              | --          | --          | --            | --              | --              | --               |                      |
| 10      | 160800Z | 09.8N | 144.4E | 54-P-5              | --          | 100         | 8850          | --              | 19              | 11               | CIRC DIA 20 MI       |
| 11      | 161100Z | 09.9N | 143.9E | 54-R--              | --          | --          | --            | --              | --              | --               |                      |
| 12      | 161400Z | 09.9N | 143.5E | 54-P-10             | --          | --          | --            | 70              | --              | --               | CIRC DIA 20 MI       |
| 13      | 162030Z | 10.3N | 142.8E | 54-P-5              | --          | --          | 8470          | 120             | 14              | 13               | CIRC DIA 17 MI       |
| 14      | 170200Z | 10.5N | 142.3E | 54-P-10             | --          | 150         | 8360          | 135             | 16              | 14               | CIRC DIA 20 MI       |
| 15      | 170800Z | 10.7N | 141.9E | 54-P-5              | --          | 120         | 8220          | 120             | 15              | 14               | ELLIP 13X15 MI       |
| 16      | 171500Z | 11.6N | 141.1E | 54-R-15             | --          | --          | --            | --              | --              | --               |                      |
| 17      | 172030Z | 12.1N | 140.5E | 54-P-3              | --          | --          | 8080          | 130             | 17              | 12               | CIRC DIA 10 MI       |
| 18      | 180100Z | 12.2N | 139.7E | 54-P-3              | --          | 150         | 8080          | 110             | 17              | 11               | CIRC DIA 15 MI       |
| 19      | 180800Z | 12.6N | 139.0E | 54-P-5              | --          | 100         | 8190          | 110             | 16              | 16               | CIRC DIA 10 MI       |
| 20      | 181400Z | 12.8N | 138.1E | 54-T-15             | --          | --          | --            | --              | --              | --               |                      |
| 21      | 182030Z | 13.5N | 137.7E | 54-P-1              | --          | --          | 8310          | --              | 15              | 15               | CIRC DIA 20 MI       |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON TILDA (CONT'D)

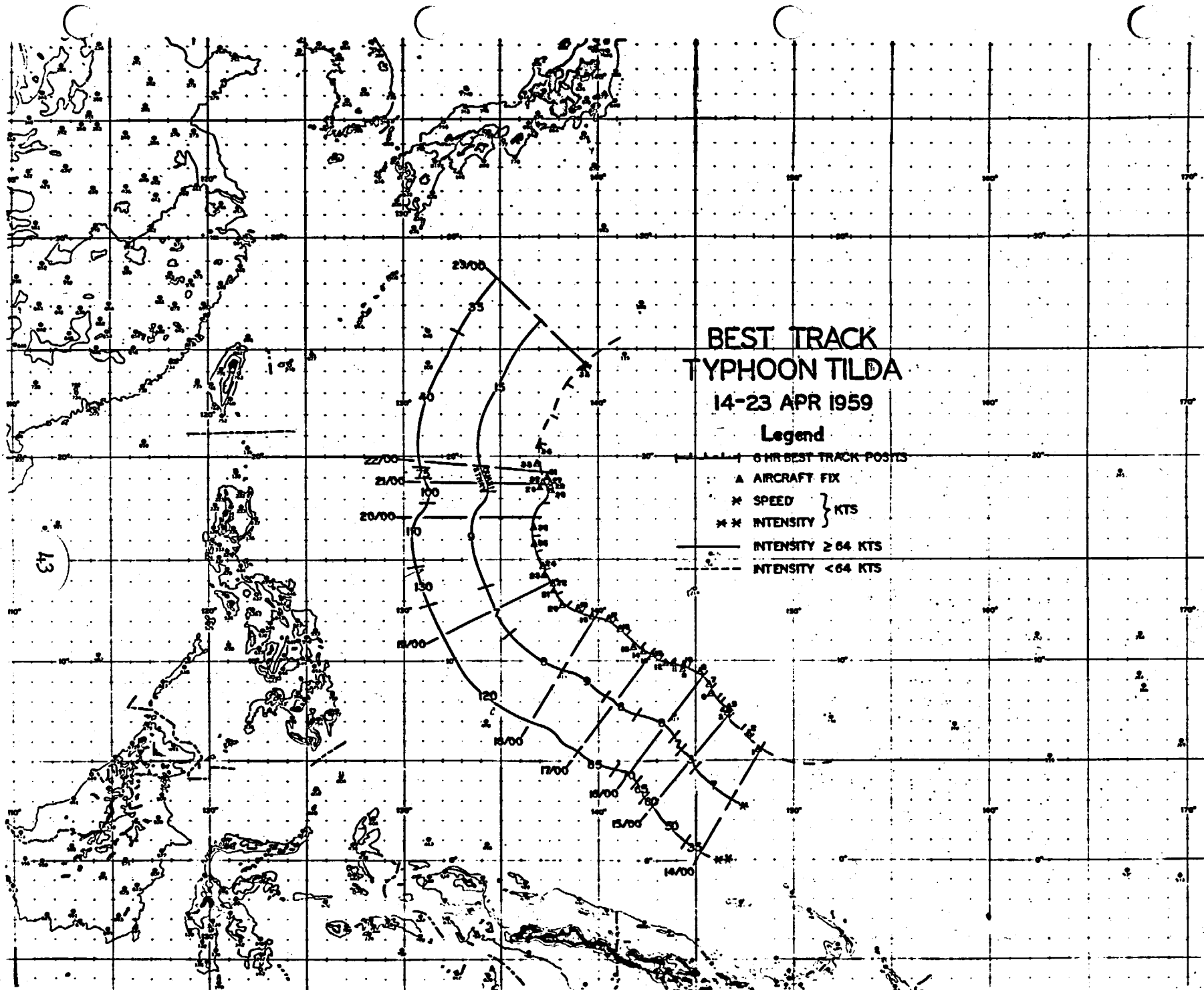
| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 22      | 190143Z | 13.8N | 137.7E | 54-P-5              | --          | 160         | 8220          | 110             | 19              | 13               | CIRC DIA 20 MI      |
| 23      | 190425Z | 14.2N | 137.2E | VW-R-10             | --          | --          | --            | --              | --              | --               | -----               |
| 24      | 190800Z | 14.7N | 137.1E | 54-P-5              | --          | 175         | 8080          | 125             | 19              | 15               | CIRC DIA 20 MI      |
| 25      | 191400Z | 15.8N | 136.8E | 54-R-20             | --          | --          | --            | --              | --              | --               | -----               |
| 26      | 192030Z | 16.5N | 136.6E | 54-P-5              | --          | 125         | 8510          | --              | 21              | 21               | CIRC DIA 35 MI      |
| 27      | 201400Z | 18.8N | 137.5E | 54-R-10             | --          | --          | --            | --              | --              | --               | -----               |
| 28      | 202030Z | 18.6N | 137.0E | 54-P-5              | 964         | --          | 9290          | 70              | 21              | 15               | CIRC DIA 30 MI      |
| 29      | 210329Z | 18.7N | 137.5E | 56-P-10             | 987         | 80          | 9750          | 60              | 18              | 12               | CLDS IN EYE         |
| 30      | 210800Z | 18.6N | 137.6E | 54-P-5              | 985         | 70          | 9750          | --              | 15              | 10               | HORSESHOE SHAPE     |
| 31      | 211400Z | 19.0N | 137.4E | 54-P-10             | --          | --          | --            | --              | --              | --               | -----               |
| 32      | 212155Z | 18.7N | 137.1E | 54-P-15             | 992         | 45          | --            | 47              | 23              | 23               | CIRC DIA 30 MI      |
| 33      | 220208Z | 19.7N | 136.9E | 54-P-10             | 993         | --          | 10080         | 40              | --              | --               | CIRC DIA 30 MI      |
| 34      | 220520Z | 20.5N | 137.0E | 54-P-10             | 996         | 70          | 10070         | 50              | --              | --               | CIRC DIA 30 MI      |
| 35      | 222220Z | 24.1N | 139.2E | 54-P-5              | 999         | 40          | 10080         | 40              | --              | --               | EYE DIFFUSE         |

TYPHOON TILDA 14 APRIL - 23 APRIL 1959  
POSITION AND FORECAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 140000Z | 05.6N          | 148.3E | -           | -        | -           | -        |
| 140600Z | 06.1N          | 147.8E | -           | -        | -           | -        |
| 141200Z | 06.5N          | 147.3E | -           | -        | -           | -        |
| 141800Z | 07.1N          | 146.7E | 325         | - 17     | -           | -        |
| 150000Z | 07.3N          | 146.6E | 310         | - 52     | -           | -        |
| 150600Z | 07.6N          | 146.6E | 300         | - 62     | 305         | - 95     |
| 151200Z | 08.1N          | 146.1E | 180         | - 17     | 300         | - 110    |
| 151800Z | 08.6N          | 145.8E | 320         | - 81     | 292         | - 86     |
| 160000Z | 09.3N          | 145.3E | 280         | - 26     | 168         | - 58     |
| 160600Z | 09.7N          | 144.6E | 118         | - 30     | 140         | - 130    |
| 161200Z | 09.9N          | 143.8E | 042         | - 50     | 006         | - 45     |
| 161800Z | 10.0N          | 143.2E | 016         | - 55     | 070         | - 68     |
| 170000Z | 10.3N          | 142.6E | 256         | - 36     | 030         | - 90     |
| 170600Z | 10.6N          | 142.1E | 270         | - 25     | 010         | - 105    |
| 171200Z | 11.3N          | 141.4E | 225         | - 37     | 230         | - 100    |
| 171800Z | 11.9N          | 140.7E | 180         | - 43     | 220         | - 66     |
| 180000Z | 12.2N          | 139.8E | 360         | - 06     | 208         | - 65     |
| 180600Z | 12.4N          | 139.1E | 019         | - 42     | 162         | - 55     |
| 181200Z | 12.8N          | 138.4E | 358         | - 30     | 332         | - 31     |
| 181800Z | 13.3N          | 137.9E | 360         | - 06     | 350         | - 65     |
| 190000Z | 13.9N          | 137.5E | 250         | - 23     | 320         | - 42     |
| 190600Z | 14.5N          | 137.2E | 246         | - 30     | 270         | - 30     |
| 191200Z | 15.3N          | 136.8E | 162         | - 38     | 254         | - 60     |
| 191800Z | 16.2N          | 136.6E | 213         | - 25     | 240         | - 60     |
| 200000Z | 17.1N          | 136.7E | 266         | - 20     | 192         | - 85     |
| 200600Z | 17.8N          | 137.1E | 281         | - 35     | 248         | - 80     |
| 201200Z | 18.6N          | 137.4E | 278         | - 37     | 270         | - 28     |
| 201800Z | 18.7N          | 137.3E | 360         | - 58     | 285         | - 25     |
| 210000Z | 18.7N          | 137.3E | 033         | - 97     | 014         | - 110    |
| 210600Z | 18.7N          | 137.3E | 022         | - 60     | 010         | - 155    |
| 211200Z | 18.7N          | 137.3E | 028         | - 85     | 040         | - 212    |
| 211800Z | 18.7N          | 137.3E | 035         | - 30     | 042         | - 175    |

TYPHOON TILDA 14 APRIL - 23 APRIL 1959  
 POSITION AND FORECAST VERIFICATION DATA (CONT'D)

| DTG                            | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|--------------------------------|----------------|--------|-------------|----------|-------------|----------|
|                                | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 220000Z                        | 19.3N          | 137.1E | 045         | - 24     | 033         | - 175    |
| 220600Z                        | 20.7N          | 137.0E | 172         | - 130    | 295         | - 45     |
| 221200Z                        | 22.0N          | 137.6E | 205         | - 100    | 180         | - 83     |
| 221800Z                        | 23.3N          | 138.3E | 248         | - 50     | 188         | - 275    |
| 230000Z                        | 24.3N          | 139.3E | 270         | - 36     | 040         | - 218    |
| AVERAGE 12 HOUR FORECAST ERROR |                |        | 43.9 NM     |          |             |          |
| AVERAGE 24 HOUR FORECAST ERROR |                |        | 94.6 NM     |          |             |          |



# BEST TRACK TYPHOON TILDA

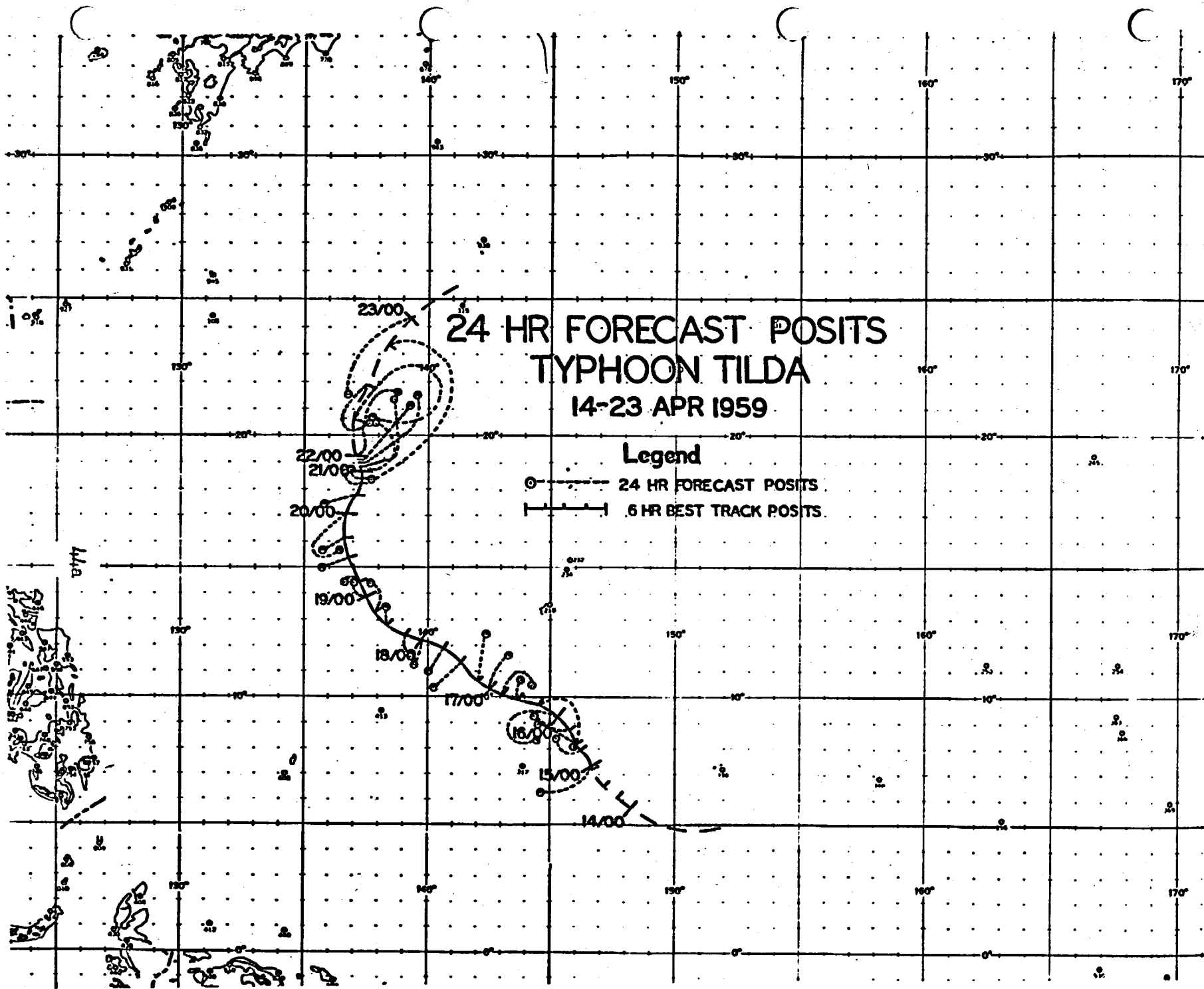
14-23 APR 1959

## Legend

- 6 HR BEST TRACK POSTS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \*\* INTENSITY } KTS
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS

43





B. TYPHOON BILLIE (12-18 JULY 1959)

As early as 090000Z, a reconnaissance aircraft was dispatched to investigate a suspect area between the islands of Yap and Koror. However, it was not until 120000Z that a closed surface circulation was confirmed, and at that time a tropical depression warning was issued by JTWC. Within six hours Tropical Depression BILLIE reached tropical storm intensity and twenty-four hours later, at 130600Z, BILLIE was a full-blown typhoon with winds of 65 knots near the center.

From the beginning, BILLIE moved in a northwesterly direction at an average speed of 11 knots. She reached her maximum intensity at 14-0200Z when surface winds of 100 knots were observed. Later, at 150900Z, reconnaissance aircraft located Typhoon BILLIE approximately 20 miles off the northern tip of Taiwan. She continued to travel in a northwesterly direction and passed inland over the China Mainland at 16-0000Z, at which time JTWC issued a final warning pending recurvature. Orographic effect took its toll and BILLIE gradually degenerated to a tropical storm, curving abruptly northward. Tracking from land data indicated that BILLIE would enter the Yellow Sea at approximately 32N - 122E. JTWC resumed warnings at 170000Z. The storm center rapidly accelerated and moved through North Korea heading for Vladivostok. By 171800Z cold air advection in connection with a polar front rapidly caused BILLIE to become extra-tropical and the final warning was issued.

Typhoon BILLIE's movement followed a decided minor sine wave from inception until near the Chinese coast. Elliptical center reports suggested eccentric movement. Originally, BILLIE was forecast to re-



curve and remain over the open water east of the China coast. However, westward intensification of the subtropical high aloft caused BILLIE to move farther west than forecast, and onto the China coast near 27 degrees north. Marked northward recurvature over the Mainland of China is believed to have been caused by a combination of the orographic effect of the mountains of east-central China and a weak trough over Manchuria. No major forecasting difficulties were encountered and the 24-hour forecast error remained well below the annual average. In general BILLIE followed July seasonal climatology quite well in movement and speed. Twenty-two warnings were issued covering a period of 6 days.

For damage caused by Typhoon BILLIE see Section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON BILLIE

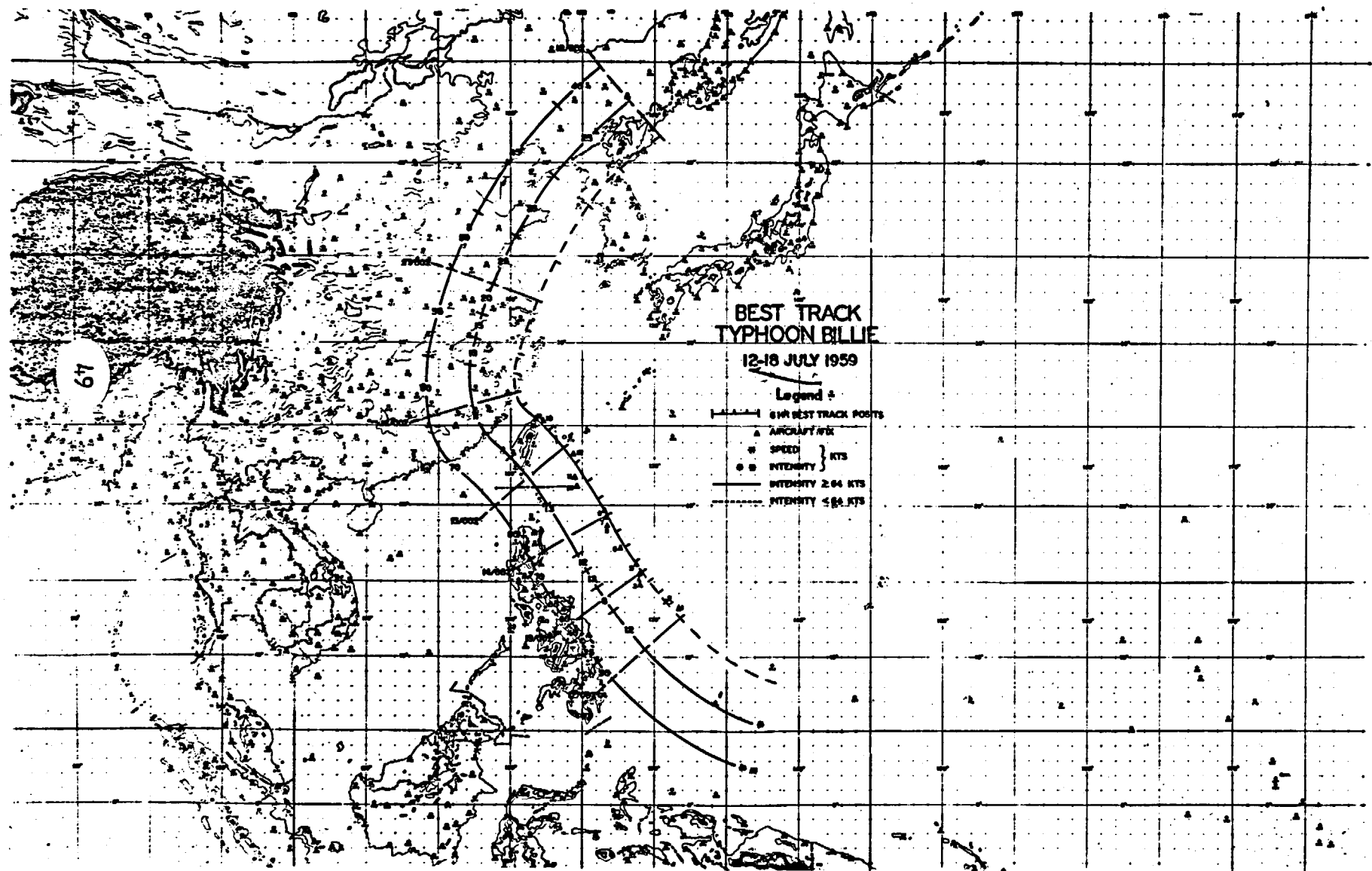
| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|--------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 120316Z | 13.2N | 131.8E | 54-P-20            | 997         | 40          | 9990          | --              | 26              | 21               | CIRC DIA 100 MI     |
| 2       | 120700Z | 13.7N | 130.9E | 54-P-15            | 996         | 35          | --            | --              | 27              | 21               | CIRC DIA 30 MI      |
| 3       | 122155Z | 14.9N | 129.0E | 54-P-5             | 984         | 45          | 9830          | 45              | --              | --               | CIRC DIA 40 MI      |
| 4       | 130130Z | 15.5N | 129.0E | 54-P-5             | --          | 70          | 9750          | 60              | 13              | 09               | CIRC DIA 60 MI      |
| 5       | 130600Z | 16.1N | 128.9E | 54-P-5             | 984         | 75          | 9680          | 60              | 18              | 11               | CIRC DIA 20 MI      |
| 6       | 131400Z | 17.2N | 127.7E | 54-R-25            | --          | --          | --            | --              | --              | --               | CIRC DIA 30 MI      |
| 7       | 132100Z | 19.2N | 126.7E | 54-P-5             | 974         | 65          | 9560          | 40              | 15              | 09               | ELLIP 100X75 MI     |
| 8       | 132305Z | 18.8N | 126.8E | 12-R-20            | --          | --          | --            | --              | --              | --               | CIRC DIA 30 MI      |
| 9       | 140200Z | 19.6N | 126.4E | 54-P-10            | 979         | 100         | 9560          | 60              | 13              | 12               | EYE INDEFINITE      |
| 10      | 141000Z | 21.2N | 124.6E | 12-R-10            | --          | --          | --            | --              | --              | --               |                     |
| 11      | 141400Z | 21.9N | 124.4E | 54-T-5             | --          | --          | --            | 58              | --              | --               | CIRC DIA 40 MI      |
| 12      | 142100Z | 23.2N | 124.3E | 54-P-5             | 968         | 65          | 9360          | 85              | 16              | 13               | CIRC DIA 30 MI      |
| 13      | 150900Z | 25.2N | 122.2E | 54-P-5             | 969         | 70          | 9270          | 65              | 15              | 14               | CIRC DIA 25 MI      |
| 14      | 151400Z | 25.4N | 121.8E | 54-R-30            | --          | --          | --            | --              | --              | --               | EYE INDEFINITE      |

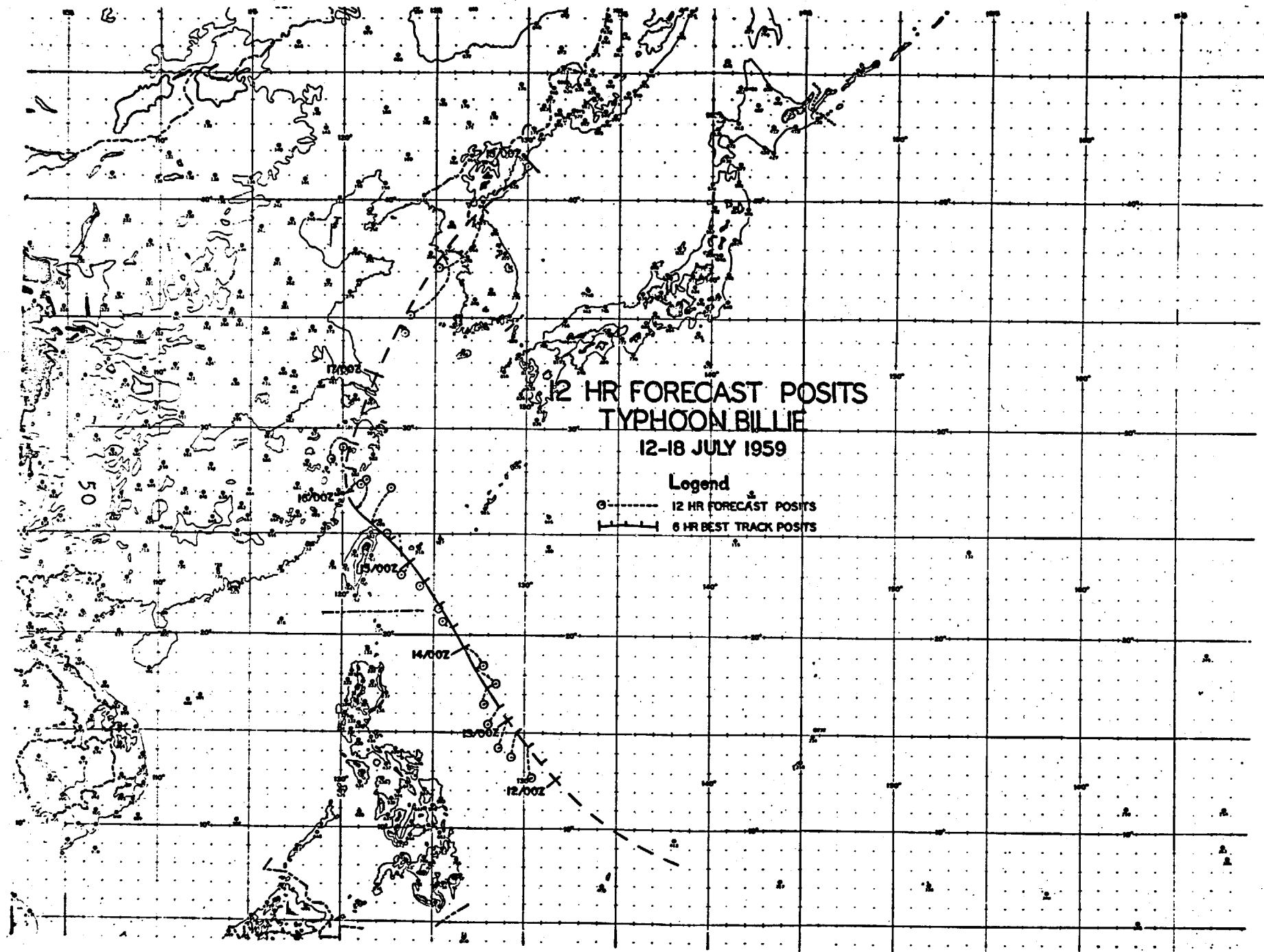
L7

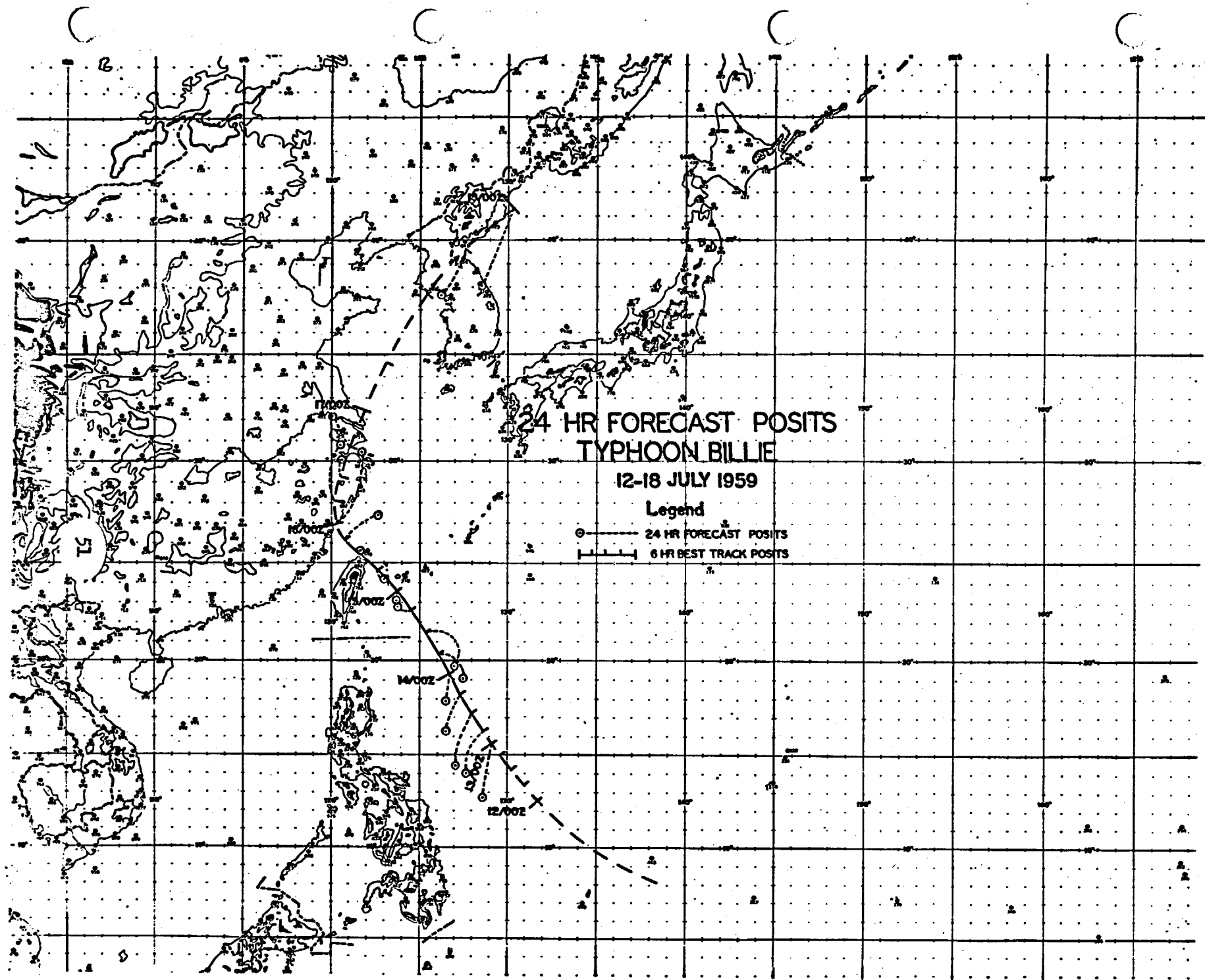
TYPHOON BILLIE 12 - 17 JULY 1959  
POSITION AND FORECAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 120000Z | 12.6N          | 131.7E | --          | --       | --          | --       |
| 120600Z | 13.4N          | 130.8E | --          | --       | --          | --       |
| 121200Z | 14.2N          | 130.2E | --          | --       | --          | --       |
| 121800Z | 15.0N          | 129.6E | 185         | - 71     | --          | --       |
| 130000Z | 15.7N          | 129.1E | 196         | - 98     | --          | --       |
| 130600Z | 16.3N          | 128.6E | 211         | - 66     | 198         | - 145    |
| 131200Z | 17.2N          | 128.0E | 188         | - 40     | 200         | - 170    |
| 131800Z | 18.2N          | 127.2E | 121         | - 71     | 201         | - 125    |
| 140000Z | 19.2N          | 126.5E | 130         | - 85     | 180         | - 80     |
| 140600Z | 20.3N          | 125.9E | 326         | - 33     | 145         | - 172    |
| 141200Z | 21.5N          | 125.2E | 180         | - 20     | 137         | - 146    |
| 141800Z | 22.7N          | 124.5E | 243         | - 20     | 304         | - 38     |
| 150000Z | 23.7N          | 123.7E | 239         | - 33     | 173         | - 38     |
| 150600Z | 24.7N          | 122.7E | 065         | - 41     | 152         | - 32     |
| 151200Z | 25.4N          | 121.8E | 025         | - 171    | 280         | - 08     |
| 151800Z | 26.1N          | 120.9E | 012         | - 92     | 052         | - 115    |
| 160000Z | 27.0N          | 120.2E | 072         | - 50     | 021         | - 210    |
| 160600Z | 28.1N          | 120.1E | 355         | - 58     | 007         | - 167    |
| 161200Z | 29.3N          | 120.5E | 239         | - 76     | 023         | - 46     |
| 161800Z | 30.7N          | 121.2E | --          | --       | 325         | - 104    |
| 170000Z | 32.4N          | 122.2E | --          | --       | --          | --       |
| 170600Z | 34.7N          | 123.5E | --          | --       | --          | --       |

AVERAGE 12 HOUR FORECAST ERROR      64.1 NM  
AVERAGE 24 HOUR FORECAST ERROR      106.4 NM







C. HURRICANE DOT (01-08 August 1959)

I. Introduction: This report was prepared by FWC, Pearl Harbor and edited by FWC/JTWC, Guam.

At 0000Z on 24 July the SS PACIFICUS at 19.5N - 127.5W, 1000 miles west of Lower California, reported 35 knot surface winds. Based on this report a tropical warning was issued at 240000Z with the remark that the accuracy of the position was poor. At 240600Z the same ship reported 55 knot winds, and the position given on the 0600Z warning was 18.4N - 120.6W. The movement of the unnamed storm was forecast to be west northwest at 12 knots. From 240600Z until 270000Z, there were no further ship reports. Subsequent warning positions were therefore based upon extrapolation. The storm was "killed" with the 270000Z warning. However, if the storm actually moved west southwest at 6 knots, it would have been positioned, by 2100Z on 1 August, at 15.7N - 141.2W, the point where Tropical Storm DOT was "discovered." This was possibly the case. There was no data available between 240600Z July and 012100Z August in the area of the unnamed storm, so it is impossible to determine whether the original storm dissipated or simply was rediscovered as DOT.

II. Method of Detection:

At 011800Z an unidentified ship reported 60 knot surface winds at 15.7N.- 141.2W. This was fixed as the first warning position (011800Z) of Tropical Storm DOT.

III. Best Track Analysis:

Between the first reconnaissance at 030000Z and the final

eye fix by reconnaissance at 071858Z, there were a total of 16 aircraft reconnaissance fixes on DOT, and many land-based radar fixes. The warnings issued by Fleet Weather Central, Pearl Harbor during DOT are summarized on page 56. The aircraft fixes were considered to be the most accurate. Due to strong attenuation by heavy precipitation, the land-based radar fixes were considered less reliable. As a result of excellent electronic navigation aids in the vicinity of the Hawaiian Islands, most reconnaissance fixes were considered to have been accurate to within 10 miles.

#### IV. Analysis of Development:

At 020000Z the following message was received from the SS SONOMA:

"0200Z RECORDED LOW PRESS OF 963PT4 AT 012300Z 15PT7N 141PT8W X WIND BACKING FROM NE AT 011800Z TO NW AT 012300Z X WIND SHIFT AND BARO INDICATES VESSEL PASSED THRU SRI PART OF STORM CNTR AT 012300Z"

The maximum surface wind recorded at this time was 90 knots. From 011800Z until 020600Z DOT's position was based upon the reports of this one ship. From 020600Z until the first aircraft fix at 030000Z, positions were based upon extrapolation only. From 030000Z until degeneration into an open wave at 080600Z, DOT's center was fixed continuously by aircraft reconnaissance. The minimum sea level pressure during the period of aircraft reconnaissance fixes was recorded, by dropsonde, as 952 millibar at 030000Z. Using the following equation, developed for determining the maximum winds of a tropical cyclone, the maximum surface wind was computed as 130 knots.



$$\text{Wind max} = \left( 20 - \frac{\phi}{5} \right) \sqrt{1010 - P_c}$$

(Where  $\phi$  is latitude in degrees, and  $P_c$  is central pressure in mb.)

The central pressure rose steadily, as determined from dropsonde observations and from the minimum 700 mb height using the below equation (see TABLE 1):

$$P_c = \frac{H700\text{mb}}{28} + 638$$

(Where  $P_c$  is central pressure in mb, and H700mb is 700 mb height in feet.)

TABLE 1. CENTRAL PRESSURE HURRICANE DOT

| <u>DATE</u> | <u>TIME Z</u> | <u>CENTRAL PRESSURE</u> | <u>LAT N</u> | <u>LONG W</u> | <u>MAX OBSERVED SFC WIND</u> |
|-------------|---------------|-------------------------|--------------|---------------|------------------------------|
| 3 AUG       | 0000Z         | # 952                   | 15.3         | 145.8         | Not observed                 |
| 3 AUG       | 1612Z         | # 957                   | 15.8         | 148.1         | 100 kt                       |
| 4 AUG       | 0412Z         | # 961                   | 16.2         | 150.1         | 100 kt                       |
| 4 AUG       | 2104Z         | # 966                   | 16.9         | 154.4         | 140 kt                       |
| 5 AUG       | 1150Z         | * 992                   | 17.3         | 156.0         | Not observed                 |
| 5 AUG       | 1633Z         | # 970                   | 17.6         | 156.6         | Not observed                 |
| 5 AUG       | 2222Z         | # 968                   | 18.1         | 157.4         | 95 kt                        |
| 6 AUG       | 1643Z         | * 976                   | 20.3         | 158.9         | Not observed                 |
| 7 AUG       | 1934Z         | * 999                   | 22.8         | 161.2         | 45 kt                        |

# Indicates dropsonde observation

\* Indicates computed from min 700 mb height

#### V. Storm Movement:

The indicated 700-500 mb flow during the entire period between the discovery and dissipation of DCT was ESE becoming WSW north of Lihue. The indicated 200 mb flow for the same period was also constant from the ESE, curving gradually northward in the vicinity of the Island of Hawaii. The best track analysis indicates that the fully developed storm was steered by the flow near the 300 mb level. As the

storm weakened after passing Hawaii, the best steering flow appears to have been near the 500 mb level. This indicates the possibility of a direct, or nearly direct, relationship between storm intensity and height of steering level.

VI. Summarization:

South Point, Hawaii received heavy seas and gusty winds to 75 knots as DOT reached her closest point of approach to that island. The most significant effect of DOT on Oahu was the rainfall. The U.S. Weather Bureau, Honolulu recorded 2.66 inches, while normal rainfall for the entire month of August is only 0.80 inches. The greatest damage occurred on Kauai. The track analysis indicates that the storm center passed directly over Lihue, county seat of Kauai, and although that station reported gusts to 65 knots as the highest winds, unofficial reports of 90 knot winds were received from other parts of the island. The hurricane unroofed homes, uprooted trees and knocked down power and telephone lines as it raked the entire island of Kauai. Many roadways were blocked and huge waves pounded the shoreline. Torrential rains swelled rivers and streams to raise flood threats, and Kauai was subsequently proclaimed a disaster area.

WARNINGS ISSUED BY FWC, PEARL HARBOR

| <u>WNG<br/>NO.</u> | <u>DTG OF<br/>WARNING</u> | <u>WARNING<br/>BASIS</u> | <u>LAT<br/>(N)</u> | <u>LONG<br/>(W)</u> | <u>MOVEMENT</u> |                      | <u>MAX<br/>WIND<br/>(KTS)</u> | <u>POSIT</u> |
|--------------------|---------------------------|--------------------------|--------------------|---------------------|-----------------|----------------------|-------------------------------|--------------|
|                    |                           |                          |                    |                     | <u>DIR</u>      | <u>SPD<br/>(KTS)</u> |                               |              |
| 1                  | 011800Z                   | Ship                     | 15.7               | 141.2               | W               | 9                    | 60                            | Fair         |
| 2                  | 020000Z                   | Ship                     | 15.8               | 142.0               | WNW             | 9                    | 90                            | Fair         |
| 3                  | 020600Z                   | Ship                     | 15.7               | 142.9               | W               | 10                   | 90                            | Fair         |
| 4                  | 021200Z                   | Extrap                   | 15.6               | 144.0               | WSW             | 10                   | 85                            | Poor         |
| 5                  | 021800Z                   | Extrap                   | 16.0               | 144.5               | W               | 7                    | 75                            | Poor         |
| 6                  | 030000Z                   | Recon                    | 15.3               | 145.8               | W               | 9                    | 120                           | Good         |
| 7                  | 030600Z                   | Extrap                   | 15.3               | 146.3               | W               | 7                    | 120                           | Poor         |
| 8                  | 031200Z                   | Extrap                   | 15.3               | 147.0               | W               | 7                    | 115                           | Poor         |
| 9(WB)              | 031800Z                   | Recon                    | 15.8               | 148.5               | WNW             | 9                    | 110                           | Fair         |
| 10                 | 040000Z                   | Extrap                   | 15.9               | 149.5               | WNW             | 10                   | 115                           | Fair         |
| 11                 | 040600Z                   | Recon                    | 16.2               | 150.5               | WNW             | 10                   | 120                           | Good         |
| 12                 | 041200Z                   | Extrap                   | 16.5               | 151.5               | WNW             | 10                   | 115                           | Fair         |
| 13                 | 041800Z                   | Recon                    | 16.7               | 152.5               | WNW             | 10                   | 120                           | Good         |
| 14                 | 050000Z                   | Recon                    | 17.0               | 154.0               | WNW             | 12                   | 115                           | Good         |
| 15                 | 050600Z                   | Recon                    | 17.5               | 155.3               | WNW             | 13                   | 115                           | Fair         |
| 16                 | 051200Z                   | Recon                    | 17.5               | 156.0               | WNW             | 12                   | 115                           | Fair         |
| 17                 | 051800Z                   | Recon                    | 17.7               | 156.8               | WNW             | 11                   | 90                            | Fair         |
| 18                 | 060000Z                   | Recon                    | 18.2               | 157.7               | WNW             | 11                   | 1st 12 hrs                    |              |
|                    |                           |                          |                    |                     | NW              | 11                   | 100                           | Good         |
| 19                 | 060600Z                   | Recon                    | 18.9               | 158.3               | NW              | 10                   | 100                           | Good         |
| 20                 | 061200Z                   | Recon                    | 19.6               | 158.8               | N               | 8                    | 90                            | Good         |
| 21                 | 061800Z                   | Radar                    | 20.4               | 158.9               | N               | 4                    | 1st 12 hrs                    |              |
|                    |                           |                          |                    |                     | N               | 10                   | 65                            | Fair         |
| 22                 | 070000Z                   | Radar                    | 21.2               | 159.2               | NNE             | 10                   | 1st 12 hrs                    |              |
|                    |                           |                          |                    |                     | NE              | 10                   | 65                            | Good         |
| 23                 | 070600Z                   | Land Sta                 | 22.1               | 159.2               | NNE             | 13                   | 90                            | Fair         |
| 24                 | 071200Z                   | Analysis                 | 22.8               | 160.0               | NNW             | 13                   | 1st 12 hrs                    |              |
|                    |                           |                          |                    |                     | NNE             | 13                   | 70                            | Poor         |
| 25                 | 071800Z                   | Recon                    | 22.8               | 161.1               | WNW             | 9                    | 45                            | Fair         |
| 26                 | 080000Z                   | Extrap                   | 23.0               | 162.1               | WNW             | 10                   | 45                            | Poor         |
| 27                 | 080600Z                   | Recon                    | 23.0               | 161.0               | STNY            | —                    | 40                            | Poor         |

**BEST TRACK ANALYSIS**  
**HURRICANE DOT**  
**02-07 AUG 1959**

Legend  
△ INDICATES RECON FIX

07/1858Z △ 07/0850Z

07/0220Z △

06/2110Z △

05/1843Z △

06/0514Z △

05/222Z △

03/1633Z △

05/0340Z △

05/1150Z △

04/1708Z △

04/2104Z △

04/0412Z △

03/2104Z △

03/161Z △

02/2356Z △

57

D. TYPHOON ELLEN (2-9 AUGUST 1959)

On 1 August, a well-developed low pressure cell, accompanied by a strong easterly wave, was evident to the northwest of Guam. A reconnaissance aircraft was directed into the area, and at 020535Z a definite eye with surface winds of 25 knots was found. Thus at 020600Z JTWC issued the first warning on Tropical Depression ELLEN. Six hours later ELLEN had reached tropical storm intensity and twenty-four hours later ELLEN was upgraded to a typhoon with center winds of 65 knots.

ELLEN proceeded to move in a northwesterly direction at an average speed of 12 knots, reaching her peak intensity approximately 200 miles south-southeast of Okinawa with center winds of 100 knots and a sea level pressure of 970 mbs. At 050200Z ELLEN passed abeam of Okinawa at a distance of 10 miles to the east-northeast. The highest wind recorded on the island was at Naha where sustained winds of 35 knots with gusts to 50 knots were observed. ELLEN then veered to a more northerly course and decelerated, finally stagnating off the southwest coast of Kyushu. She remained in this location for approximately 48 hours, blocked from further movement by a strong upper air ridge to the north. During this time ELLEN weakened considerably, and was downgraded to a tropical storm at 080600Z. By 071200Z it was evident that the ridge aloft had weakened to a marked degree, and ELLEN began to accelerate toward the east-northeast. She moved along the southern coast of Japan passing directly over Tokyo, and reached the open sea east of Honshu at 091100Z. ELLEN was now an extra-tropical storm moving in excess of twenty knots.

Typhoon ELLEN was characterized by an erratic path which is typical of early August typhoon climatology. Typhoon MARGE of 1951 had a similar path except that the unusual blocking southwest of Japan did not occur. The diameter of Typhoon ELLEN's eye was very large, averaging 50 miles, and several times reconnaissance aircraft reported the eye as having a diameter of 100 miles. Twenty-five warnings covering a period of 7 days were issued.

For damage caused by Typhoon ELLEN see section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON ELLEN

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 010345Z | 18.1N | 139.4E | 54-P-5              | 991         | 35          | 10090         | 30              | 10              | 09               | NO EYE              |
| 2       | 020535Z | 18.9N | 138.1E | 54-P-5              | 995         | 25          | 9980          | 25              | 08              | 07               | CIRC DIA 50 MI      |
| 3       | 020820Z | 18.9N | 137.8E | 54-T-10             | --          | --          | --            | --              | --              | --               |                     |
| 4       | 022030Z | 22.0N | 135.7E | 54-P-5              | 998         | --          | 9900          | 48              | 11              | 06               | CIRC DIA 40 MI      |
| 5       | 030215Z | 22.8N | 135.0E | 54-P-5              | 993         | 50          | 9840          | 35              | 10              | 09               | EYE DIFFUSE         |
| 09<br>6 | 030505Z | 22.5N | 135.2E | 54-P-5              | 987         | 75          | 9760          | 45              | 16              | 08               | EYE INDEFINITE      |
| 7       | 031144Z | 23.6N | 133.9E | 12-R-20             | --          | --          | --            | --              | --              | --               | HORSESHOE SHAPE     |
| 8       | 031702Z | 23.6N | 132.6E | 12-R-5              | --          | --          | --            | --              | --              | --               | HORSESHOE 30X20 MI  |
| 9       | 032030Z | 24.0N | 131.4E | 54-P-2              | 979         | 60          | 9560          | --              | 16              | 14               | CIRC OPEN NORTH     |
| 10      | 032300Z | 23.6N | 131.4E | 12-R-0              | --          | --          | --            | --              | --              | --               | HORSESHOE 55X25 MI  |
| 11      | 040200Z | 24.2N | 130.7E | 54-P-0              | 975         | 110         | 9520          | 40              | 17              | 15               | CIRC DIA 25 MI      |
| 12      | 040352Z | 24.0N | 130.3E | 56-P-5              | 970         | 65          | --            | --              | --              | --               | EYE INDEFINITE      |
| 13      | 041049Z | 25.1N | 129.6E | 12-R-3              | --          | --          | --            | --              | --              | --               | HORSESHOE 60X30 MI  |
| 14      | 041115Z | 24.0N | 129.9E | 54-R-20             | --          | --          | --            | --              | --              | --               |                     |
| 15      | 041400Z | 25.0N | 129.5E | 54-R-20             | --          | --          | --            | --              | --              | --               | CIRC DIA 60 MI      |
| 16      | 042030Z | 25.7N | 128.2E | 54-P-2              | --          | --          | 9570          | 60              | 17              | 11               | CIRC DIA 40 MI      |
| 17      | 050138Z | 26.7N | 128.6E | 56-P-3              | 971         | 60          | 9461          | --              | --              | --               | ELLIP 30X25 MI      |
| 18      | 050200Z | 26.5N | 128.9E | 54-P-2              | 973         | 50          | 9460          | 45              | 17              | 16               | CIRC DIA 30 MI      |
| 19      | 050800Z | 28.3N | 128.3E | 54-P-0              | 971         | 100         | 9390          | 60              | 16              | 12               | CIRC DIA 60 MI      |
| 20      | 051115Z | 27.7N | 128.7E | 12-R-2              | --          | --          | --            | --              | --              | --               | HORSESHOE SHAPE     |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON ELLEN (CONT'D)

| FLX<br>NO. | TIME    | LAT.  | LONG.  | *UNIT<br>METHOD<br>& ACY | MIN<br>SLP<br>MBS | MAX<br>SFC<br>WND | MIN<br>700MB<br>HGT | MAX<br>FLT<br>LVL<br>WND | 700MB<br>TEMP<br>(°C) | 700MB<br>DEWPT<br>(°C) | EYE CHARACTERISTICS |
|------------|---------|-------|--------|--------------------------|-------------------|-------------------|---------------------|--------------------------|-----------------------|------------------------|---------------------|
| 21         | 051300Z | 29.0N | 127.8E | 54-T-20                  | --                | --                | --                  | --                       | --                    | --                     |                     |
| 22         | 052130Z | 29.1N | 126.9E | 54-P-10                  | 974               | 75                | 9270                | 90                       | 20                    | 13                     | CIRC DIA 75 MI      |
| 23         | 052220Z | 29.6N | 128.2E | 12-R-0                   | --                | --                | --                  | --                       | --                    | --                     | ELLIP 100X60 MI     |
| 24         | 060103Z | 31.3N | 127.7E | 56-P-5                   | --                | --                | --                  | --                       | --                    | --                     | CIRC DIA 30 MI      |
| 25         | 060200Z | 29.9N | 127.0E | 56-P-7                   | 965               | --                | --                  | --                       | --                    | --                     | CIRC DIA 60 MI      |
| 26         | 060845Z | 30.0N | 126.9E | 54-P-5                   | 967               | 70                | 9260                | --                       | 19                    | 13                     | CIRC DIA 30 MI      |
| 27         | 061400Z | 30.6N | 127.4E | 54-T-15                  | --                | --                | --                  | 65                       | --                    | --                     |                     |
| 28         | 062200Z | 31.7N | 127.7E | 54-P-6                   | 964               | 80                | 9200                | 60                       | 16                    | 12                     | CIRC DIA 60 MI      |
| 29         | 062259Z | 31.0N | 128.1E | 12-R-5                   | --                | --                | --                  | --                       | --                    | --                     | CIRC DIA 100 MI     |
| 30         | 070200Z | 31.3N | 128.4E | 54-P-5                   | 964               | 80                | 9140                | 65                       | 18                    | 15                     | CIRC DIA 100 MI     |
| 31         | 070700Z | 30.4N | 128.5E | 54-P-6                   | 966               | 60                | 9120                | 75                       | 17                    | 15                     | CIRC DIA 100 MI     |
| 32         | 072000Z | 31.2N | 129.9E | 54-R-2                   | --                | --                | --                  | 65                       | --                    | --                     | CIRC DIA 05 MI      |
| 33         | 080940Z | 32.8N | 133.0E | 54-P-0                   | 978               | 55                | 9330                | 50                       | 16                    | 14                     | EYE VERY DIFFUSE    |

19



TYPHOON ELLEN 02 - 09 AUGUST 1959  
POSITION AND FORECAST VERIFICATION DATA

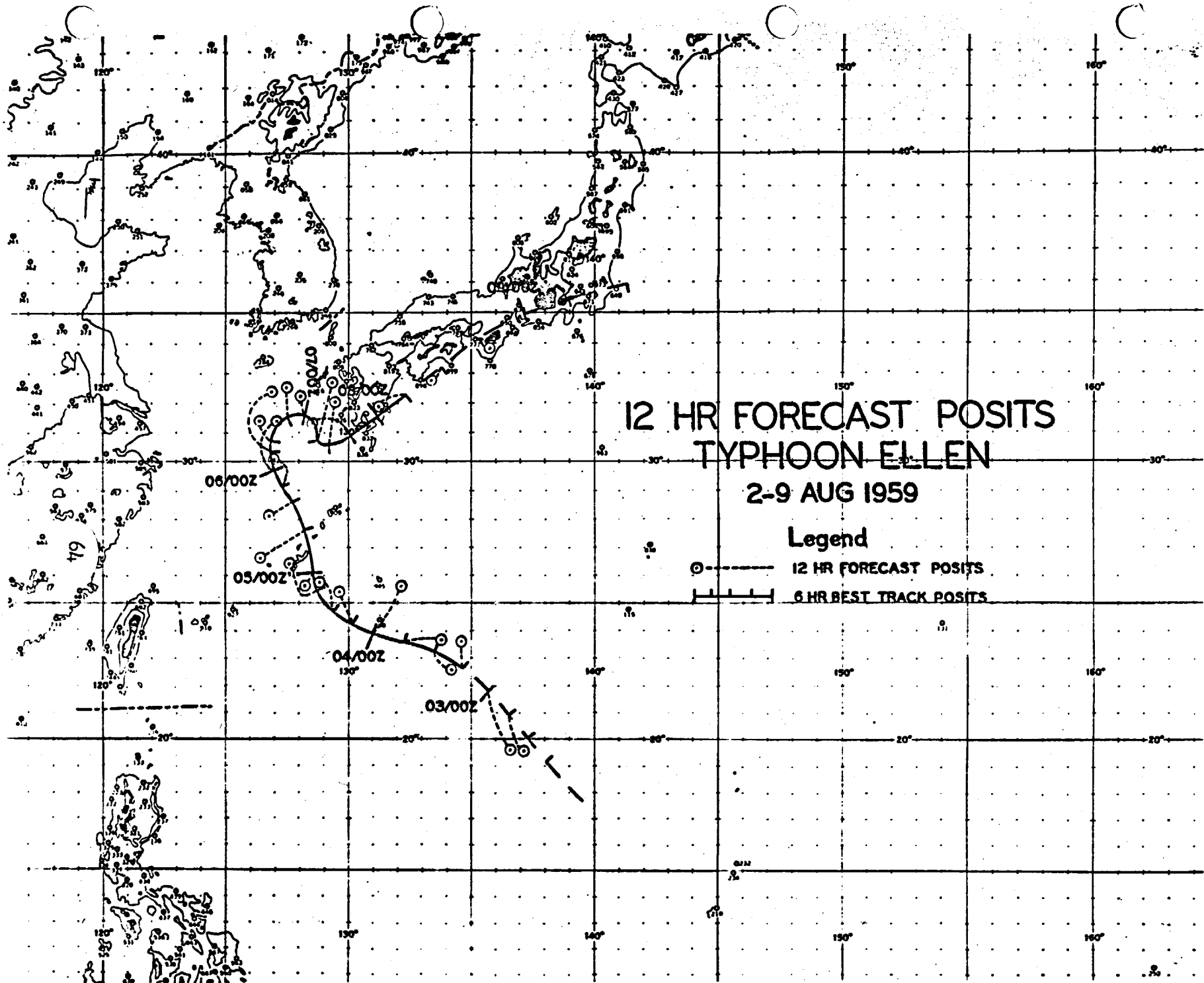
| DTG                            | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|--------------------------------|----------------|--------|-------------|----------|-------------|----------|
|                                | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 020600Z                        | 19.1N          | 138.1E | -           | -        | -           | -        |
| 021200Z                        | 20.1N          | 137.3E | -           | -        | -           | -        |
| 021800Z                        | 21.0N          | 136.5E | -           | -        | -           | -        |
| 030000Z                        | 21.9N          | 135.7E | 157         | - 141    | -           | -        |
| 030600Z                        | 22.7N          | 134.7E | 006         | - 55     | -           | -        |
| 031200Z                        | 23.3N          | 133.5E | 143         | - 61     | 146         | - 216    |
| 031800Z                        | 23.8N          | 132.3E | 097         | - 85     | 045         | - 188    |
| 040000Z                        | 24.0N          | 131.0E | 035         | - 108    | 095         | - 115    |
| 040600Z                        | 24.3N          | 130.2E | 338         | - 70     | 083         | - 137    |
| 041200Z                        | 24.8N          | 129.4E | 330         | - 62     | 019         | - 160    |
| 041800Z                        | 25.4N          | 128.8E | 315         | - 86     | 323         | - 133    |
| 050000Z                        | 26.2N          | 128.6E | 158         | - 46     | 300         | - 125    |
| 050600Z                        | 27.8N          | 128.2E | 234         | - 117    | 278         | - 145    |
| 051200Z                        | 28.7N          | 127.6E | 225         | - 55     | 219         | - 123    |
| 051800Z                        | 29.3N          | 127.3E | 339         | - 53     | 245         | - 165    |
| 060000Z                        | 29.8N          | 127.1E | 002         | - 91     | 264         | - 117    |
| 060600Z                        | 30.3N          | 126.9E | 360         | - 122    | 330         | - 141    |
| 061200Z                        | 30.8N          | 126.9E | 004         | - 107    | 359         | - 210    |
| 061800Z                        | 31.6N          | 127.4E | 007         | - 54     | 349         | - 194    |
| 070000Z                        | 31.6N          | 128.2E | 353         | - 32     | 351         | - 212    |
| 070600Z                        | 30.8N          | 128.7E | 015         | - 115    | 360         | - 234    |
| 071200Z                        | 30.6N          | 129.2E | 008         | - 87     | 007         | - 210    |
| 071800Z                        | 30.8N          | 130.0E | 250         | - 82     | 013         | - 234    |
| 080000Z                        | 31.5N          | 131.1E | 068         | - 33     | 347         | - 84     |
| 080600Z                        | 32.3N          | 132.3E | 245         | - 65     | 241         | - 158    |
| 081200Z                        | 33.3N          | 133.7E | 220         | - 37     | 233         | - 145    |
| 081800Z                        | 34.2N          | 135.3E | 317         | - 28     | 235         | - 175    |
| 090000Z                        | 34.9N          | 137.1E | -           | -        | 228         | - 43     |
| 090600Z                        | 35.4N          | 138.9E | -           | -        | -           | -        |
| 091200Z                        | 36.0N          | 141.3E | -           | -        | -           | -        |
| AVERAGE 12 HOUR FORECAST ERROR |                |        | 74.7 NM     |          |             |          |
| AVERAGE 24 HOUR FORECAST ERROR |                |        | 158.8 NM    |          |             |          |



# 12 HR FORECAST POSITS TYPHOON ELLEN 2-9 AUG 1959

## Legend

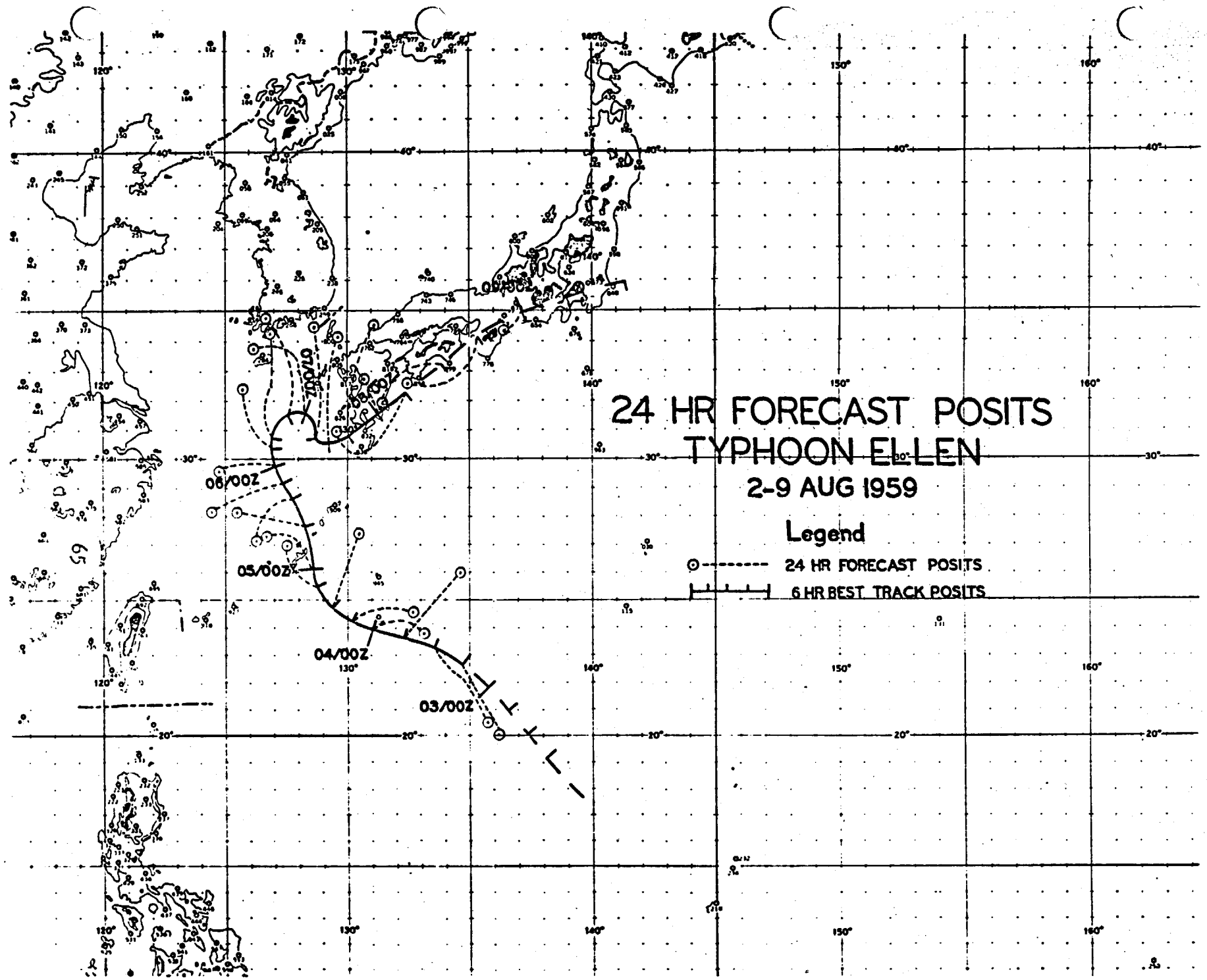
- ⊙----- 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS



# 24 HR FORECAST POSITS TYPHOON ELLEN 2-9 AUG 1959

## Legend

- 24 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS



E. TYPHOON GEORGIA (12-14 AUGUST 1959)

For several days beginning on 10 August, a weak, ill-defined low pressure system was forming in the vicinity of Guam. A Weather reconnaissance aircraft, directed into the area, located Tropical Depression FRAN approximately 60 miles north of the island at 111200Z. However, some 12 hours later, it was evident that a second center induced by a fracture of the upper air polar trough was forming approximately 400 miles to the north of FRAN. Again a reconnaissance aircraft was sent to investigate and, at 120100Z, Tropical Storm GEORGIA was located at 22.4N - 145.2E with maximum observed surface winds of 45 knots. GEORGIA subsequently became the predominant circulation and FRAN quickly dissipated. At 120900Z, eight hours after initial detection, Tropical Storm GEORGIA was upgraded to a typhoon with center winds of 65 knots.

For twenty-four hours Typhoon GEORGIA moved in a northwesterly direction at an average speed of 14 knots. During this time GEORGIA passed 40 miles northeast of Iwo Jima and 50 miles southwest of Chichi Jima. During the passage of the typhoon, Iwo Jima reported maximum winds of 40 knots with gusts to 53 knots and Chichi Jima reported maximum winds of 30 knots with gusts to 48 knots. The reason neither of the islands experienced stronger winds was due to the fact that in the early stages GEORGIA was a "tight" circulation with maximum winds concentrated within a small distance of the center. After passing Chichi Jima, GEORGIA accelerated and increased in intensity reaching her peak at 130908Z when reconnaissance aircraft reported surface winds of 120 knots. She then turned to a north-northwesterly course and moved

at 25 knots. At 132230Z Typhoon GEORGIA, with center winds of 75 knots, passed approximately 45 miles west of Tokyo. At 140000Z she was downgraded to a tropical storm, having expended much of her energy crossing the Japanese Mainland. Six hours later, at 140600Z, GEORGIA had become an extra-tropical storm.

The formation of typhoons north of 20 degrees due to a fracture of the polar trough, while quite rare, is most common in the month of August. A check of climatology showed none with a history entirely similar to that of Typhoon GEORGIA. A strong gradient, associated with the upper level high oriented north-south to the east of GEORGIA, caused her to rapidly accelerate and move northward over Japan into the Sea of Japan. A total of only 9 warnings covering 3 days were issued.

For damage caused by Typhoon GEORGIA see section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON GEORGIA

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 120100Z | 22.4N | 145.2E | 54-P-5              | 991         | 45          | 9860          | 40              | 11              | 11               | CIRC DIA 25 MI      |
| 2       | 120905Z | 23.4N | 143.4E | 54-P-15             | 968         | 65          | 9620          | 55              | 15              | 11               | CIRC DIA 20 MI      |
| 3       | 121100Z | 24.3N | 143.0E | 54-R-20             | --          | --          | --            | 28              | --              | --               | CIRC DIA 20 MI      |
| 4       | 122000Z | 25.8N | 141.8E | 54-P-0              | 964         | 95          | 9050          | 72              | 19              | 16               | CIRC DIA 08 MI      |
| 5       | 130200Z | 27.3N | 140.8E | 54-P-0              | 956         | 110         | 8960          | 60              | 20              | 17               | CIRC DIA 15 MI      |
| 6       | 130230Z | 27.2N | 140.8E | 54-P-1              | 953         | 75          | --            | --              | --              | --               | ELLIP 18X09 MI      |
| 7       | 130734Z | 29.2N | 140.2E | 12-R-4              | --          | --          | --            | --              | --              | --               | CIRC DIA 09 MI      |
| 8       | 130908Z | 29.6N | 139.9E | 56-P-5              | 953         | 120         | --            | --              | --              | --               | CIRC DIA 10 MI      |
| 9       | 131400Z | 31.5N | 139.8E | 56-R-5              | --          | --          | --            | 55              | --              | --               | CIRC DIA 10 MI      |
| 10      | 132000Z | 34.4N | 138.9E | 54-P-2              | 961         | 90          | 9030          | 70              | 16              | 15               | CIRC DIA 25 MI      |

TYPHOON GEORGIA 12 - 14 AUGUST 1959  
POSITION AND FORECAST VERIFICATION DATA

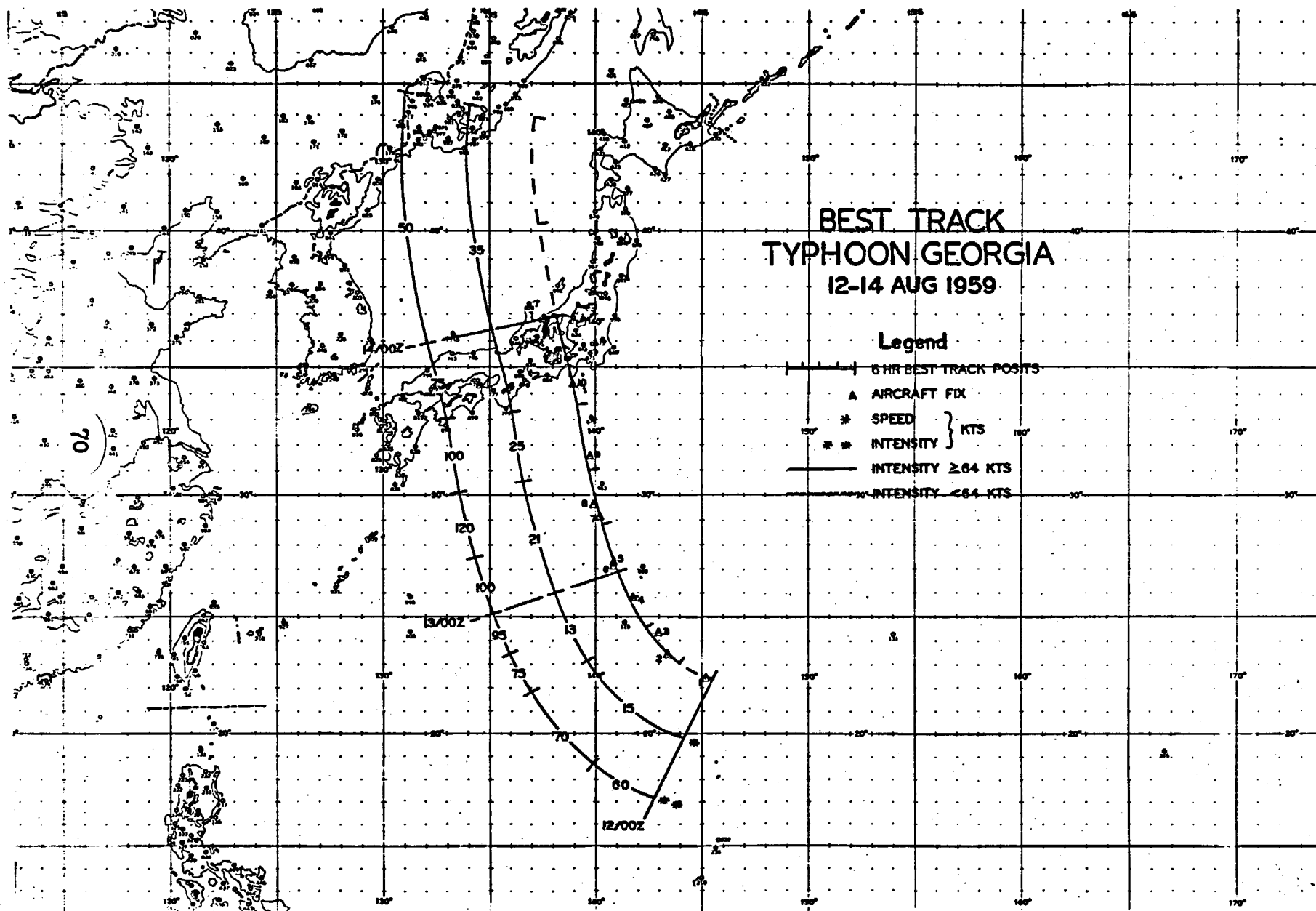
| DTG                            | STORM POSITION |        | 12 HR ERROR   | 24 HR ERROR   |
|--------------------------------|----------------|--------|---------------|---------------|
|                                | LAT.           | LONG.  | DEG. DISTANCE | DEG. DISTANCE |
| 120000Z                        | 22.4N          | 145.5E | - - - -       | - - - -       |
| 120600Z                        | 23.0N          | 144.0E | - - - -       | - - - -       |
| 121200Z                        | 24.6N          | 142.4E | 136 - 100     | - - - -       |
| 121800Z                        | 25.7N          | 141.7E | 193 - 56      | - - - -       |
| 130000Z                        | 26.9N          | 141.1E | 224 - 66      | 164 - 143     |
| 130600Z                        | 28.9N          | 140.3E | 219 - 72      | 210 - 163     |
| 131200Z                        | 31.0N          | 139.7E | 195 - 104     | 209 - 183     |
| 131800Z                        | 33.5N          | 139.2E | 207 - 115     | 214 - 192     |
| 140000Z                        | 36.9N          | 138.2E | 146 - 153     | 186 - 252     |
| 140600Z                        | 40.3N          | 137.4E | 125 - 195     | 165 - 315     |
| 141200Z                        | 43.9N          | 137.2E | 098 - 240     | 146 - 404     |
| AVERAGE 12 HOUR FORECAST ERROR |                |        | 122.3 NM      |               |
| AVERAGE 24 HOUR FORECAST ERROR |                |        | 236.0 NM      |               |

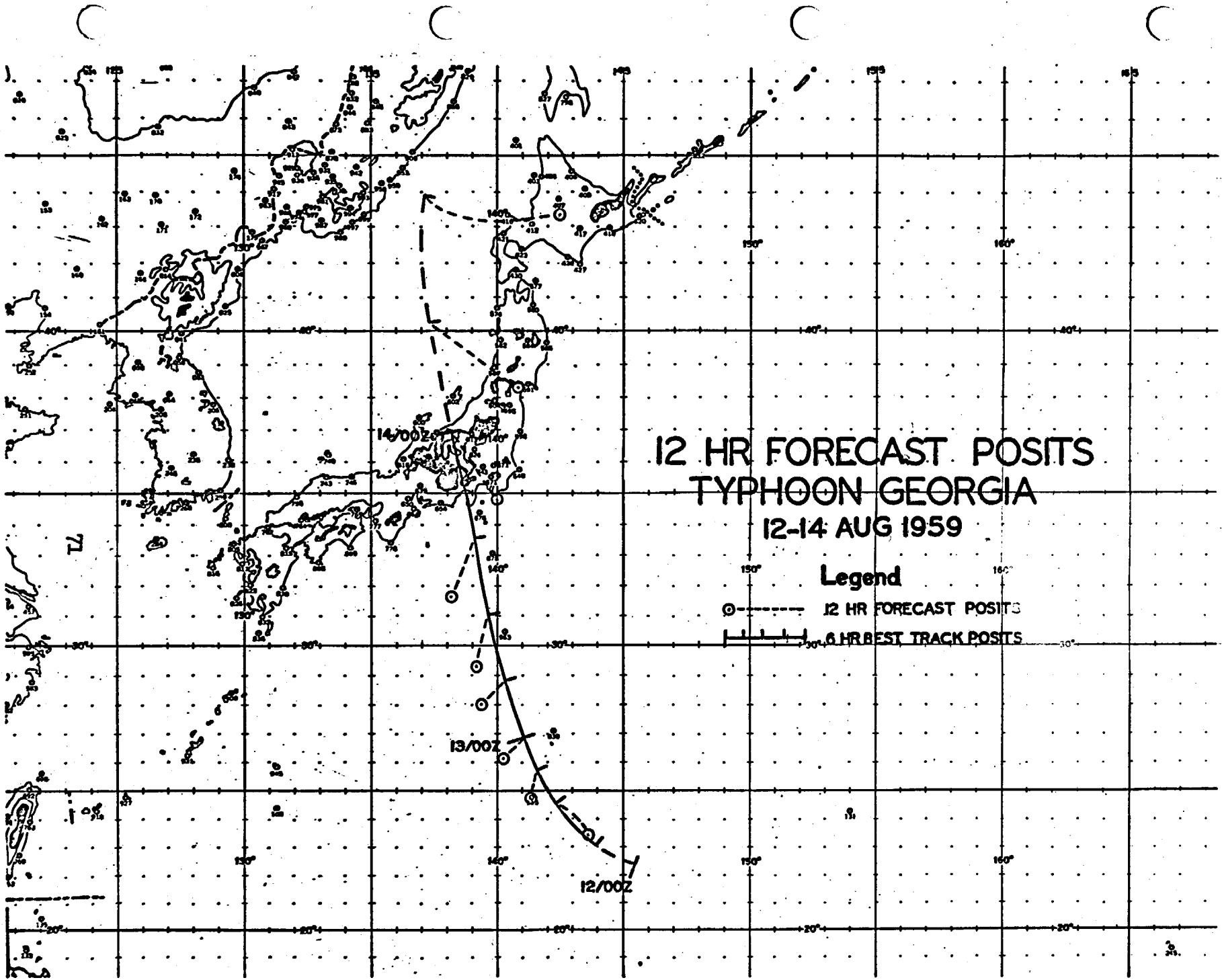


BEST TRACK  
TYPHOON GEORGIA  
12-14 AUG 1959

Legend

- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \* \* INTENSITY } KTS
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS





# 12 HR FORECAST POSITS TYPHOON GEORGIA 12-14 AUG 1959

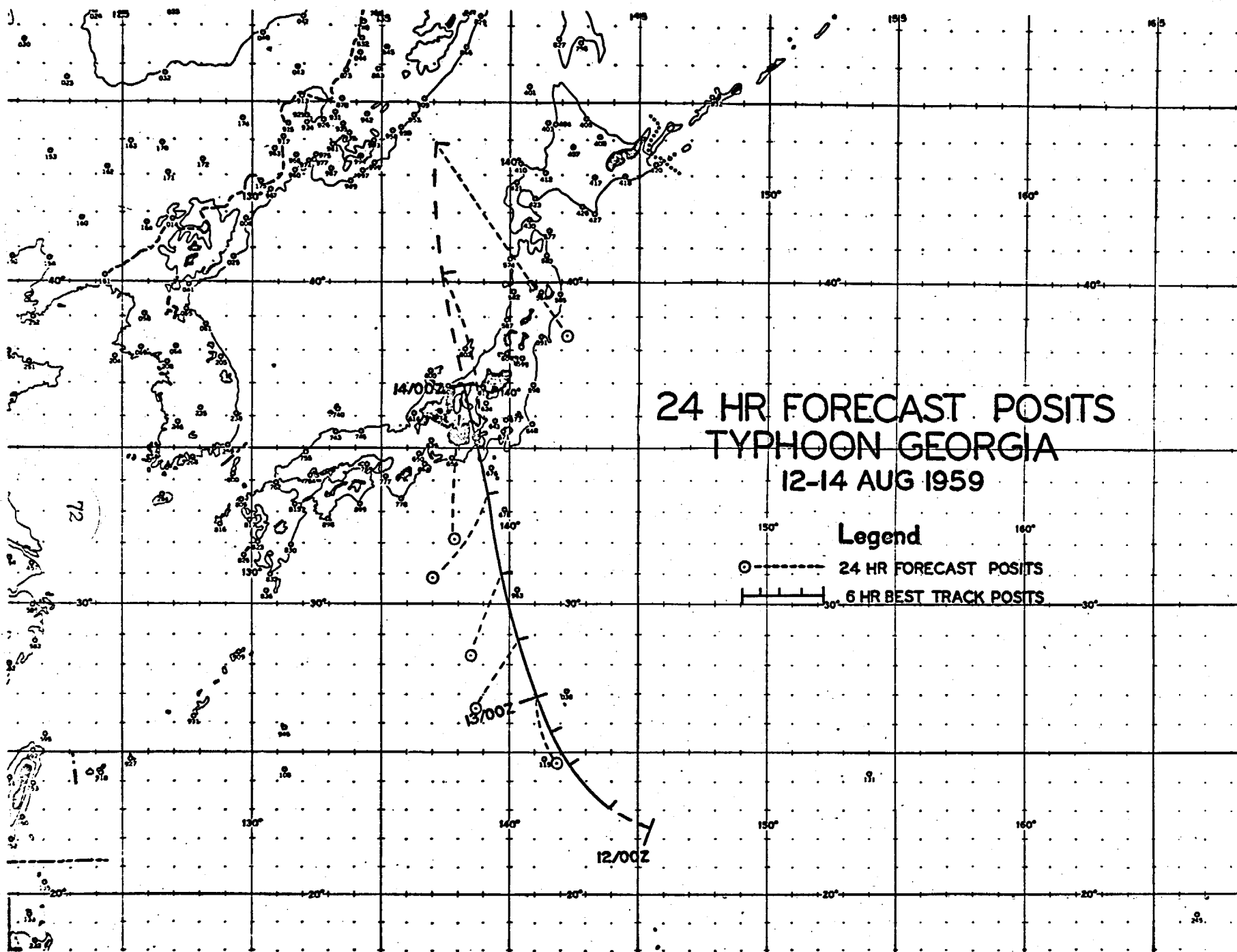
## Legend

- ⊙----- 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS

24 HR FORECAST POSITS  
TYPHOON GEORGIA  
12-14 AUG 1959

Legend

- 24 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS



F. TYPHOON IRIS (19-23 AUGUST 1959)

The first indication of the tropical disturbance, later to become Typhoon IRIS, was noted on 19 August when analysis of the 0000Z surface chart indicated a weak cyclonic circulation forming on the Intertropical Convergence Zone in the vicinity of 16N - 128E. The area was designated Cyclone 18, and a reconnaissance aircraft was requested to make an investigation. At 200200Z a closed surface circulation was found at 16.5N - 125.9E with maximum observed surface winds of 70 knots. This was the fifth typhoon of 1959, Typhoon IRIS.

At first IRIS moved west-northwesterly at 7 knots, blocked from any pronounced northward movement by a strong high lying across Southeastern Asia. However, the high gradually weakened and receded, enabling the typhoon to veer more northerly. Thus IRIS began moving to the northwest at 15 knots, a track which took her within 45 miles of the southern tip of Taiwan. IRIS then moved on to the coast of China near Kao-Chi where she rapidly became extra-tropical and subsequently dissipated.

IRIS was characterized by rapid intensification. There were no unusual forecasting problems in connection with IRIS, and the forecast errors were near average for 12, 24 and 48 hours. A total of twelve warnings were issued covering a period of 3 days.

For damage caused by Typhoon IRIS see section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON IRIS

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 200200Z | 16.5N | 125.9E | 54-P-5              | 994         | 70          | 9980          | 40              | 12              | 05               | CIRC DIA 20 MI      |
| 2       | 201400Z | 17.0N | 124.2E | 54-R-10             | --          | --          | --            | 45              | --              | --               | HVY SPIRAL BANDS    |
| 3       | 202000Z | 17.1N | 124.0E | 54-R-10             | --          | --          | --            | 80              | --              | --               | CIRC DIA 40 MI      |
| 4       | 202140Z | 17.1N | 123.6E | 54-P-5              | 985         | 85          | 9760          | 80              | 14              | 10               | CIRC DIA 45 MI      |
| 5       | 210200Z | 17.3N | 123.5E | 54-P-5              | 998         | 85          | 9650          | 80              | 15              | 10               | CIRC DIA 40 MI      |
| 6       | 210800Z | 18.2N | 123.1E | 54-P-2              | 976         | 100         | 9500          | 80              | 13              | 11               | EYE ELLIP 45X60 MI  |
| 7       | 212210Z | 20.3N | 121.2E | 54-P-2              | 971         | 65          | 9570          | 80              | 17              | 08               | CIRC DIA 20 MI      |
| 8       | 220200Z | 20.5N | 120.7E | 54-P-2              | 976         | 85          | 9430          | 100             | 16              | 07               | CIRC DIA 25 MI      |
| 9       | 220800Z | 21.8N | 120.0E | 54-P-2              | 966         | 85          | 9130          | 75              | 19              | 11               | CIRC DIA 30 MI      |
| 10      | 221000Z | 22.1N | 119.9E | 54-P-10             | 966         | 100         | 9140          | 80              | 19              | 10               | CIRC DIA 15 MI      |

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TYPHOON IRIS 19 - 23 AUGUST 1959  
POSITION AND FORECAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 190000Z | 16.2N          | 128.4E | - - - -     | - - - -  | - - - -     | - - - -  |
| 190600Z | 16.2N          | 128.0E | - - - -     | - - - -  | - - - -     | - - - -  |
| 191200Z | 16.3N          | 127.3E | - - - -     | - - - -  | - - - -     | - - - -  |
| 191800Z | 16.3N          | 126.8E | - - - -     | - - - -  | - - - -     | - - - -  |
| 200000Z | 16.4N          | 126.1E | - - - -     | - - - -  | - - - -     | - - - -  |
| 200600Z | 16.6N          | 125.5E | - - - -     | - - - -  | - - - -     | - - - -  |
| 201200Z | 16.8N          | 124.8E | 270         | - 36     | - - - -     | - - - -  |
| 201800Z | 17.2N          | 124.1E | 215         | - 25     | - - - -     | - - - -  |
| 210000Z | 17.4N          | 123.7E | 260         | - 45     | 260         | - 90     |
| 210600Z | 17.9N          | 123.2E | 155         | - 44     | 220         | - 64     |
| 211200Z | 18.5N          | 122.5E | 155         | - 61     | 235         | - 81     |
| 211800Z | 19.4N          | 121.6E | 140         | - 43     | 150         | - 130    |
| 220000Z | 20.3N          | 120.9E | 145         | - 90     | 155         | - 154    |
| 220600Z | 21.4N          | 120.2E | 040         | - 54     | 155         | - 143    |
| 221200Z | 22.6N          | 119.3E | 180         | - 64     | 155         | - 181    |
| 221800Z | 23.9N          | 118.4E | 165         | - 50     | 205         | - 127    |
| 230000Z | 25.0N          | 117.3E | 045         | - 10     | 175         | - 144    |

AVERAGE 12 HOUR FORECAST ERROR  
AVERAGE 24 HOUR FORECAST ERROR

47.5 NM  
123.8 NM

# BEST TRACK TYPHOON IRIS 19-23 AUG 1959

## Legend

6 HR BEST TRACK POSITS

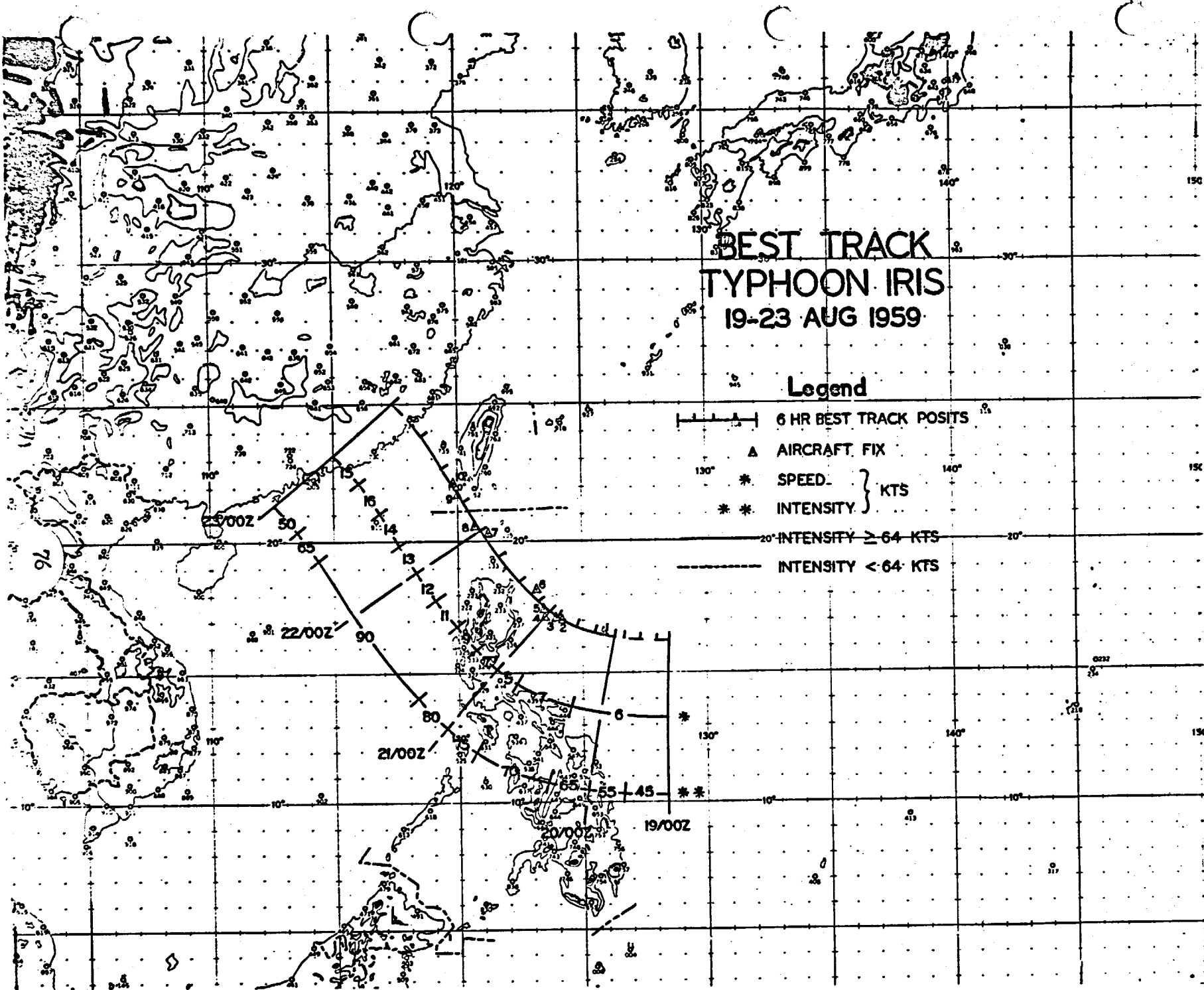
AIRCRAFT FIX

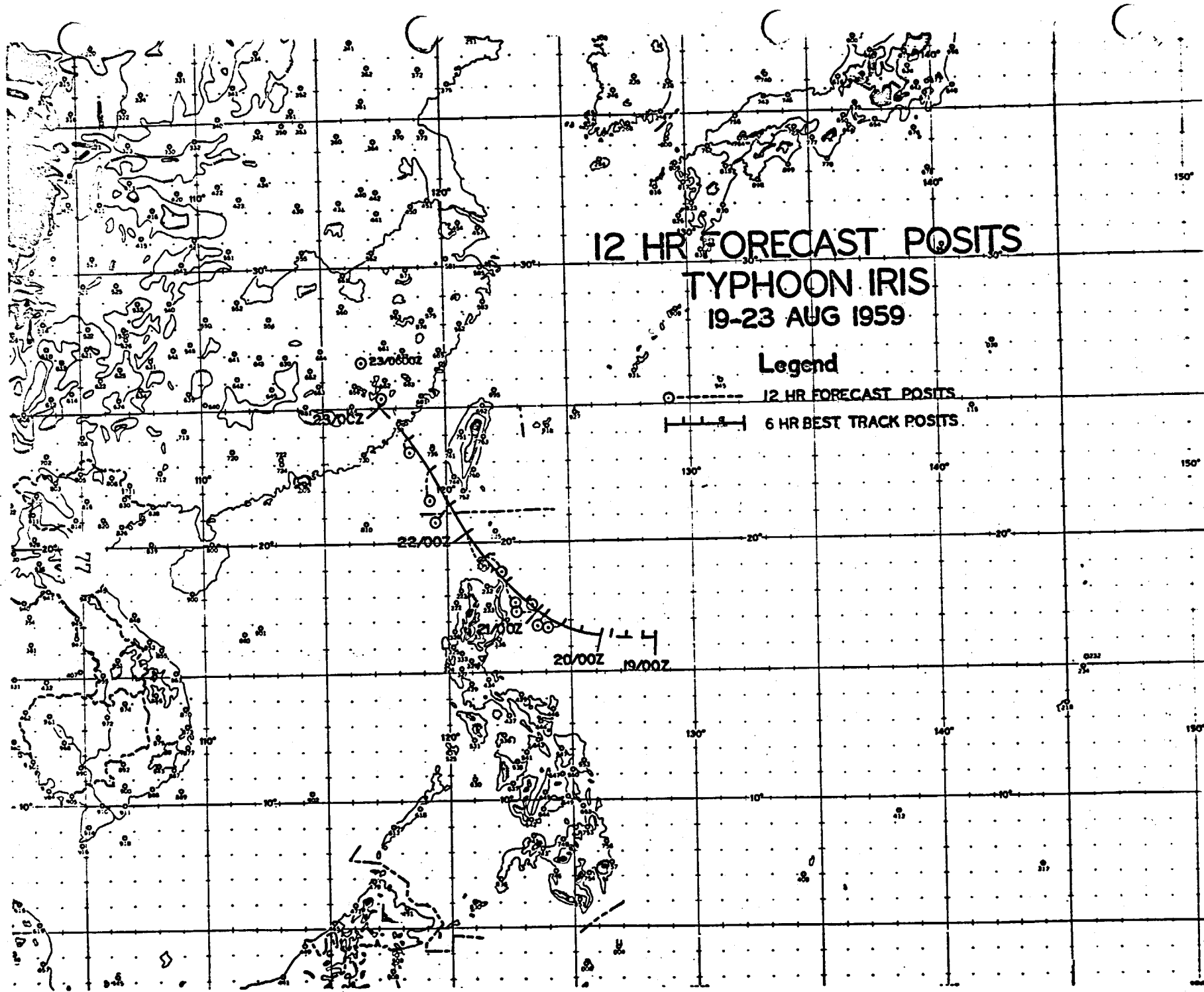
SPEED. } KTS

INTENSITY. }

— INTENSITY  $\geq$  64 KTS

--- INTENSITY  $<$  64 KTS







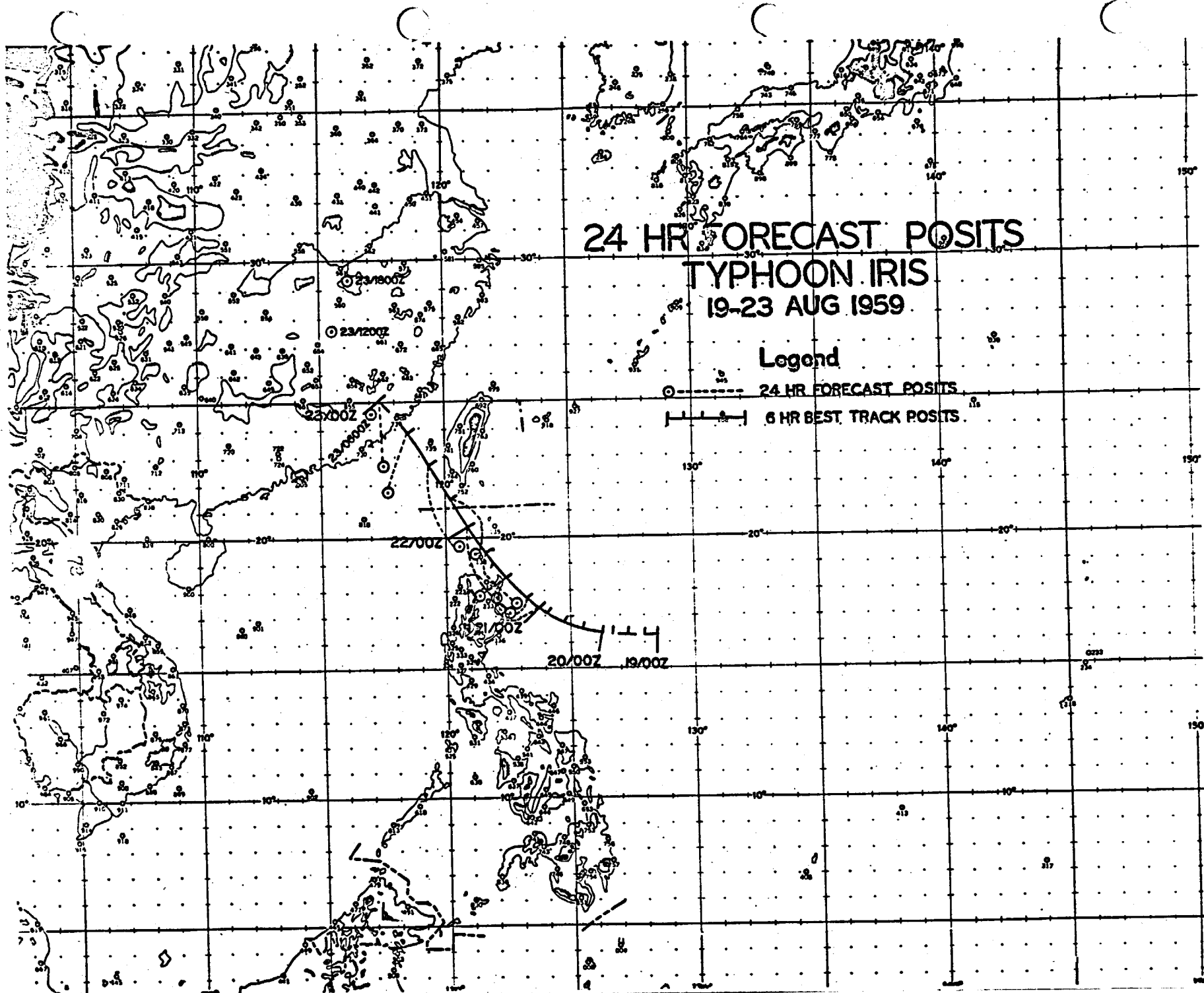
# 24 HR FORECAST POSITS

## TYPHOON IRIS

19-23 AUG 1959

### Legend

- 24 HR FORECAST POSITS
- +—+—+— 6 HR BEST TRACK POSITS



G. TYPHOON JOAN (25-30 AUGUST 1959)

On 23 August, Guam's winds aloft shifted from easterly to northerly, and surface analyses indicated a surface center northeast of the island. A reconnaissance aircraft was directed into this suspect area, and a fix was made at 250325Z. On the basis of this information, Tropical Storm JOAN Warning Number 1 was transmitted with maximum surface winds near the center of 40 knots. The storm intensified very rapidly, and 23 hours later was upgraded to a typhoon with winds near the center of 85 knots.

Typhoon JOAN assumed and maintained a northwesterly course bore-sighted for the island of Taiwan. Movement began with a speed of 10 knots gradually increasing to 17 knots prior to hitting Taiwan. Her peak intensity was reached at 290800Z when aircraft reconnaissance observed maximum surface winds of 200 knots and a sea level pressure of 891 millibars. Orographic effect of the mountains of Taiwan had a decided weakening effect on JOAN as the center moved directly across the island. However, winds in excess of 50 knots were reported by several stations on Taiwan and there was considerable damage. Moving at a slower speed of 10 knots, and with surface winds under 100 knots, JOAN moved on to the Chinese Mainland at 300500Z and began to degenerate. At 301800Z, when it was evident that JOAN would remain inland and continue rapid dissipation, JTWC issued a final warning.

Climatologically JOAN was slightly premature since her track was similar to the path normal for early September. Typhoon NELLIE of September 1949 most closely approximated JOAN's track. JOAN was 1959's strongest typhoon in size and intensity. In horizontal extent, JOAN

dominated an area of the Western Pacific of more than 1,000 miles in diameter, and 50 knot winds extended up to a radius of 300 miles. Her minimum 700 millibar height and minimum sea level pressure set the record lows for the 1959 Typhoon Season. JOAN presented few forecast difficulties, although two questionable fixes on the 28th led to an erroneous recurvature forecast. Twenty-four warnings were issued covering a period of 6 days.

For damage caused by Typhoon JOAN see section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON JOAN

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS   |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|-----------------------|
| 1       | 250325Z | 16.0N | 143.3E | 54-P-5              | 1001        | 20          | 10040         | 30              | 10              | 10               | CIRC DIA 20 MI        |
| 2       | 250600Z | 15.9N | 143.2E | 54-P-5              | 998         | 45          | 10020         | 45              | 10              | 09               | CIRC DIA 40 MI        |
| 3       | 252015Z | 15.8N | 140.4E | 54-P-5              | 992         | 45          | 9890          | 38              | 12              | 09               | EYE CIRC - OPEN NORTH |
| 4       | 260215Z | 15.6N | 139.5E | 54-P-10             | 984         | 85          | 9730          | 50              | 17              | 10               | CIRC DIA 50 MI        |
| 5       | 260800Z | 15.7N | 138.7E | 54-P-10             | 979         | 95          | 9600          | 60              | 16              | 09               | CIRC DIA 50 MI        |
| 6       | 261400Z | 16.0N | 138.0E | 54-R-15             | --          | --          | --            | --              | --              | --               | -----                 |
| 7       | 262315Z | 16.5N | 136.1E | 54-P-5              | 972         | 100         | 9280          | 70              | 15              | 13               | CIRC DIA 30 MI        |
| 8       | 270230Z | 16.5N | 135.4E | 54-P-10             | 961         | 100         | 9190          | 80              | 17              | 12               | CIRC DIA 30 MI        |
| 9       | 270745Z | 16.7N | 134.0E | 54-P-5              | 961         | 100         | 8850          | 80              | 20              | 13               | CIRC DIA 30 MI        |
| 10      | 271400Z | 17.4N | 132.7E | 54-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 25 MI        |
| 11      | 271730Z | 17.9N | 132.4E | 54-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 25 MI        |
| 12      | 272000Z | 18.0N | 131.5E | 54-R-5              | --          | --          | --            | 80              | --              | --               | CIRC DIA 25 MI        |
| 13      | 272100Z | 18.3N | 131.0E | 54-P-5              | 916         | 100         | 7930          | 110             | 23              | 12               | CIRC DIA 25 MI        |
| 14      | 272230Z | 18.6N | 130.9E | 12-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI        |
| 15      | 280200Z | 18.8N | 130.0E | 54-P-5              | 906         | 100         | 7520          | 125             | 24              | 12               | CIRC DIA 18 MI        |
| 16      | 280800Z | 19.3N | 128.8E | 54-P-5              | 906         | 175         | 7240          | 125             | 23              | 15               | ELLIP AXIS 20 MI      |
| 17      | 281100Z | 20.1N | 128.3E | 12-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI        |
| 18      | 281415Z | 21.0N | 127.6E | 54-R-5              | --          | --          | --            | 125             | --              | --               | CIRC DIA 18 MI        |
| 19      | 282125Z | 21.1N | 125.3E | 54-P-5              | 891         | 190         | 6850          | 150             | 25              | 13               | CIRC DIA 18 MI        |

RECONNAISSANCE AIRCRAFT FIXES - JOAN (CONT'D)

| FIX<br>NO. | TIME    | LAT.  | LONG.  | *UNIT<br>METHOD<br>& ACCY | MIN<br>SLP<br>MBS | MAX<br>SFC<br>WND | MIN<br>700MB<br>HGT | MAX<br>FLT<br>LVL<br>WND | 700MB<br>TEMP<br>(°C) | 700MB<br>DEWPT<br>(°C) | EYE CHARACTERISTICS |
|------------|---------|-------|--------|---------------------------|-------------------|-------------------|---------------------|--------------------------|-----------------------|------------------------|---------------------|
| 20         | 290200Z | 21.5N | 124.2E | 54-P-2                    | 898               | --                | 7190                | 140                      | 17                    | 12                     | CIRC DIA 20 MI      |
| 21         | 290340Z | 21.8N | 123.8E | 56-R-5                    | 900               | 150               | --                  | --                       | --                    | --                     | ELLIP 35E-W 40N-S   |
| 22         | 290800Z | 22.4N | 123.0E | 54-P-2                    | 898               | 200               | 7280                | 180                      | 21                    | 16                     | CIRC DIA 20 MI      |
| 23         | 290522Z | 22.1N | 123.7E | 12-R-2                    | --                | --                | --                  | --                       | --                    | --                     | -----               |
| 24         | 292050Z | 24.0N | 120.7E | 54-T-30                   | --                | --                | --                  | 65                       | --                    | --                     | -----               |

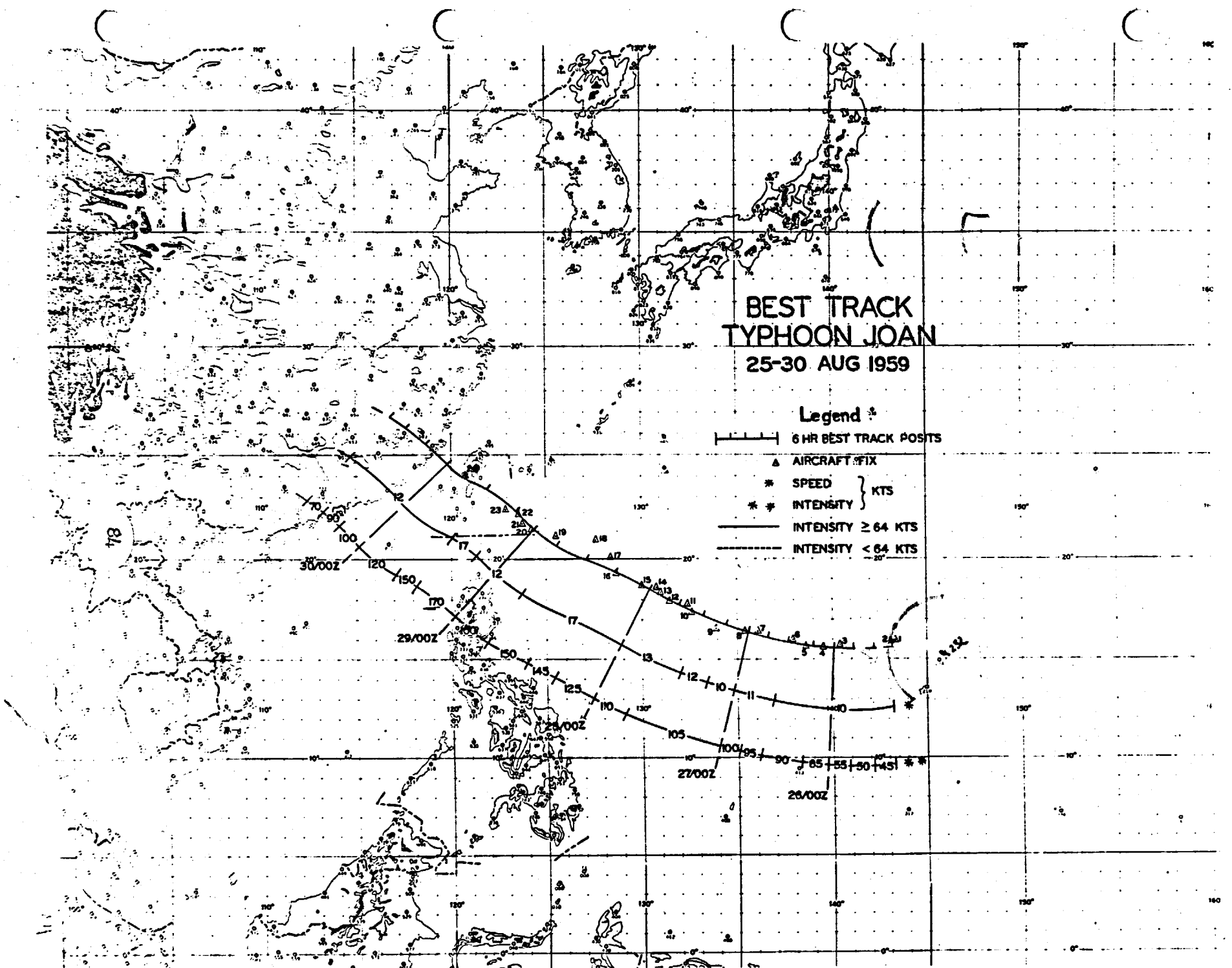
TYPHOON JOAN 25 - 30 AUGUST 1959  
POSITION AND FORECAST VERIFICATION DATA

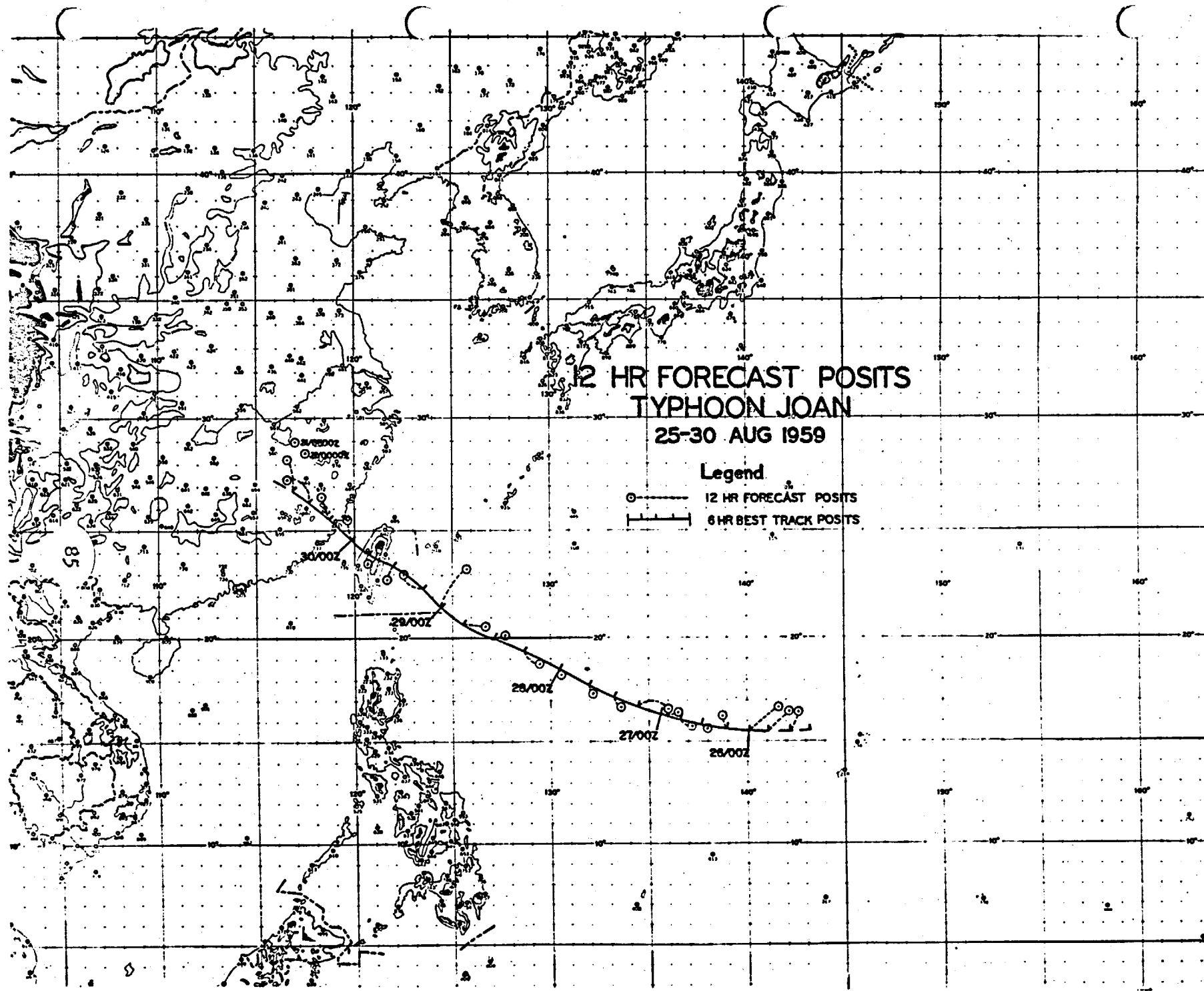
| DTG                   | STORM POSITION |          | 12 HR ERROR |          | 24 HR ERROR |          |
|-----------------------|----------------|----------|-------------|----------|-------------|----------|
|                       | LAT.           | LONG.    | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 250600Z               | 15.5N          | 143.2E   | -           | -        | -           | -        |
| 251200Z               | 15.5N          | 142.2E   | 025         | - 58     | -           | -        |
| 251800Z               | 15.6N          | 141.1E   | 045         | - 79     | -           | -        |
| 260000Z               | 15.7N          | 140.1E   | 051         | - 112    | 045         | - 118    |
| 260600Z               | 15.8N          | 139.0E   | 065         | - 60     | 057         | - 139    |
| 261200Z               | 15.9N          | 137.8E   | 159         | - 17     | 060         | - 174    |
| 261800Z               | 16.2N          | 136.7E   | 120         | - 31     | 040         | - 51     |
| 270000Z               | 16.4N          | 135.7E   | 110         | - 54     | 145         | - 36     |
| 270600Z               | 16.8N          | 134.5E   | 108         | - 130    | 134         | - 63     |
| 271200Z               | 17.2N          | 133.3E   | 122         | - 28     | 112         | - 106    |
| 271800Z               | 17.7N          | 132.0E   | 169         | - 28     | 114         | - 156    |
| 280000Z               | 18.4N          | 130.4E   | 116         | - 13     | 152         | - 84     |
| 280600Z               | 19.2N          | 128.8E   | 116         | - 38     | 135         | - 85     |
| 281200Z               | 20.0N          | 127.2E   | 080         | - 25     | 099         | - 66     |
| 281800Z               | 20.8N          | 125.6E   | 110         | - 66     | 110         | - 92     |
| 290000Z               | 21.5N          | 124.5E   | 036         | - 123    | 052         | - 46     |
| 290600Z               | 22.2N          | 123.5E   | 310         | - 75     | 072         | - 72     |
| 291200Z               | 23.2N          | 122.0E   | 216         | - 23     | 033         | - 221    |
| 291800Z               | 23.9N          | 120.9E   | 213         | - 29     | 300         | - 108    |
| 300000Z               | 24.7N          | 119.9E   | 345         | - 48     | 253         | - 75     |
| 300600Z               | 25.4N          | 118.9E   | 332         | - 76     | 214         | - 37     |
| 301200Z               | 26.2N          | 117.9E   | 278         | - 72     | 017         | - 180    |
| 301800Z               | 26.9N          | 116.8E   | 342         | - 72     | 019         | - 204    |
| AVERAGE 12 HOUR ERROR |                | 57.1 NM  |             |          |             |          |
| AVERAGE 24 HOUR ERROR |                | 105.7 NM |             |          |             |          |

# BEST TRACK TYPHOON JOAN 25-30 AUG 1959

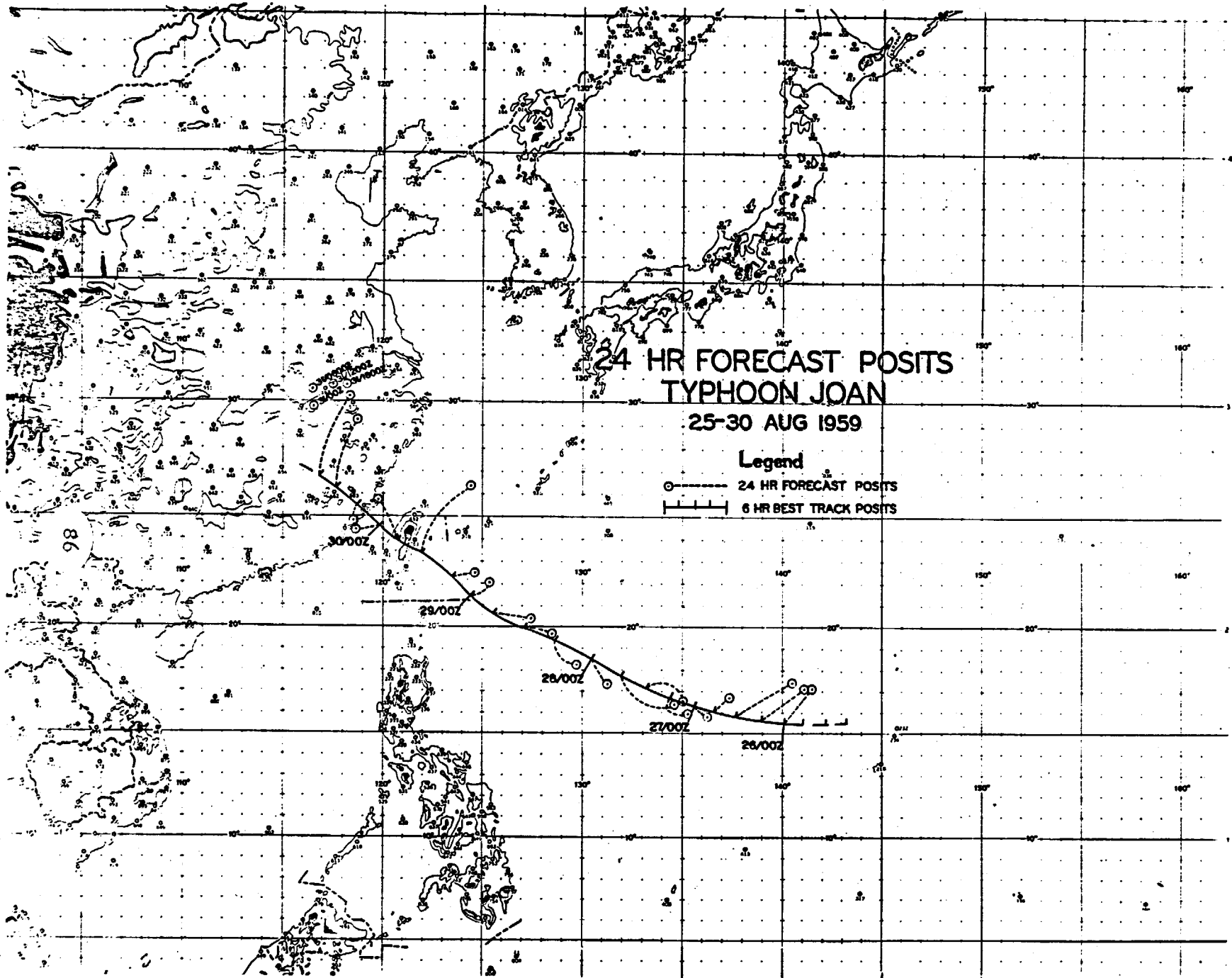
## Legend \*

- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \* \* INTENSITY } KTS
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS









H. TYPHOON LOUISE (30 AUGUST - 7 SEPTEMBER 1959)

On 27 August, while Typhoon JOAN was approximately 400 miles southeast of Taiwan, an elongated low pressure area extended from the vicinity of Truk eastward along the Intertropical Convergence Zone. Throughout the 28th, surface analyses indicated the formation of a closed circulation between Truk and Guam. Reconnaissance on the afternoon of the 30th confirmed the existence of a closed surface circulation, and Tropical Depression LOUISE was named. Subsequently, multiple circulations in the same general area were reported, but the strongest center, relocated west-northwest of Guam, retained the name LOUISE.

Throughout the 31st, LOUISE intensified and moved westerly at a speed of 12 knots. At 312105Z, based on reconnaissance, LOUISE was upgraded to a tropical storm. Throughout September 1st, slow recurvature toward the north-northwest took place with little change in speed. LOUISE also intensified rapidly so that at 010800Z she was upgraded to a typhoon. From the 2nd through the 5th, Typhoon LOUISE maintained a north-northwesterly movement at speeds varying from 5 to 14 knots accompanied by steady intensification. She appears to have reached peak intensity on the 3rd when maximum winds near the center of 125 knots and a sea level pressure of 964 millibars were reported. LOUISE crossed the northern coast of Taiwan at approximately 031300Z with estimated maximum surface winds of 115 knots. The diameter of the eye at this time was approximately 50 miles, and the center tended to slide over and around northern Taiwan. On reaching the Taiwan Straits, the eye diameter had increased to 100 miles, and the maximum surface winds had decreased to an estimated 65 knots. At

040600Z, due to rapid weakening, LOUISE was reduced to a tropical storm, and at approximately 041200Z she entered the Chinese coast near 26.5 degrees north. Shortly thereafter recurvature toward the north-northeast took place. Due to continued orographic weakening LOUISE was reduced to a tropical depression at 041800Z. At 052100Z, in the vicinity of Shanghai, LOUISE regained the open sea and proceeded northward intensifying slightly. At 060000Z she once again increased to tropical storm intensity. As LOUISE moved farther into northern latitudes she again began to weaken, and at 072100Z she was reduced to a tropical depression and the final tropical warning issued. By this time LOUISE had developed into an extra-tropical low imbedded in the Polar Front.

Post analysis of the upper air charts indicates that the persistence of the semi-permanent Pacific High to the northeast of LOUISE resulted in her prolonged, steady, north northwesterly movement onto the China Coast. This is typical of late August climatology. After reaching approximately 30 degrees latitude, she passed the ridge-line of the high and thereafter had a more northerly to northeasterly movement. Thirty-eight warnings were issued covering a period of 10 days.

For damage caused by Typhoon LOUISE see section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON LOUISE

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS     |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|-------------------------|
| 1       | 300030Z | 14.5N | 141.0E | 54-P-5              | 1008        | 15          | --            | --              | 24              | 20               | CNTR CALM               |
| 2       | 310645Z | 14.3N | 134.9E | 54-P-5              | 1001        | 20          | --            | 25              | 24              | 24               | EYE DIFFUSE             |
| 3       | 312105Z | 15.0N | 131.9E | 54-P-5              | 996         | 35          | 9950          | 45              | 11              | 08               | WALL CLDS, SPIRAL BANDS |
| 4       | 010800Z | 15.2N | 129.7E | 54-P-5              | 986         | 65          | 9830          | 60              | 13              | 10               | CIRC DIA 60 MI          |
| 5       | 011930Z | 16.6N | 127.0E | 54-P-2              | --          | --          | 9820          | 25              | 13              | 08               | EYE INDEFINITE          |
| 6       | 012110Z | 16.9N | 127.7E | 54-P-2              | 985         | 65          | 9720          | --              | 13              | 08               | CIRC DIA 40 MI          |
| 7       | 020200Z | 16.9N | 126.1E | 54-P-2              | 980         | 85          | 9660          | --              | 12              | 12               | CIRC DIA 50 MI          |
| 8       | 020800Z | 18.1N | 125.2E | 54-P-2              | 977         | 80          | 9450          | 80              | 16              | 13               | ELLIP 35X20 MI          |
| 9       | 021050Z | 18.7N | 124.6E | 12-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 30 MI          |
| 10      | 021430Z | 20.0N | 124.4E | 54-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 55 MI          |
| 11      | 022000Z | 20.4N | 123.6E | 54-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 50 MI          |
| 12      | 022215Z | 20.8N | 123.4E | 54-P-3              | 971         | 100         | 9180          | --              | 17              | 11               | CIRC DIA 50 MI          |
| 13      | 022244Z | 20.9N | 123.5E | 12-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 50 MI          |
| 14      | 030200Z | 21.8N | 122.9E | 54-P-5              | 971         | 125         | 9180          | --              | 16              | 11               | CIRC DIA 40 MI          |
| 15      | 030810Z | 22.9N | 122.4E | 54-P-5              | 964         | 95          | 9120          | 90              | 16              | 13               | CIRC DIA 65 MI          |
| 16      | 031042Z | 23.6N | 121.8E | 12-R-0              | --          | --          | --            | --              | --              | --               | CIRC DIA 50 MI          |
| 17      | 031400Z | 24.3N | 121.4E | 54-T-20             | --          | --          | --            | --              | --              | --               |                         |
| 18      | 032000Z | 25.0N | 121.4E | 54-T-25             | --          | --          | --            | --              | --              | --               | EYE INDEFINITE          |
| 19      | 032315Z | 25.0N | 120.7E | 54-P-2              | 993         | 125         | 9940          | --              | 11              | 11               | CIRC DIA 50 MI          |
| 20      | 040200Z | 25.5N | 120.4E | 54-P-2              | 994         | 65          | 9910          | --              | 12              | 11               | CIRC DIA 100 MI         |

TYPHOON LOUISE 30 AUG - 07 SEPT 1959  
 POSITION AND FORECAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 300000Z | 14.4N          | 141.2E | -           | -        | -           | -        |
| 300600Z | 14.5N          | 140.0N | -           | -        | -           | -        |
| 301200Z | 14.5N          | 138.8E | -           | -        | -           | -        |
| 301800Z | 14.5N          | 137.7E | -           | -        | -           | -        |
| 310000Z | 14.5N          | 136.6E | -           | -        | -           | -        |
| 310600Z | 14.5N          | 135.2E | -           | -        | -           | -        |
| 311200Z | 14.6N          | 133.9E | -           | -        | -           | -        |
| 311800Z | 14.7N          | 132.6E | -           | -        | -           | -        |
| 010000Z | 14.9N          | 131.2E | -           | -        | -           | -        |
| 010600Z | 15.2N          | 130.0E | 013         | - 22     | -           | -        |
| 011200Z | 15.5N          | 128.8E | 017         | - 32     | -           | -        |
| 011800Z | 16.0N          | 127.6E | 175         | - 32     | 010         | - 18     |
| 020000Z | 16.8N          | 126.3E | 042         | - 13     | 076         | - 55     |
| 020600Z | 17.8N          | 127.3E | 079         | - 69     | 183         | - 87     |
| 021200Z | 18.9N          | 124.5E | 171         | - 35     | 193         | - 122    |
| 021800Z | 20.1N          | 123.7E | 190         | - 15     | 112         | - 45     |
| 030000Z | 21.5N          | 123.1E | 341         | - 75     | 345         | - 80     |
| 030600Z | 22.8N          | 122.4E | -           | 0        | 203         | - 58     |
| 031200Z | 23.9N          | 121.6E | 040         | - 26     | 353         | - 144    |
| 031800Z | 24.6N          | 121.1E | 050         | - 40     | 025         | - 94     |
| 040000Z | 25.2N          | 120.6E | 002         | - 72     | 023         | - 167    |
| 040600Z | 25.7N          | 120.2E | 028         | - 89     | 037         | - 162    |
| 041200Z | 26.2N          | 120.1E | 358         | - 76     | 005         | - 190    |
| 041800Z | 26.7N          | 120.0E | 311         | - 70     | 015         | - 204    |
| 050000Z | 27.2N          | 120.0E | 325         | - 58     | 000         | - 195    |
| 050600Z | 28.0N          | 120.2E | -           | -        | 310         | - 123    |
| 051200Z | 29.0N          | 120.5E | -           | -        | 293         | - 90     |
| 051800Z | 30.2N          | 121.1E | -           | -        | -           | -        |
| 060000Z | 31.3N          | 121.8E | -           | -        | -           | -        |
| 060600Z | 32.6N          | 122.2E | -           | -        | -           | -        |
| 061200Z | 33.8N          | 122.5E | 107         | - 71     | -           | -        |
| 061800Z | 35.2N          | 122.8E | -           | -        | -           | -        |

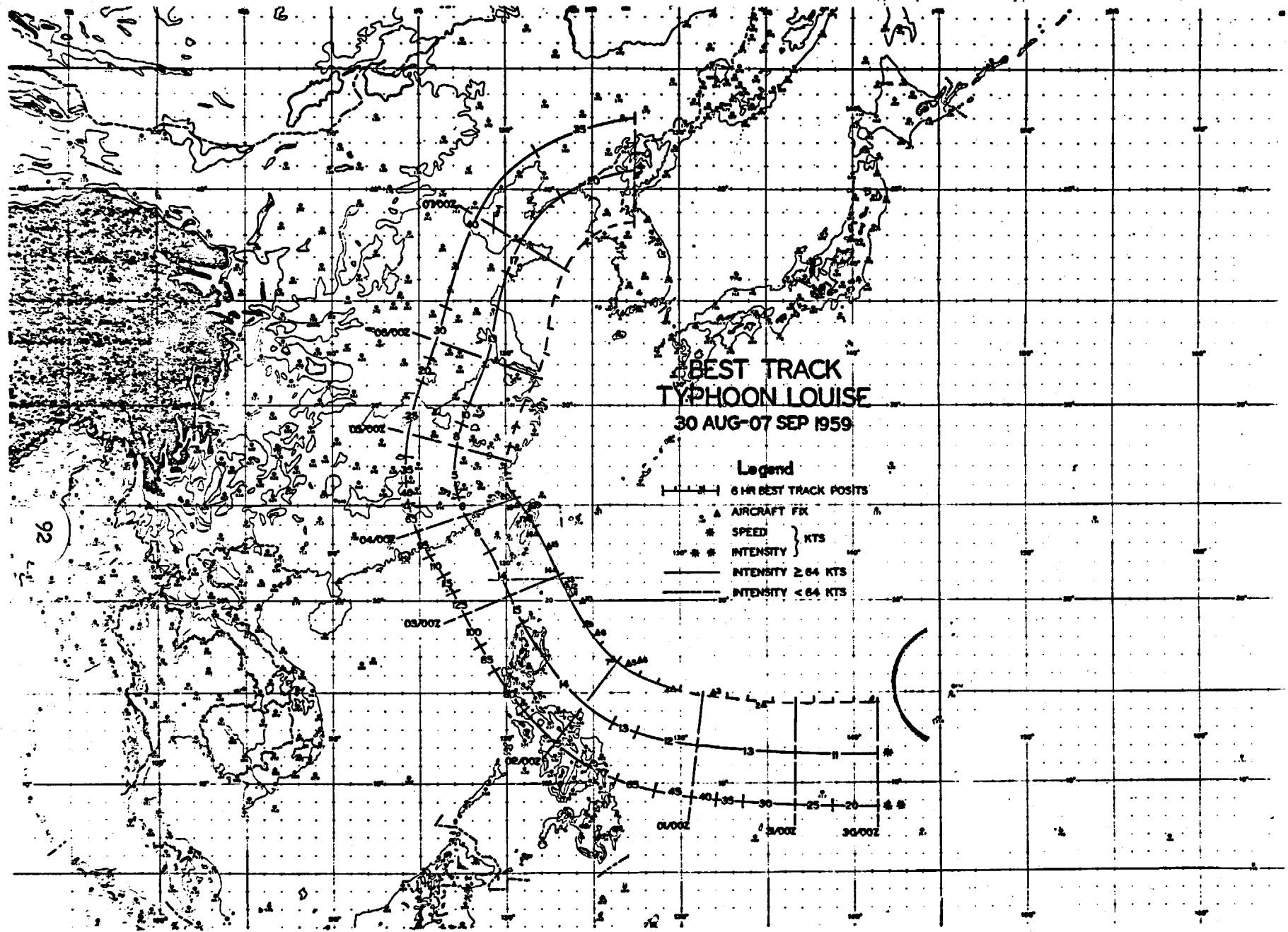
TYPHOON LOUISE 30 AUG - 07 SEPT 1959  
 POSITION AND FORECAST VERIFICATION DATA (CONT'D)

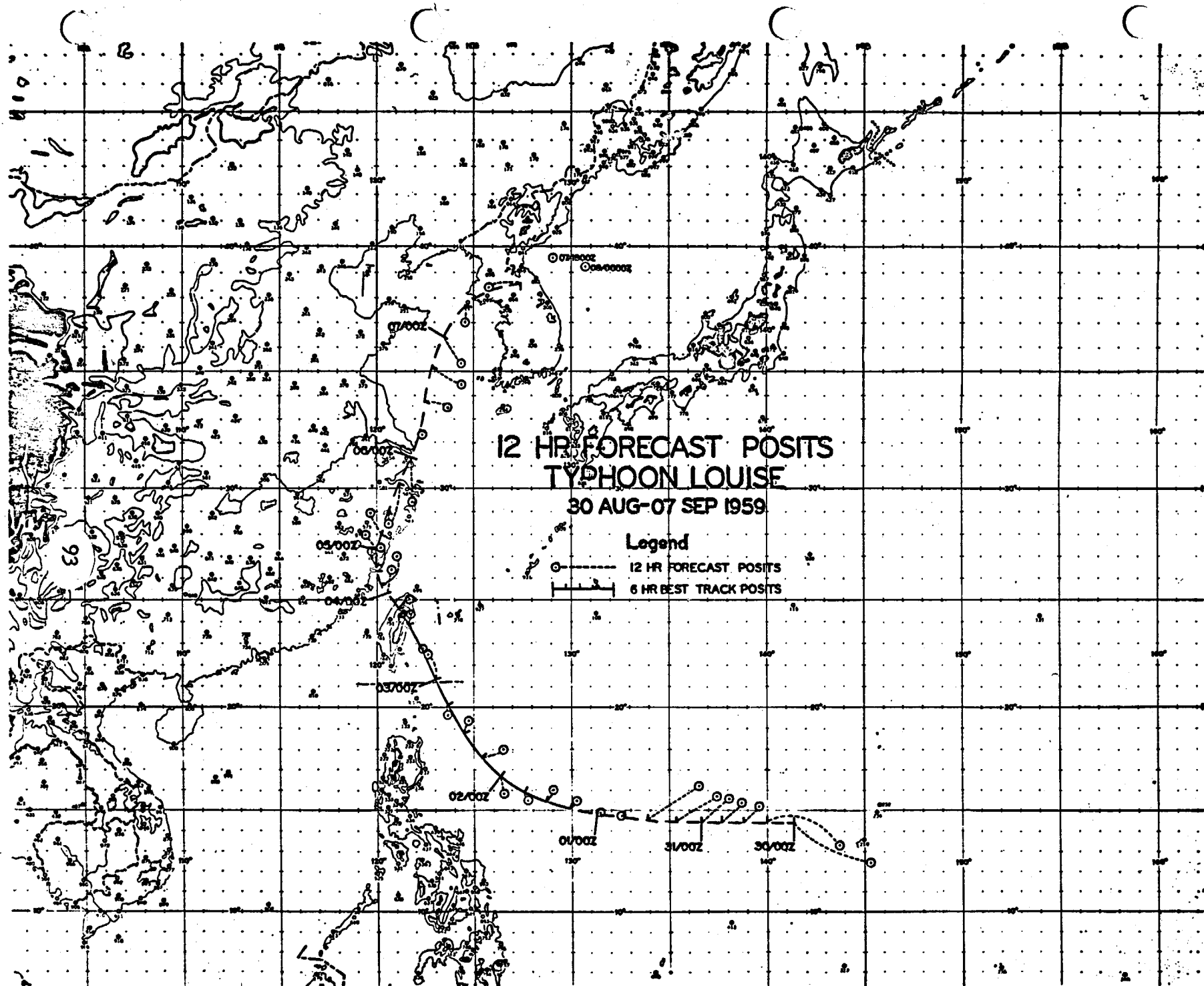
| DTG                            | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|--------------------------------|----------------|--------|-------------|----------|-------------|----------|
|                                | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 070000Z                        | 36.3N          | 123.4E | - - - -     |          | - - - -     |          |
| 070600Z                        | 37.7N          | 124.7E | - - - -     |          | - - - -     |          |
| 071200Z                        | 38.5N          | 127.0E | - - - -     |          | - - - -     |          |
| AVERAGE 12 HOUR FORECAST ERROR |                |        | 46.8 NM     |          |             |          |
| AVERAGE 24 HOUR FORECAST ERROR |                |        | 114.6 NM    |          |             |          |

BEST TRACK  
TYPHOON LOUISE  
30 AUG-07 SEP 1959

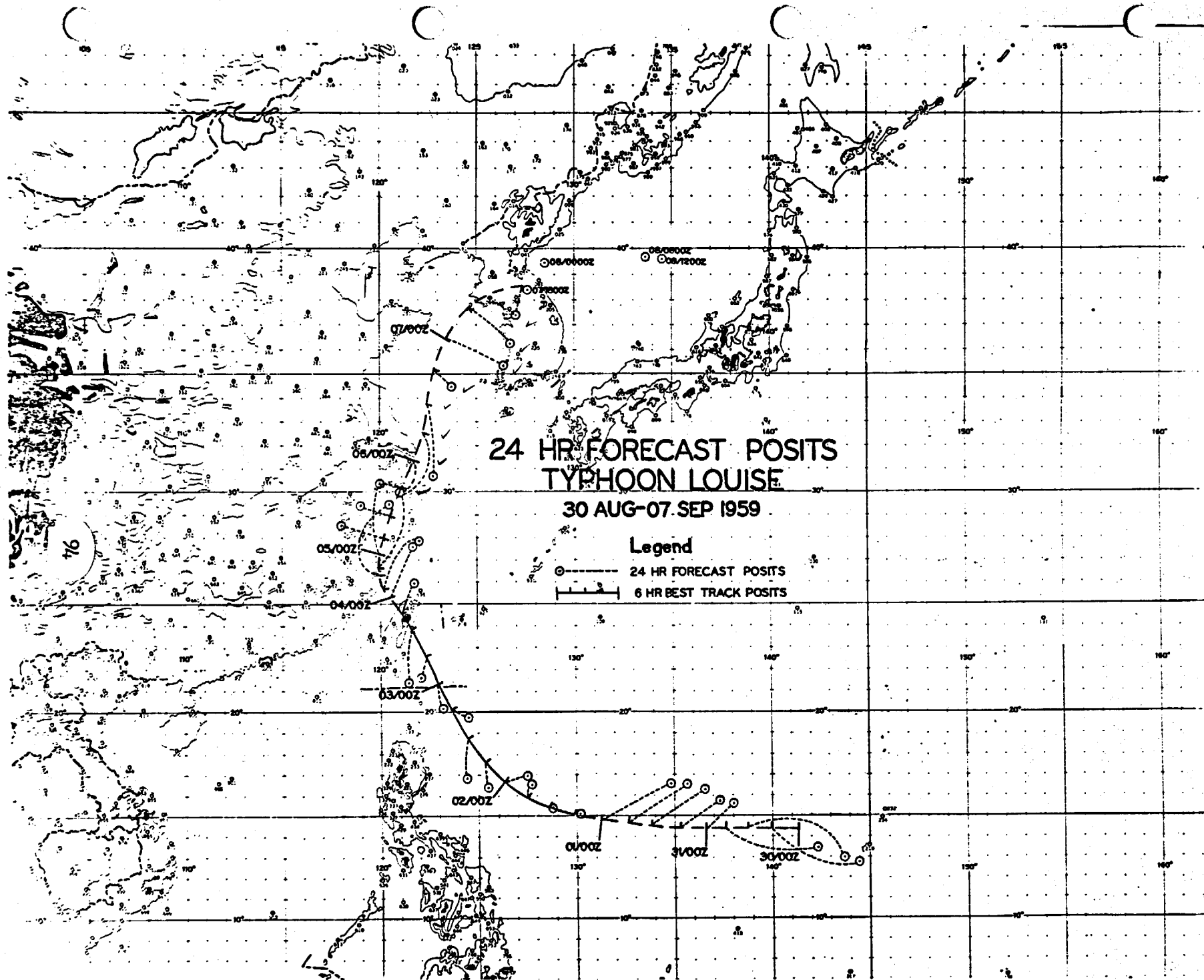
Legend

- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \*\* INTENSITY }
- INTENSITY ≥ 64 KTS
- INTENSITY < 64 KTS









I. TYPHOON PATSY (6-10 SEPTEMBER 1959)

Early on 6 September, quite unexpectedly, a series of pilot reports were received which confirmed the existence of a tropical cyclone, of at least tropical storm intensity, approximately 600 miles south-southwest of Midway Island. Based on these reports, which were from scheduled commercial and MATS flights between Honolulu and Wake Island, JTWC issued the first warning on Tropical Storm PATSY. Reconnaissance was requested, and a fix was made by a B-50 of the 54th Weather Reconnaissance Squadron at 061905Z. The maximum observed surface wind was 150 knots. PATSY was therefore upgraded to a typhoon in the next warning. Because of the sparsity of data in the area where PATSY was first discovered, surface and upper air charts, analyzed prior to receipt of the initial pilot reports pertaining to PATSY, failed to show any indication of a tropical cyclone in the formative stage of development.

PATSY at first moved to the northeast at 15 knots, steered by an upper level trough in the westerlies located to the west of the typhoon. However, 48 hours later, a second trough developed to the west of PATSY, and became the dominant trough. Under the influence of the latter trough, which had an unusual northwest-southeast orientation, PATSY curved to the northwest moving at 15 knots. As the trough-line neared the longitude of the typhoon, PATSY decelerated rapidly and began recurving to the northeast. Then, after making the turn, PATSY moved up the 180th meridian at 10 to 12 knots for the next 30 hours, slowly weakening. The final tropical warning was

issued at 101200Z.

PATSY was somewhat unique in that, by oscillating back and forth across the 180th meridian, she was quite properly called both a typhoon and hurricane. Perusal of climatological data covering the past 10 years failed to reveal a track similar to that of PATSY. A total of 17 warnings were issued covering a period of 5 days.

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON PATSY

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 061905Z | 22.4N | 178.4W | 54-P-30             | 960         | 150         | 9280          | 85              | 21              | 14               | CIRC DIA 10 MI      |
| 2       | 062205Z | 22.5N | 178.0W | 54-P-25             | --          | 150         | 9360          | 50              | 22              | 15               | CIRC DIA 10 MI      |
| 3       | 072000Z | 27.2N | 179.4E | 54-P-5              | 972         | 100         | 9400          | 50              | --              | --               | CIRC DIA 10 MI      |
| 4       | 080545Z | 27.8N | 178.0E | 55-P-20             | 960         | 70          | 9310          | 85              | --              | --               | CIRC DIA 10 MI      |
| 5       | 081900Z | 27.9N | 178.0E | 55-P---             | 970         | --          | 9620          | --              | --              | --               | CIRC DIA 10 MI      |
| 6       | 090314Z | 28.5N | 178.0E | AF-R---             | --          | --          | --            | --              | --              | --               | -----               |
| 7       | 090650Z | 29.3N | 179.0E | 54-P-10             | 968         | 60          | 9250          | 60              | 16              | 10               | CIRC DIA 40 MI      |
| 8       | 092058Z | 31.9N | 179.5E | VW-R---             | --          | --          | --            | --              | --              | --               | -----               |
| 9       | 092244Z | 32.0N | 179.2W | VW-R---             | --          | --          | --            | --              | --              | --               | -----               |

66

TYPHOON PATSY 06 - 10 AUGUST 1959  
POSITION AND FORECAST VERIFICATION DATA

| DTG                   | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|-----------------------|----------------|--------|-------------|----------|-------------|----------|
|                       | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 060600Z               | 20.0N          | 179.0E | - - - -     |          | - - - -     |          |
| 061200Z               | 20.8N          | 179.5W | - - - -     |          | - - - -     |          |
| 061800Z               | 22.2N          | 178.5W | 243         | - 151    | - - - -     |          |
| 070000Z               | 23.5N          | 178.1W | 219         | - 179    | - - - -     |          |
| 070600Z               | 24.9N          | 178.2W | 188         | - 75     | 222         | - 236    |
| 071200Z               | 26.2N          | 179.1W | 160         | - 114    | 194         | - 248    |
| 071800Z               | 26.9N          | 179.7E | 113         | - 135    | 101         | - 212    |
| 080000Z               | 27.3N          | 178.7E | 087         | - 176    | 119         | - 141    |
| 080600Z               | 27.7N          | 178.2E | 006         | - 152    | 090         | - 150    |
| 081200Z               | 27.9N          | 178.0E | 019         | - 260    | 056         | - 164    |
| 081800Z               | 28.1N          | 177.9E | 290         | - 82     | 025         | - 354    |
| 090000Z               | 28.4N          | 178.0E | 273         | - 134    | 028         | - 446    |
| 090600Z               | 29.2N          | 178.7E | 203         | - 87     | 270         | - 161    |
| 091200Z               | 30.2N          | 179.3E | 243         | - 99     | 254         | - 276    |
| 091800Z               | 31.2N          | 180.0- | 352         | - 46     | 221         | - 184    |
| 100000Z               | 32.4N          | 179.6W | 252         | - 29     | 230         | - 185    |
| 100600Z               | 33.5N          | 179.6W | 180         | - 16     | 010         | - 83     |
| 101200Z               | 34.5N          | 179.8E | 106         | - 80     | 138         | - 38     |
| AVERAGE 12 HOUR ERROR |                |        | 113.4 NM    |          |             |          |
| AVERAGE 24 HOUR ERROR |                |        | 205.6 NM    |          |             |          |

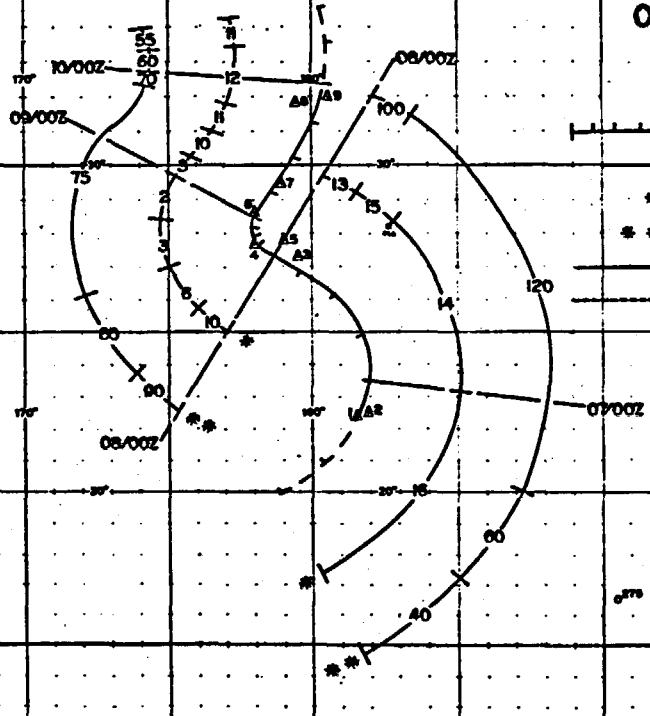
# BEST TRACK TYPHOON PATSY

06-10 SEP 1959

## Legend

- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \*\* INTENSITY } KTS
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS

66



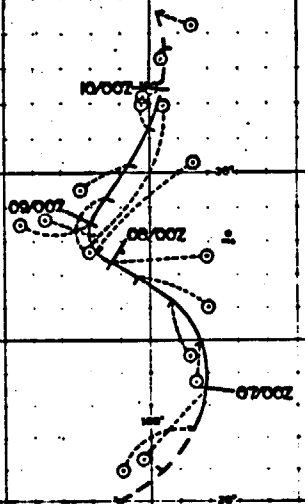
# 12 HR FORECAST POSITS TYPHOON PATSY

08-10 SEP 1959

## Legend

- — 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS

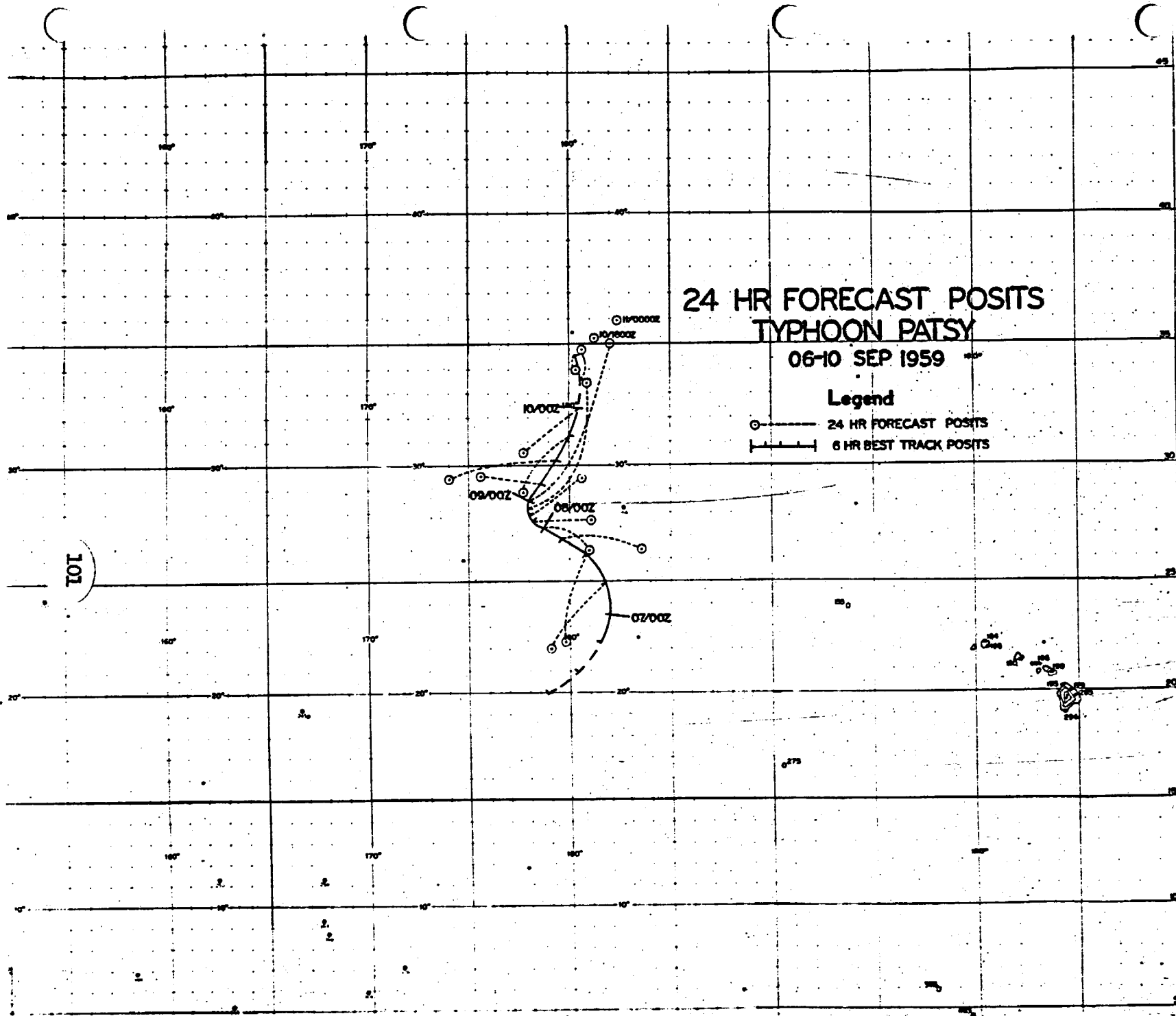
100



24 HR FORECAST POSITS  
TYPHOON PATSY  
06-10 SEP 1959

Legend

- 24 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS





J. TYPHOON SARAH (11-18 SEPTEMBER 1959)

Early on 10 September Tropical Storm NORA in the South China Sea, Tropical Depression RUTH midway between Guam and the Philippines, and a suspect area north of Ponape, all lay along the Intertropical Convergence Zone. By 101200Z RUTH had dissipated and reconnaissance into the suspect area was planned for the next day. The reconnaissance aircraft located a center 70 miles east of Guam at 110200Z. Tropical Depression SARAH was named and warning number 1 was issued with center winds of 30 knots. Subsequent fixes by the same aircraft indicated a rather indefinite situation with several small centers. However, from land radar, it was possible to determine that the primary center (SARAH) passed just north of Guam at 111000Z. Guam experienced only light gusty winds and occasional showers. By 112000Z, SARAH, now a fairly well defined circulation, had reached tropical storm intensity; and twelve hours later, at 120800Z, she was a typhoon with center winds of 65 knots.

SARAH followed a rather classical parabolic track, a track which took her directly over the island of Miyako Jima and just a few miles west of Pusan, Korea. SARAH passed over Miyako Jima at approximately 150900Z. Maximum sustained winds of 106 knots were reported there with gusts to 130 knots (which caused the anemometer to blow away). Although SARAH passed 150 miles to the west of Okinawa, Naha reported winds of 73 knots. After SARAH raked the southeastern tip of Korea she began to weaken and accelerate. Further weakening took place over the Sea of Japan. By 180600Z, over Hokkaido, SARAH had become extra-tropical and the final tropical warning was issued.

SARAH was the third most intense typhoon of the year. Surface winds reached a maximum of 165 knots, and the surface pressure dropped to a minimum of 905 millibars. Climatologically, SARAH recurved slightly farther west than is normal for mid-September. Although this caused Miyako Jima to bear the brunt of the onslaught, SARAH was also the worst typhoon experienced by Korea in 50 years. As previously indicated, SARAH followed a very stable path, and only minor forecasting difficulties were encountered. Thirty warnings were issued covering a period of 8 days.

For damage caused by Typhoon SARAH see Section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON SARAH

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 110200Z | 13.6N | 146.2E | 54-P-10             | 1008        | 35          | --            | --              | --              | --               | CNTR OVC HVY RAIN   |
| 2       | 110645Z | 13.7N | 145.4E | 54-P-2              | 999         | 20          | 10140         | 20              | 10              | 09               | CNTR DIFFUSE        |
| 3       | 110800Z | 13.8N | 145.6E | 54-P-2              | --          | --          | 10120         | --              | 09              | 09               | CNTR DIFFUSE        |
| 4       | 112000Z | 13.5N | 142.4E | 54-P-5              | 996         | 30          | 9900          | 50              | 12              | 09               | CNTR DIFFUSE        |
| 5       | 120200Z | 13.4N | 141.2E | 54-P-2              | 988         | 60          | 9760          | 55              | 15              | 10               | CIRC DIA 30 MI      |
| 6       | 120800Z | 14.0N | 140.0E | 54-P-5              | 980         | 60          | 9660          | 65              | 13              | 12               | CIRC DIA 35 MI      |
| 7       | 121415Z | 14.9N | 138.3E | 54-R-5              | --          | --          | --            | 55              | --              | --               | EYE DIA 35 MI       |
| 8       | 122038Z | 16.0N | 136.5E | 54-P-10             | 964         | 75          | 9090          | 70              | 14              | 11               | CIRC DIA 07 MI      |
| 9       | 122330Z | 16.3N | 135.8E | 54-P-5              | 963         | 115         | 9040          | 85              | 16              | 11               | CIRC DIA 08 MI      |
| 10      | 130800Z | 17.5N | 133.7E | 54-P-8              | 959         | 125         | 8880          | 100             | 16              | --               | CIRC DIA UNKN       |
| 11      | 131400Z | 18.7N | 131.8E | 54-R-20             | --          | --          | --            | --              | --              | --               | EYE DIA 20 MI       |
| 12      | 132000Z | 19.3N | 130.6E | 54-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI      |
| 13      | 132030Z | 19.4N | 130.4E | 54-P-5              | 943         | --          | 8530          | --              | 20              | 09               | CIRC DIA 20 MI      |
| 14      | 132307Z | 19.6N | 130.0E | 12-R-15             | --          | --          | --            | --              | --              | --               | CIRC DIA 30 MI      |
| 15      | 140225Z | 19.8N | 129.3E | 54-P-2              | --          | --          | 8230          | 100             | 20              | 14               | OBLONG 35 MI WIDE   |
| 16      | 140800Z | 20.6N | 128.3E | 54-P-3              | 919         | 150         | 7830          | 120             | 21              | 10               | CIRC DIA 20 MI      |
| 17      | 141100Z | 20.9N | 128.0E | 12-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI      |
| 18      | 141400Z | 21.3N | 127.4E | 54-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI      |
| 19      | 142200Z | 22.4N | 126.6E | 54-P-2              | 905         | 170         | 7510          | 135             | 26              | 15               | CIRC DIA 15 MI      |

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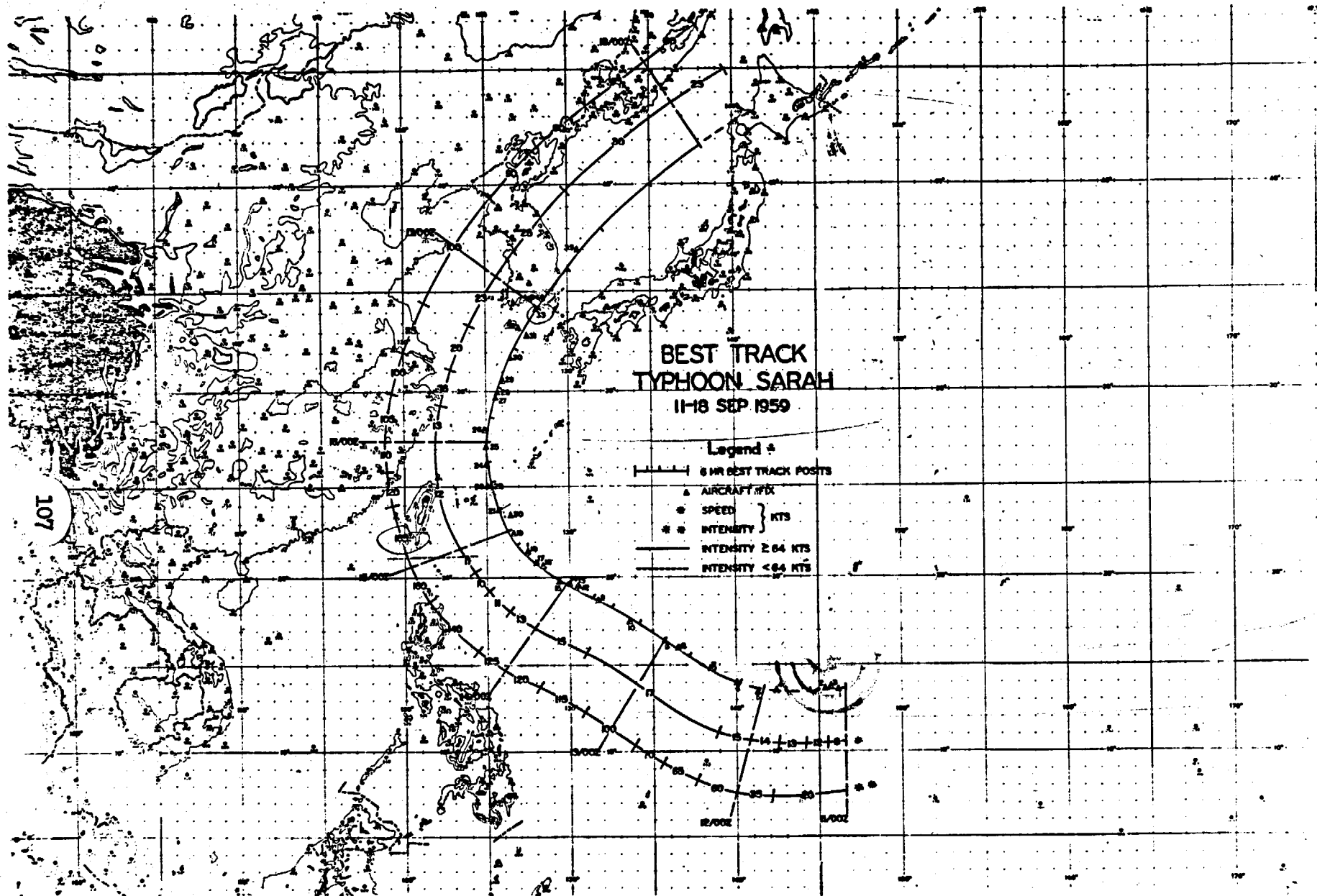
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON SARAH (CONT'D)

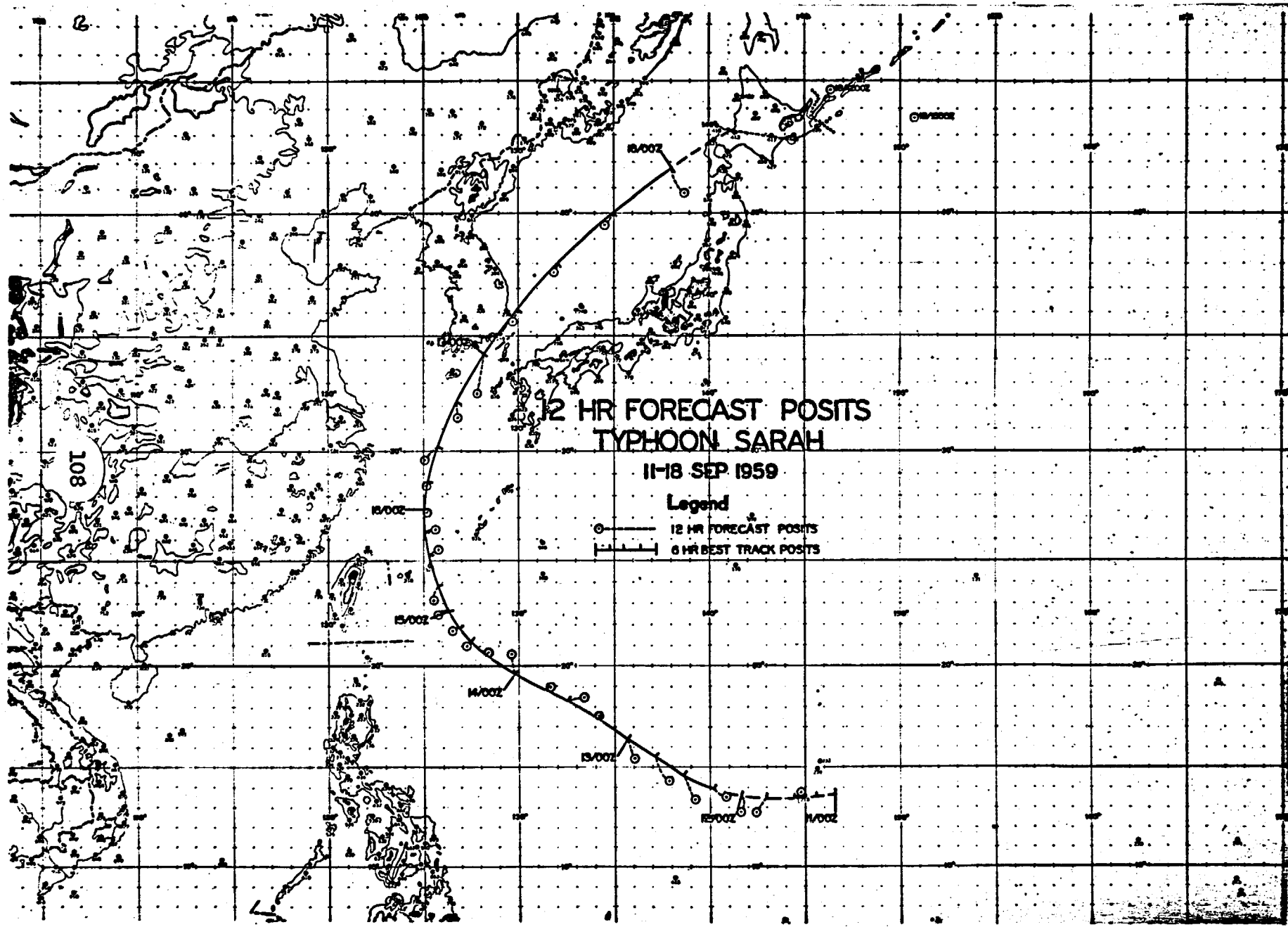
| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 20      | 150156Z | 23.4N | 126.3E | 56-P-5              | 905         | 130         | --            | --              | --              | --               | CIRC DIA 15 MI      |
| 21      | 150540Z | 23.8N | 125.8E | 56-R-5              | --          | --          | --            | --              | --              | --               |                     |
| 22      | 151110Z | 25.0N | 125.2E | 12-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 25 MI      |
| 23      | 151230Z | 25.0N | 125.1E | 54-R-3              | --          | --          | --            | --              | --              | --               | ELLIP 20x15 MI      |
| 24      | 151853Z | 26.1N | 125.0E | 56-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI      |
| 25      | 152309Z | 27.1N | 125.0E | 12-R-2              | --          | --          | --            | --              | --              | --               | CIRC DIA 23 MI      |
| 105 26  | 160342Z | 28.0N | 124.9E | 56-P-5              | 930         | --          | 8330          | --              | 15              | 15               | CIRC DIA 25 MI      |
| 27      | 161030Z | 29.7N | 125.6E | 54-P-5              | 936         | --          | 8340          | 90              | 19              | 15               | CIRC DIA 20 MI      |
| 28      | 161100Z | 30.0N | 125.6E | 12-R-15             | --          | --          | --            | --              | --              | --               | DIA 20 MI           |
| 29      | 161400Z | 30.5N | 126.0E | 54-R-5              | --          | --          | 8750          | 95              | --              | --               | CIRC DIA 20 MI      |
| 30      | 161700Z | 31.6N | 126.5E | 54-R-20             | --          | --          | --            | --              | --              | --               |                     |
| 31      | 162000Z | 32.9N | 127.6E | 54-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI      |
| 32      | 162140Z | 33.1N | 127.0E | 54-P-5              | 944         | 150         | 8630          | 90              | 19              | 13               | CIRC DIA 25 MI      |
| 33      | 170025Z | 34.1N | 128.1E | 12-R-5              | --          | --          | --            | --              | --              | --               | CIRC POORLY DEFINED |
| 34      | 170200Z | 34.6N | 128.4E | 56-P-3              | 942         | 100         | --            | --              | --              | --               | CIRC DIA 20 MI      |
| 35      | 170900Z | 37.0N | 130.6E | 54-P-2              | --          | 150         | 9190          | 60              | 19              | 13               | CIRC DIA 60 MI      |

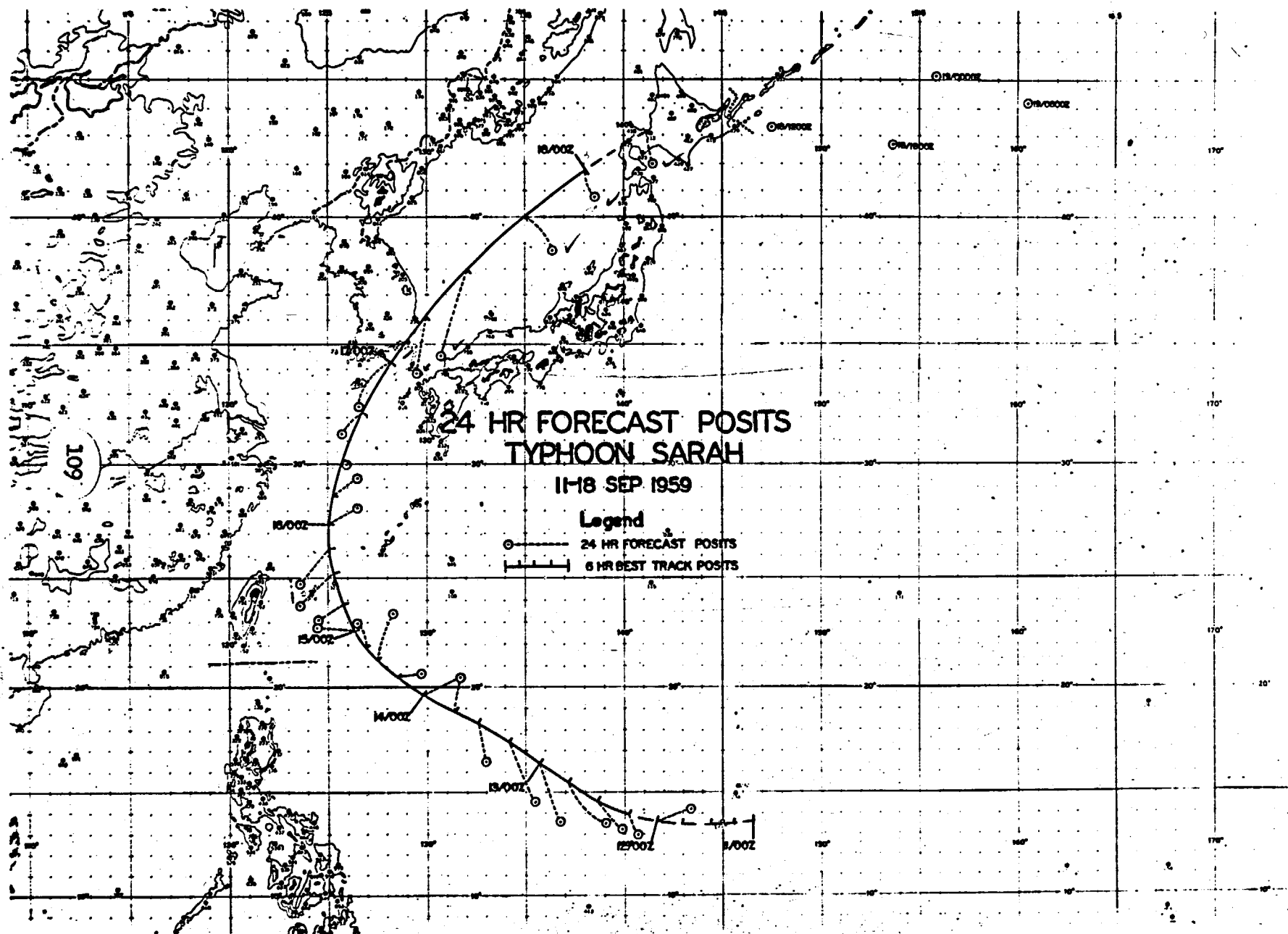
TYPHOON SARAH 11 - 19 SEPT. 1959  
POSITION AND FORECAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 110000Z | 13.8N          | 146.4E | -           | -        | -           | -        |
| 110600Z | 13.6N          | 145.6E | -           | -        | -           | -        |
| 111200Z | 13.5N          | 144.3E | -           | -        | -           | -        |
| 111800Z | 13.4N          | 143.0E | -           | -        | -           | -        |
| 120000Z | 13.5N          | 141.5E | -           | -        | -           | -        |
| 120600Z | 14.0N          | 140.1E | 123         | - 55     | -           | -        |
| 121200Z | 14.7N          | 138.7E | 162         | - 85     | -           | -        |
| 121800Z | 15.5N          | 137.1E | 152         | - 96     | 137         | - 159    |
| 130000Z | 16.4N          | 135.6E | 160         | - 70     | 160         | - 180    |
| 130600Z | 17.3N          | 134.1E | 352         | - 20     | 155         | - 175    |
| 131200Z | 18.2N          | 132.6E | 067         | - 45     | 165         | - 124    |
| 131800Z | 18.9N          | 131.2E | 090         | - 27     | 023         | - 82     |
| 140000Z | 19.7N          | 129.8E | 270         | - 10     | 110         | - 112    |
| 140600Z | 20.5N          | 128.6E | 280         | - 14     | 073         | - 69     |
| 141200Z | 21.2N          | 127.7E | 240         | - 30     | 010         | - 128    |
| 141800Z | 21.9N          | 126.9E | 255         | - 30     | 330         | - 74     |
| 150000Z | 22.8N          | 126.3E | 230         | - 44     | 268         | - 95     |
| 150600Z | 23.9N          | 125.7E | 200         | - 52     | 225         | - 87     |
| 151200Z | 25.2N          | 125.2E | 040         | - 44     | 230         | - 114    |
| 151800Z | 26.2N          | 125.0E | 065         | - 32     | 220         | - 110    |
| 160000Z | 27.4N          | 124.9E | 138         | - 23     | 245         | - 89     |
| 160600Z | 28.7N          | 125.1E | 195         | - 21     | 065         | - 73     |
| 161200Z | 30.2N          | 125.8E | 225         | - 53     | 240         | - 19     |
| 161800Z | 32.1N          | 126.8E | 175         | - 32     | 220         | - 69     |
| 170000Z | 34.2N          | 128.1E | 190         | - 92     | 215         | - 138    |
| 170600Z | 36.2N          | 129.8E | -           | -        | -           | -        |
| 171200Z | 38.0N          | 132.0E | -           | -        | -           | -        |
| 171800Z | 40.1N          | 134.8E | -           | -        | -           | -        |
| 180000Z | 41.9N          | 138.0E | -           | -        | -           | -        |
| 180600Z | 43.1N          | 141.1E | -           | -        | -           | -        |
| 181200Z | 44.8N          | 143.6E | -           | -        | -           | -        |
| 181800Z | 46.8N          | 145.5E | -           | -        | -           | -        |
| 190000Z | 48.8N          | 146.8E | -           | -        | -           | -        |
| 190600Z | 50.4N          | 147.3E | -           | -        | -           | -        |

AVERAGE 12 HOUR ERROR      43.8 NM  
AVERAGE 24 HOUR ERROR      105.9 NM









K. TYPHOON VERA (21-27 SEPTEMBER 1959)

As early as 20 September, surface map analyses indicated a diffuse area of low pressure lying between Guam and Truk. During the 21st the low pressure area, now located approximately 300 miles east of Saipan, appeared to intensify and drift slowly westward. Late on the 21st a reconnaissance aircraft, dispatched to investigate the suspect area, was unable to reach the forecast position of the center due to an engine failure. However, periferal data from the aircraft were sufficient to confirm the existence of a tropical cyclone of at least tropical storm intensity. Tropical Storm VERA was named and the first warning, with a valid time of 211800Z, was issued.

At 220645Z an aircraft reconnaissance fix positioned VERA 110 miles north-northeast of Saipan. Later reconnaissance indicated the surface winds to be 75 knots near the center, and VERA was upgraded to a typhoon at 221800Z. VERA intensified rapidly, and at 231200Z reached her greatest intensity with winds of 165 knots near the center. At this time VERA was centered 400 miles north-northwest of Guam. During the 23rd and 24th VERA moved in a northwesterly direction at an average speed of 10 to 12 knots, with little change in intensity. Iwo Jima, although 225 miles northeast of VERA, reported gusts of 77 knots and minor damage. On the 25th, a gradual recurvature to the north began, together with a rapid acceleration in speed of movement to 18 knots. At approximately 260900Z, VERA crossed the coast of Honshu just to the west of Shiono-Misaki. The pressure tendencies and wind shifts at this station were quite classical in depicting the passage of the typhoon. At 260900Z the 3 hourly pressure tendency

showed a drop of 41.8 millibars with sustained winds of 60 knots from the southeast. At 261200Z, 3 hours after the passage of VERA, the station showed a pressure rise of 51.0 millibars and sustained winds of 50 knots from the west-southwest. To depict the lateral size as well as the intensity of Typhoon VERA, a checkerboard, showing surface reports from a number of representative stations in Japan, is included as page 113. As she passed inland, VERA moved at speeds as high as 33 knots. She thus made a rapid transit across Central Honshu, passed just to the west of Nagoya, and entered the Sea of Japan at 26-1530Z at a point north of Toyama. Moving into the Westerlies, VERA assumed a more easterly component and moved over the north coast of Honshu near Sakata. Movement over land plus strong cold air advection rapidly weakened her as she headed into the North Pacific Ocean at 26-2300Z. At 270600Z VERA was reduced to a tropical storm and the final tropical warning issued. By this time she was obviously losing her tropical characteristics and was imbedded in the Polar Front.

Typhoon VERA reached her peak intensity early in her history, and did not weaken appreciably until reaching well into northern latitudes. This may be attributed in part to strong divergence aloft which accompanied VERA until she moved into the Zonal Westerlies over Japan. As VERA moved northeastward across central Honshu, a wide swath of 50 knot winds was reported. Komaki Air Base, near Nagoya, reported 80 knot winds with gusts to 120, as the eye passed slightly to the west. Widespread heavy rain and floods accompanying the typhoon winds caused the greatest loss of life and destruction of property in Japanese Typhoon History. Climatologically, VERA followed

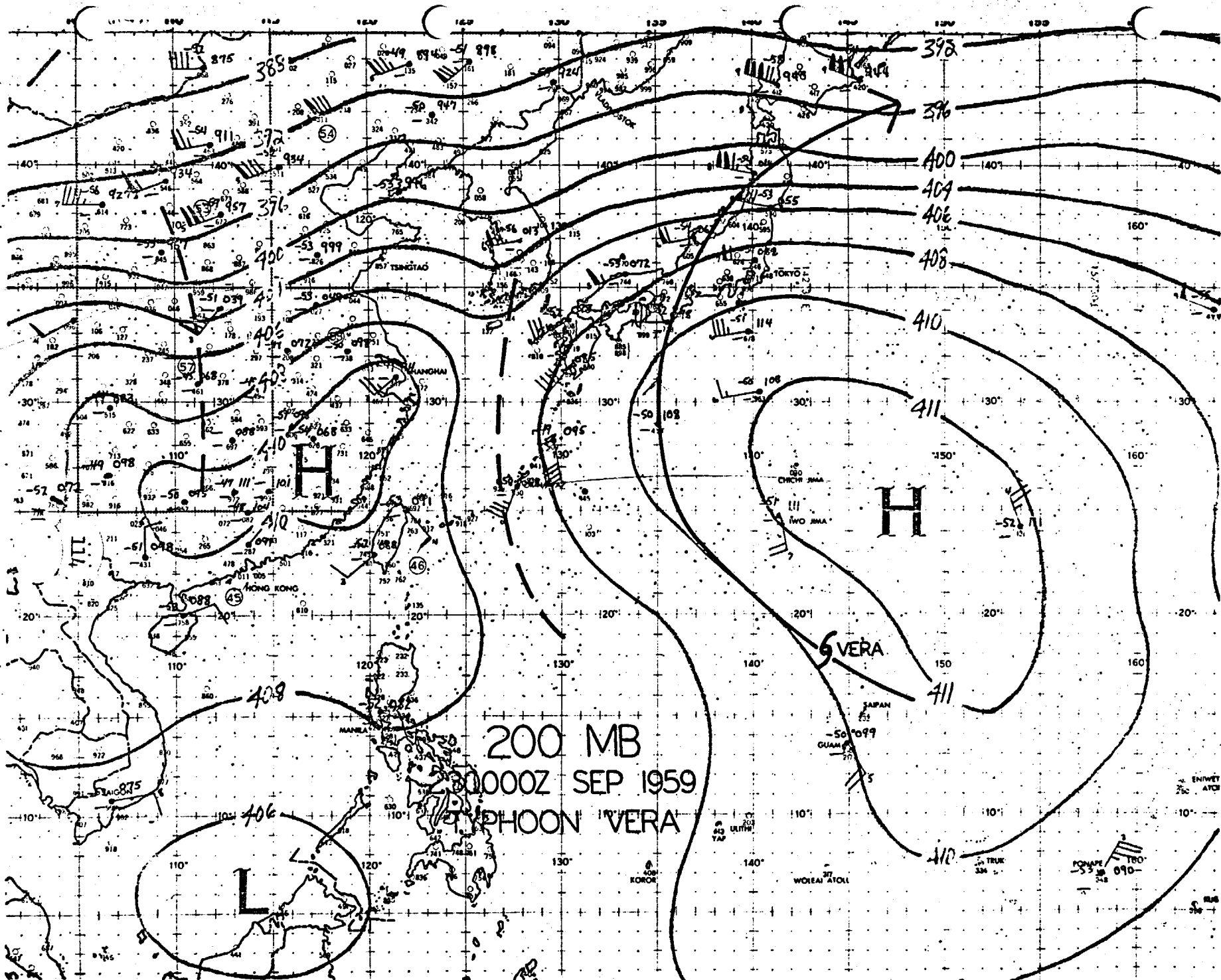
the normal September track. Forecasting accuracy was considerably better than average because of excellent steering results obtained using the 200 millibar flow (see page 114).

VERA caused an appalling loss of life and property in Japan. For details on the damage see Section VI, "Destructive Effects of Typhoons."

# SEQUENCE WEATHER REPORTS - TYPHOON VERA

DATE 26-27 SEPTEMBER 1959

| STATION          | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 0000 | 0100 | 0200 | 0300 |
|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 600              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| WAJIMA           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 602              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| AIKAWA           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 604              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| NIIGATA          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 605              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| KANAZAWA         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 612              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| TAKADA           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 616              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| MATSUMOTO        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 624              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| MEABASHI         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 635              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| NAGOYA/KOMAKI AB |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 636              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| NAGOYA           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 637              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| LIDA             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 655              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| OMAEZAKI         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 666              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| YOKOSUKA         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 750              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| MAIZURU          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 771              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| OSAKA/ITAMI AB   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 772              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| OSAKA            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 891              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| TAKAMATSU        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 898              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| SHIMZU/ASHZURI   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 899              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| MUROTOMIZAKI     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 779              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| SHONONSAKI       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |



200 MB  
0000Z SEP 1959  
PHOON VERA

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON VERA

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 220645Z | 16.8N | 146.7E | 54-P-2              | 969         | 60          | 9360          | --              | 15              | 11               | CIRC DIA 10 MI      |
| 2       | 220800Z | 17.0N | 146.3E | 54-P-2              | 964         | 60          | 9260          | 65              | 15              | 10               | CIRC DIA 10 MI      |
| 3       | 221400Z | 17.9N | 145.6E | 54-R-2              | 964         | --          | --            | --              | 15              | 10               | CIRC DIA 10 MI      |
| 4       | 222000Z | 17.5N | 144.5E | 54-P-3              | 925         | 75          | 8160          | 50              | 22              | 06               | CIRC DIA 20 MI      |
| 5       | 230200Z | 18.7N | 143.4E | 54-P-10             | 899         | 175         | 7450          | 80              | 28              | 17               | CIRC DIA 15 MI      |
| 6       | 230600Z | 19.0N | 142.9E | 54-P-2              | 896         | 175         | 7180          | 85              | 30              | 18               | ELLIP 15X30 MI      |
| 7       | 231400Z | 20.0N | 141.3E | 54-T-50             | --          | --          | --            | --              | --              | --               | -----               |
| 8       | 232000Z | 20.4N | 140.6E | 54-P-5              | 897         | 140         | 7280          | 110             | 21              | 13               | CIRC DIA 30 MI      |
| 9       | 240200Z | 20.8N | 139.6E | 54-P-10             | 911         | 165         | 7490          | 110             | 20              | 20               | CIRC DIA 20 MI      |
| 10      | 240800Z | 21.9N | 139.1E | 54-P-5              | 909         | 166         | 7660          | 105             | 23              | 23               | CIRC DIA 25 MI      |
| 11      | 241400Z | 22.4N | 137.9E | 54-T-10             | --          | --          | --            | 110             | --              | --               | -----               |
| 12      | 242230Z | 23.5N | 136.2E | 54-P-10             | 906         | 150         | 7300          | 140             | 18              | 18               | CIRC DIA 25 MI      |
| 13      | 242302Z | 24.4N | 136.6E | 12-R-15             | --          | --          | --            | --              | --              | --               | CIRC DIA 30 MI      |
| 14      | 250200Z | 24.7N | 136.3E | 54-P-5              | 905         | 120         | 7340          | --              | 20              | 17               | CIRC DIA 25 MI      |
| 15      | 250800Z | 24.8N | 135.5E | 54-P-5              | 910         | --          | 7390          | 110             | 23              | 17               | CIRC DIA 20 MI      |
| 16      | 251115Z | 26.5N | 135.5E | 12-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 30 MI      |
| 17      | 251400Z | 26.8N | 134.3E | 54-T-15             | --          | --          | --            | --              | --              | --               | -----               |
| 18      | 252045Z | 28.9N | 134.8E | 54-P-2              | 929         | --          | 7960          | 100             | 18              | 16               | CIRC DIA 20 MI      |
| 19      | 252252Z | 29.2N | 134.3E | 12-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI      |

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RECONNAISSANCE AIRCRAFT FIXES - TYPHOON VERA (CONT'D)

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 20      | 260200Z | 30.7N | 134.7E | 54-P-10             | 929         | 160         | 8010          | 100             | 20              | 17               | EYE INDEFINITE      |
| 21      | 260800Z | 32.8N | 135.5E | 54-P-2              | 926         | 100         | 8020          | 150             | 18              | 18               | CIRC DIA 20 MI      |
| 22      | 261500Z | 36.8N | 137.6E | * *                 | --          | --          | --            | --              | --              | --               | -----               |
| 23      | 261600Z | 37.4N | 137.9E | * *                 | --          | --          | --            | --              | --              | --               | -----               |
| 24      | 261700Z | 37.8N | 139.1E | * *                 | --          | --          | --            | --              | --              | --               | -----               |

TYPHOON VERA 21 - 27 SEPT. 1959  
POSITION AND FORECAST VERIFICATION DATA

| DTG                   | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|-----------------------|----------------|--------|-------------|----------|-------------|----------|
|                       | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 211800Z               | 15.8N          | 148.5E | -           | -        | -           | -        |
| 220000Z               | 16.2N          | 147.6E | -           | -        | -           | -        |
| 220600Z               | 16.6N          | 146.7E | 239         | - 25     | -           | -        |
| 221200Z               | 17.1N          | 145.8E | 212         | - 15     | -           | -        |
| 221800Z               | 17.5N          | 144.9E | 305         | - 06     | 161         | - 17     |
| 230000Z               | 18.2N          | 143.9E | 042         | - 34     | 121         | - 37     |
| 230600Z               | 18.8N          | 142.9E | 180         | - 39     | 107         | - 48     |
| 231200Z               | 19.5N          | 142.0E | 327         | - 38     | 060         | - 70     |
| 231800Z               | 20.2N          | 141.0E | 360         | - 36     | 205         | - 31     |
| 240000Z               | 20.8N          | 140.0E | 220         | - 29     | 360         | - 56     |
| 240600Z               | 21.6N          | 139.0E | 090         | - 10     | 076         | - 75     |
| 241200Z               | 22.4N          | 138.1E | 175         | - 35     | 004         | - 75     |
| 241800Z               | 23.4N          | 137.2E | 322         | - 37     | 156         | - 27     |
| 250000Z               | 24.4N          | 136.4E | 175         | - 57     | 360         | - 92     |
| 250600Z               | 25.6N          | 135.7E | 175         | - 77     | 172         | - 87     |
| 251200Z               | 26.8N          | 135.7E | 209         | - 20     | 190         | - 118    |
| 251800Z               | 28.3N          | 134.9E | 196         | - 132    | 194         | - 166    |
| 260000Z               | 30.1N          | 134.9E | 238         | - 65     | 223         | - 105    |
| 260600Z               | 32.2N          | 135.3E | 202         | - 67     | 207         | - 305    |
| 261200Z               | 35.3N          | 136.6E | -           | -        | -           | -        |
| 261800Z               | 38.3N          | 138.9E | -           | -        | -           | -        |
| 270000Z               | 40.6N          | 142.2E | -           | -        | -           | -        |
| 270600Z               | 40.2N          | 146.5E | -           | -        | -           | -        |
| AVERAGE 12 HOUR ERROR |                | 42.5   | NM          |          |             |          |
| AVERAGE 24 HOUR ERROR |                | 87.3   | NM          |          |             |          |

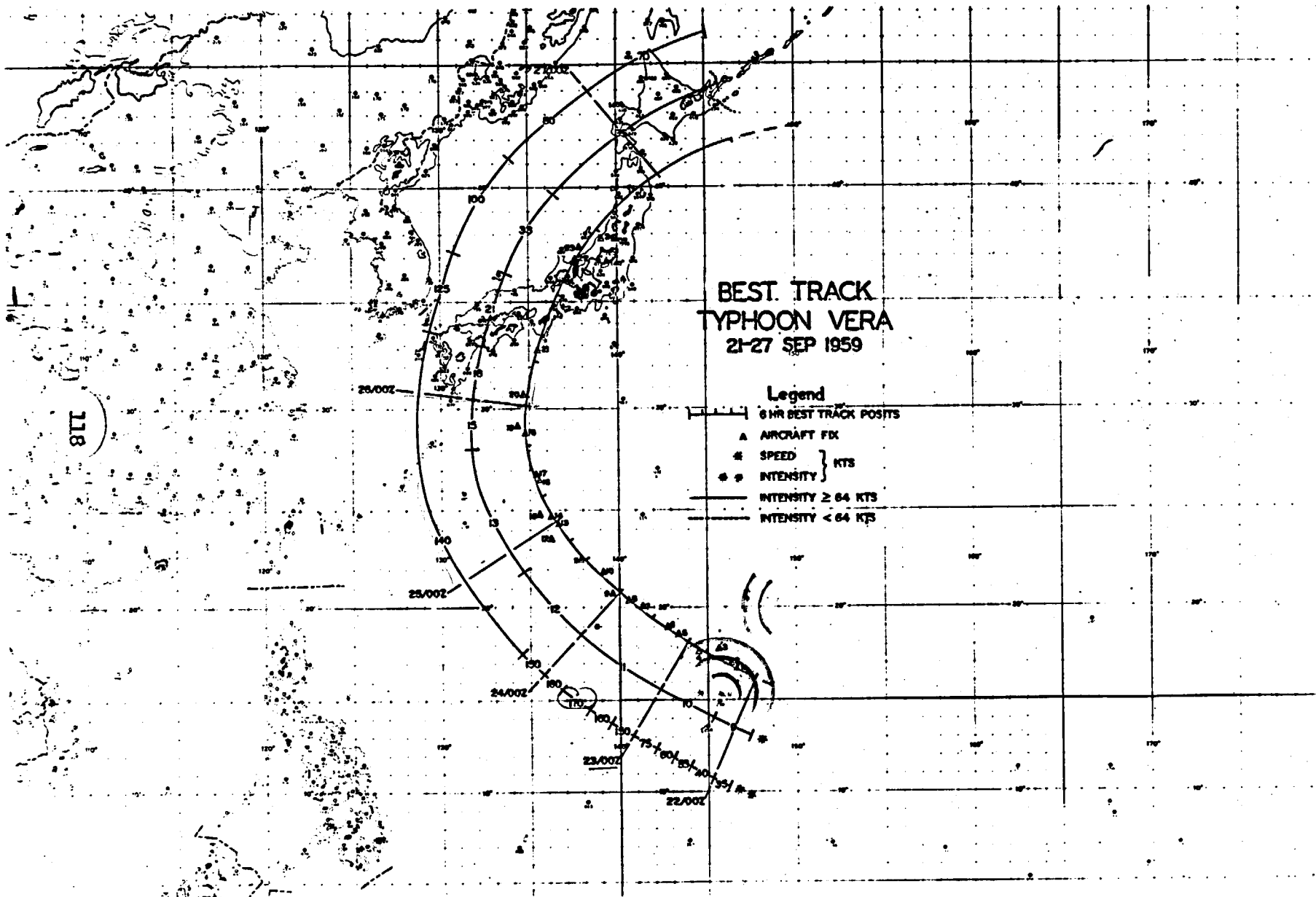


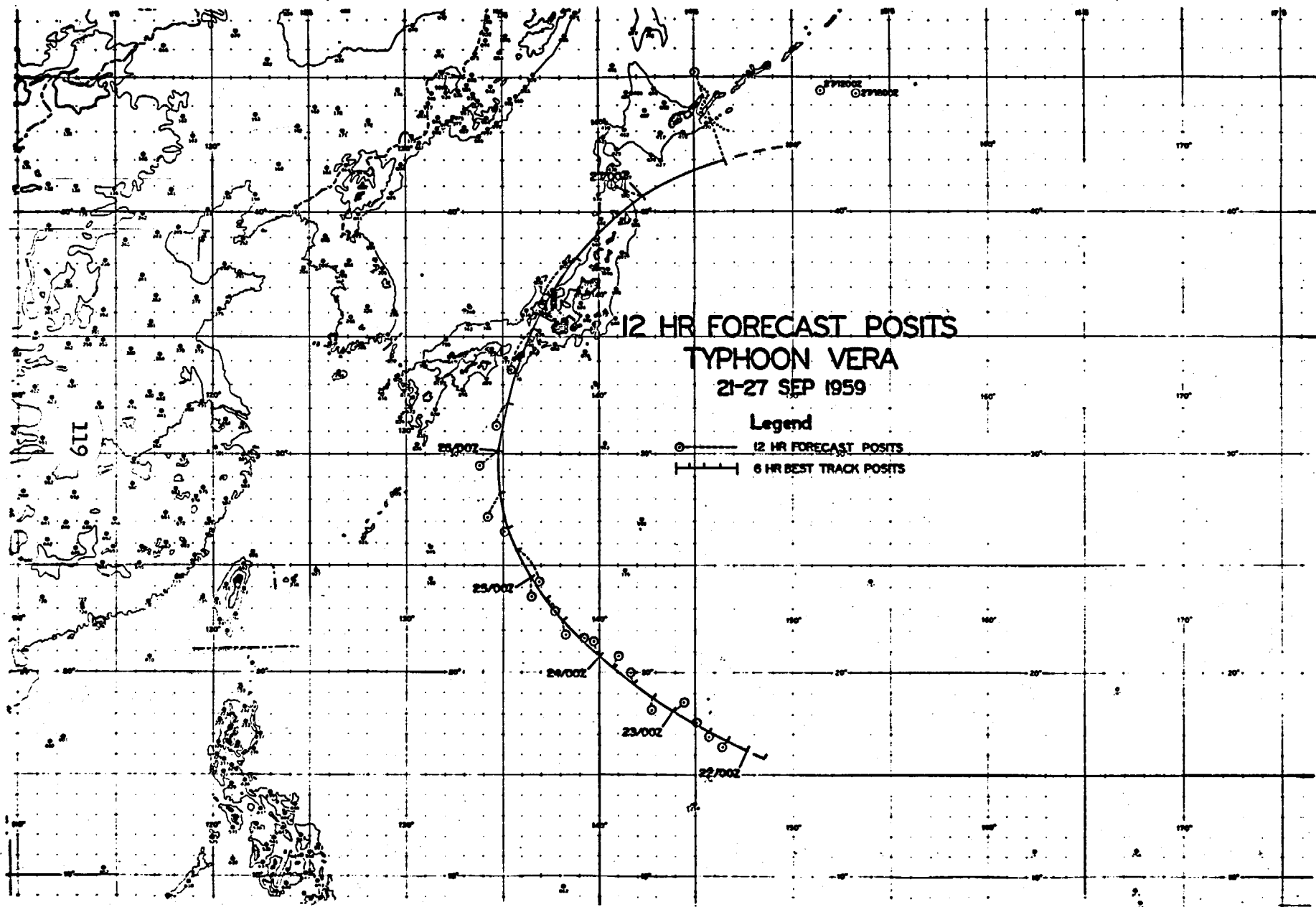
BEST TRACK  
TYPHOON VERA  
21-27 SEP 1959

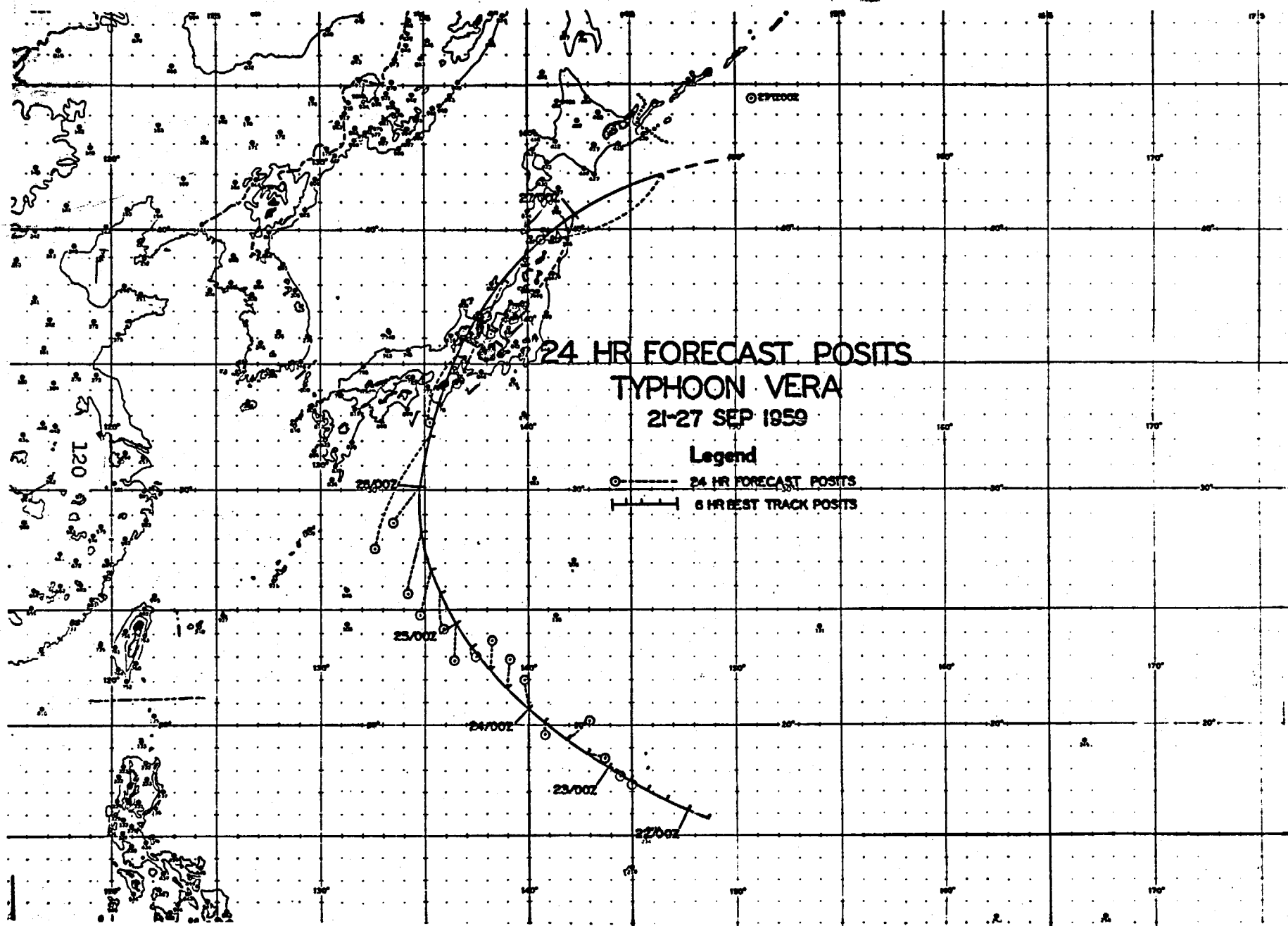
Legend

- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED
- INTENSITY } KTS
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS

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L. TYPHOON AMY (3-7 OCTOBER 1959)

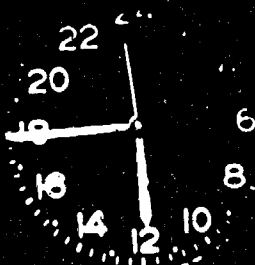
On 1 October, a weak cyclonic circulation on the Intertropical Convergence Zone was observed to the east of the Philippines. Subsequent analyses indicated that this circulation was almost stationary and that pressures in the area were gradually decreasing. Reconnaissance was therefore requested and at 030900Z a weak diffuse center, with maximum surface winds of 30 knots, was located in the vicinity of 17.5N - 125.0E. Based on this information JTWC issued warning number one on Tropical Depression AMY.

For the first 30 hours AMY moved to the north-northeast at an average speed of 6 knots. Thereafter, AMY accelerated quite rapidly, and when she passed slightly east of Kadena Air Force Base, Okinawa early on the 6th, her speed was 28 knots. During this period AMY had been upgraded to a tropical storm at 031800Z, had reached typhoon intensity at 050000Z, and had then weakened and again becoming a tropical storm at 060000Z. By 070000Z, over central Honshu, AMY had weakened further and was rapidly becoming extra-tropical. A final warning was issued at 070600Z.

AMY was somewhat unusual in that, throughout the life of the storm, the strongest surface and 700 millibar winds appeared to be confined to the eastern semicircle. As an example, when AMY passed approximately 35 miles to the east, Kadena Air Force Base reported maximum sustained winds of only 25 knots with gusts to 45 knots. However, approximately one hour later, a reconnaissance aircraft reported the surface wind to be 70 knots in AMY's southeast quadrant. A radar photograph of AMY, taken by the Kadena Weather Detachment as

AMY passed abeam of Okinawa, is included as page 123. The photograph, taken at 060245Z, clearly shows well developed wall clouds in all quadrants. The photograph therefore sheds no light as to why the winds in the east semicircle were invariably reported by reconnaissance as being 20 to 30 knots higher than those in the west semicircle. AMY also had an unusual track and did not conform to October Climatology. However, Typhoon OPAL of 1955 showed a similar path and had similar characteristics. Seventeen warnings were issued covering a period of 5 days.

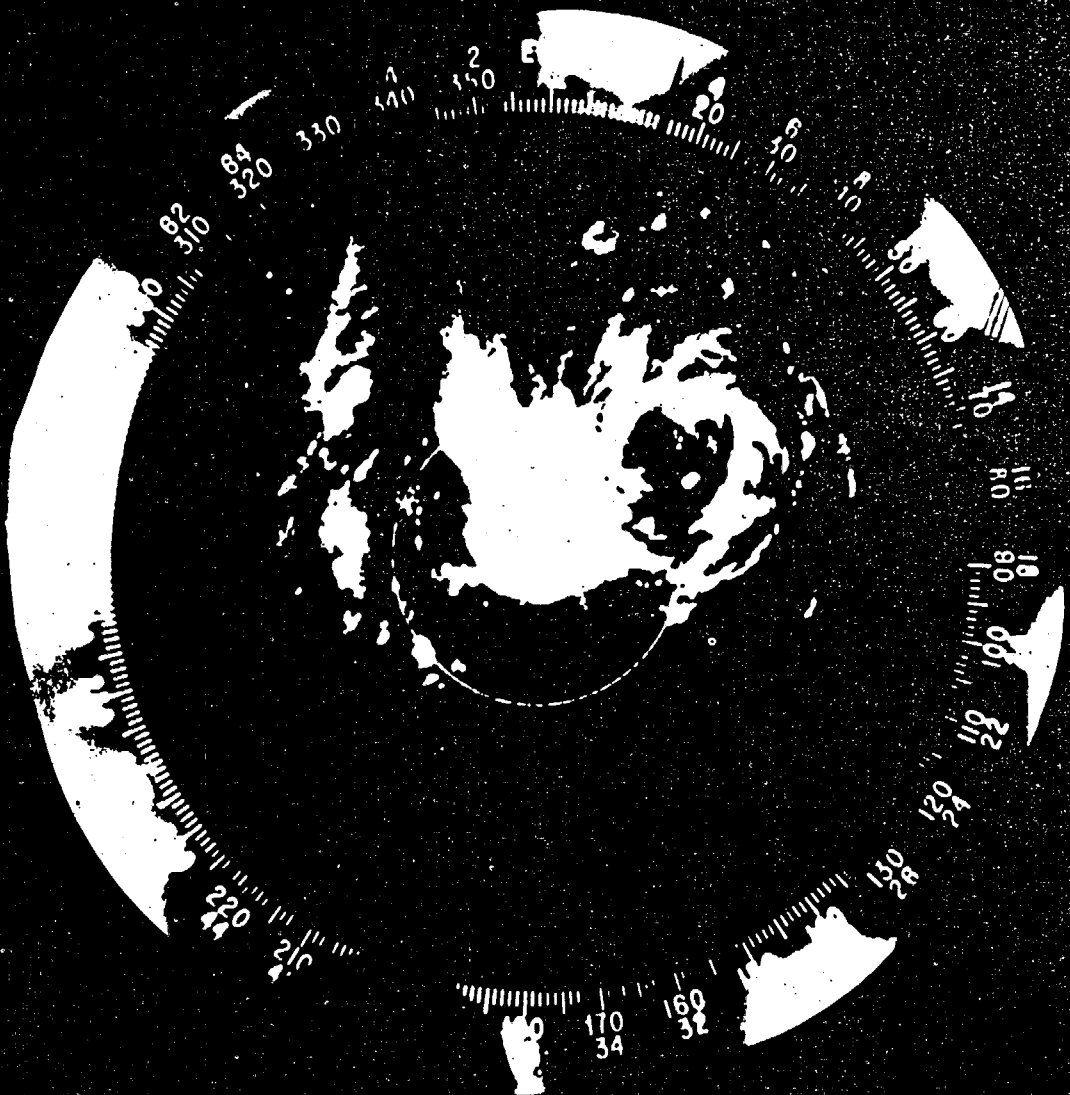
Though menacing Okinawa and Southern Japan, no damage due to Typhoon AMY was reported.



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123

AMY



RECONNAISSANCE AIRCRAFT FIXES - TYPHOON AMY

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 030900Z | 17.5N | 123.9E | 54-P-10             | 1000        | 40          | 10000         | 30              | 11              | 08               | CIRC ILL DEFINED    |
| 2       | 040600Z | 17.7N | 125.0E | 54-P-10             | 993         | --          | 9980          | 25              | 10              | 10               | NOT DEFINED         |
| 3       | 041744Z | 19.0N | 125.7E | 54-P-5              | --          | --          | 10020         | 50              | 13              | 05               |                     |
| 4       | 042000Z | 19.5N | 126.0E | 54-T-10             | --          | --          | --            | --              | --              | --               |                     |
| 5       | 042130Z | 19.7N | 126.0E | 54-P-5              | 987         | 70          | 9910          | 50              | 17              | 04               | ELLIP ILL DEFINED   |
| 6       | 050020Z | 20.0N | 126.0E | 54-P-5              | 987         | 75          | 9870          | 50              | 15              | 06               | ILL DEFINED         |
| 7       | 051145Z | 22.1N | 126.8E | 54-R-5              | --          | --          | --            | 65              | --              | --               | CIRC DIA 20 MI      |
| 8       | 051400Z | 22.7N | 126.8E | 54-R-10             | --          | --          | --            | 70              | --              | --               | CIRC DIA 20 MI      |
| 9       | 051530Z | 23.2N | 126.7E | 54-R-10             | --          | --          | 9960          | 70              | 16              | 16               | CIRC DIA 25 MI      |
| 10      | 051800Z | 23.7N | 126.8E | 54-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 25 MI      |
| 11      | 052000Z | 24.3N | 127.4E | 54-R--              | --          | --          | --            | --              | --              | --               |                     |
| 12      | 052130Z | 25.8N | 126.8E | 54-P-10             | 1000        | 45          | 10020         | 60              | 08              | 07               | EYE DIFFUSE         |
| 13      | 052237Z | 25.3N | 127.8E | 12-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 20 MI      |
| 14      | 060345Z | 27.2N | 128.3E | 54-P-1              | 990         | 70          | 9760          | 65              | 18              | 15               |                     |
| 15      | 060745Z | 28.8N | 129.2E | 54-P-1              | 977         | 95          | 9670          | 85              | 17              | 13               | CIRC DIA 40 MI      |

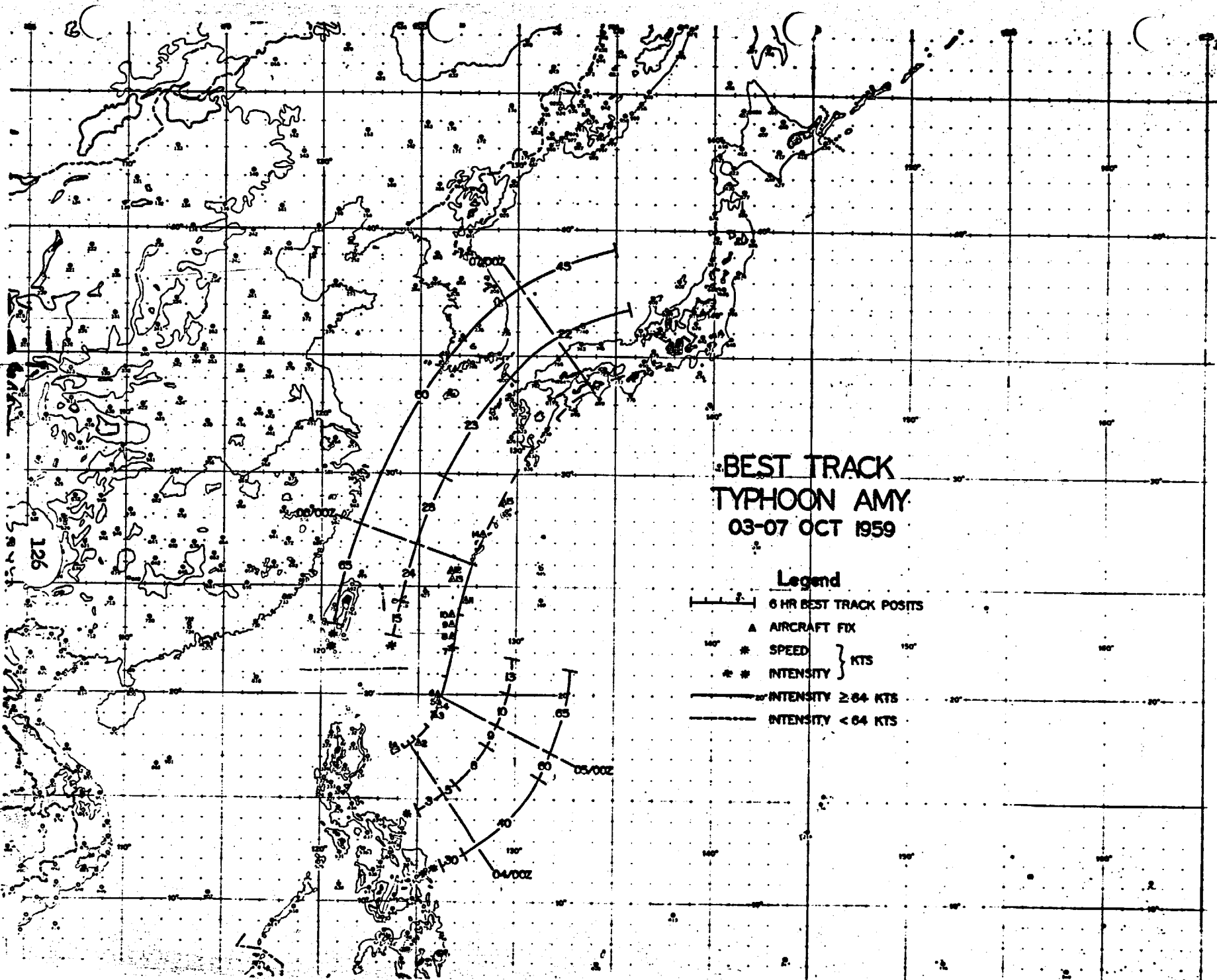
124

TYPHOON AMY 03 - 07 OCT 1959  
 POSITION AND FORECAST VERIFICATION DATA

| DTG                   | STORM POSITION |          | 12 HR ERROR |          | 24 HR ERROR |          |
|-----------------------|----------------|----------|-------------|----------|-------------|----------|
|                       | LAT.           | LONG.    | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 030600Z               | 17.2N          | 123.8E   | -           | -        | -           | -        |
| 031200Z               | 17.3N          | 124.1E   | -           | -        | -           | -        |
| 031800Z               | 17.4N          | 124.3E   | -           | -        | -           | -        |
| 040000Z               | 17.6N          | 124.6E   | -           | -        | -           | -        |
| 040600Z               | 17.8N          | 124.9E   | 296         | - 193    | -           | -        |
| 041200Z               | 18.4N          | 125.4E   | 322         | - 130    | -           | -        |
| 041800Z               | 19.1N          | 125.8E   | 247         | - 50     | 284         | - 302    |
| 050000Z               | 19.9N          | 126.2E   | 238         | - 78     | 318         | - 178    |
| 050600Z               | 20.9N          | 126.5E   | 038         | - 35     | 231         | - 106    |
| 051200Z               | 22.2N          | 126.8E   | 185         | - 26     | 220         | - 156    |
| 051800Z               | 23.8N          | 127.0E   | 180         | - 70     | 100         | - 57     |
| 060000Z               | 26.0N          | 127.9E   | 184         | - 86     | 184         | - 157    |
| 060600Z               | 28.6N          | 129.1E   | 166         | - 30     | 195         | - 278    |
| 061200Z               | 30.7N          | 130.4E   | 158         | - 53     | 201         | - 248    |
| 061800Z               | 32.4N          | 132.0E   | 197         | - 84     | 273         | - 196    |
| 070000Z               | 33.8N          | 133.9E   | 210         | - 75     | 106         | - 87     |
| 070600Z               | 34.4N          | 136.4E   | 198         | - 105    | 223         | - 180    |
| AVERAGE 12 HOUR ERROR |                | 78.1 NM  |             |          |             |          |
| AVERAGE 24 HOUR ERROR |                | 176.8 NM |             |          |             |          |



BEST TRACK  
TYPHOON AMY  
03-07 OCT 1959



Legend

- 0 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \* \* INTENSITY } KTS
- INTENSITY  $\geq 64$  KTS
- - - INTENSITY  $< 64$  KTS

The map displays the path of Typhoon Amy from October 3 to 7, 1959. The 12-hour forecast positions are marked with open circles, and the 6-hour best track positions are marked with solid dots. The path starts near the Philippines on October 3, moves north-northeast, and passes south of Japan on October 7. A coordinate grid is overlaid on the map, with latitude lines from 10°N to 40°N and longitude lines from 120°E to 160°E. The text '12 HR FORECAST POSITS' and 'TYPHOON AMY 03-07 OCT 1959' is centered on the right side of the map. A legend below the title defines the symbols used for the forecast and best track positions. The map also shows the outlines of the Philippines and Japan, with various islands and coastal features labeled.

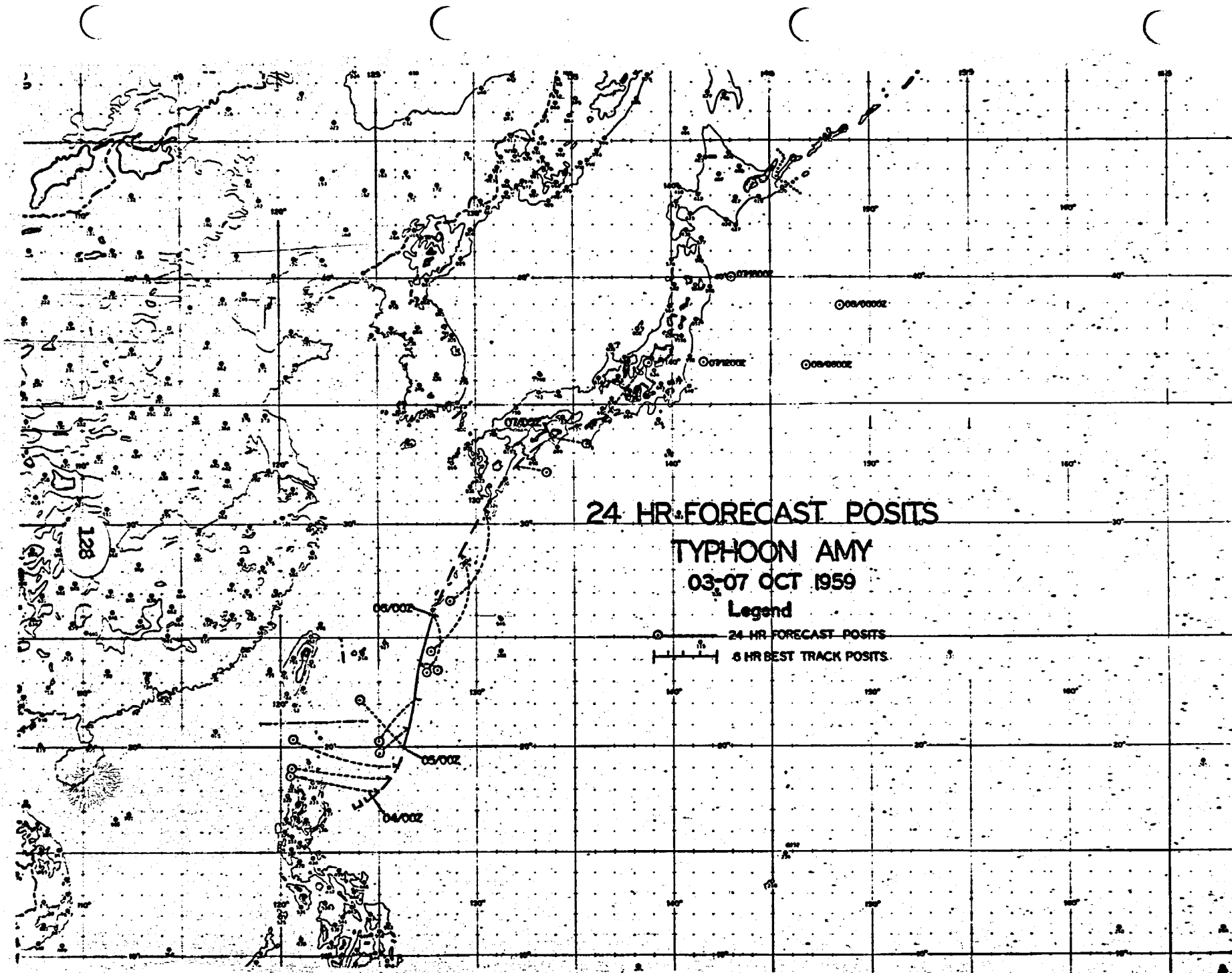
12 HR FORECAST POSITS

TYPHOON AMY

03-07 OCT 1959

Legend

○ 12 HR FORECAST POSITS  
● 6 HR BEST TRACK POSITS



24 HR FORECAST POSITS

TYPHOON AMY  
03-07 OCT 1959

Legend

- 24 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS

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M. TYPHOON CHARLOTTE (09-19 OCTOBER 1959)

As early as 4 October, surface map analyses indicated a diffuse area of low pressure extending along the Intertropical Convergence Zone from the general vicinity of the Palau Islands eastward. By 8 October, this low pressure area had deepened and contracted to the extent that surface map analyses indicated the possibility of a cyclone just to the southeast of the islands of Yap and Koror. Accordingly, a reconnaissance aircraft investigated the area late on the 8th and verified the existence of a closed circulation. This circulation was still quite weak but warranted further reconnaissance surveillance. Throughout the 9th, reconnaissance aircraft continued to track this cyclone. Finally on the 10th, as a result of an early morning penetration, Tropical Storm CHARLOTTE was named and the first warning was issued at 100600Z.

Throughout the 9th and 10th, CHARLOTTE moved northwestward at speeds varying from 6 to 9 knots. Steady intensification took place so that at 101800Z she was upgraded to a typhoon. On the 11th and 12th, CHARLOTTE intensified further and continued to move to the northwest at an average speed of 9 knots. On the 13th, as CHARLOTTE approached the western extremity of the semi-permanent Pacific High, recurvature and deceleration commenced. Also on the 13th, at 0800Z, CHARLOTTE appears to have reached her peak intensity. At this time a reconnaissance aircraft penetration reported a sea level pressure of 905 millibars and maximum surface winds of 145 knots. On the 14th CHARLOTTE reached the apex of her recurvature. She slowed to a speed

of 3-4 knots and began a movement toward the north-northeast. At approximately 161200Z, CHARLOTTE passed within 40 miles of the southern tip of Okinawa. At this time she was moving northeastward at a speed of about 9 knots. As a result of this comparatively slow speed, Okinawa experienced sustained winds of 45-55 knots for approximately 14 hours on the 16th. A peak gust of 105 knots was recorded by the Ryukyuan Weather Bureau, and 24 inches of rain caused considerable flooding. On the 18th, CHARLOTTE finally came under the influence of strong westerlies aloft and rapidly accelerated toward the northeast. An influx of colder air lying to the north and northwest caused steady weakening. At 190000Z, she was downgraded to a tropical storm and the final tropical warning was issued. Very shortly thereafter, CHARLOTTE was imbedded in the Polar Front as an extra-tropical low.

It is interesting to note the reconnaissance aircraft fixes on the 18th. At this time CHARLOTTE was rapidly proceeding northeastward off the southeastern tip of Honshu. These fixes would seem to indicate that CHARLOTTE's track was further north than that delineated by the best track. However, careful analysis of the reports from Hachijo Jima indicated that the primary center had passed close to this station. Apparently a secondary upper air center had developed on the 18th as CHARLOTTE became diffuse and cold air advection caused rapid weakening. It was this secondary center which was fixed at 181415Z and 182000Z by reconnaissance aircraft. Throughout her lifetime, CHARLOTTE's track conformed quite closely to the flow as indicated by the high level charts. The 200 millibar chart was

particularly helpful as a forecasting tool, and the 200 millibar level was undoubtedly the best steering level aloft. Thirty-six warnings were issued covering a period of 10 days.

For damage caused by Typhoon CHARLOTTE see section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON CHARLOTTE

| FLX<br>NO. | TIME    | LAT.    | LONG.  | *UNIT<br>METHOD<br>& ACCY | MIN<br>SLP<br>MS | MAX<br>SPC<br>WIND | MIN<br>700MB<br>HGT | MAX<br>FLT<br>LVL<br>WIND | 700MB<br>TEMP<br>(°C) | 700MB<br>DEWPT<br>(°C) | EYE CHARACTERISTICS   |                |
|------------|---------|---------|--------|---------------------------|------------------|--------------------|---------------------|---------------------------|-----------------------|------------------------|-----------------------|----------------|
| 1          | 090215Z | 10.4N   | 137.3E | 54-P-10                   | --               | 35                 | 10120               | 35                        | 09                    | 09                     | EYE ILL DEFINED       |                |
| 2          | 090700Z | 10.9N   | 136.6E | 54-P-5                    | 1006             | 40                 | 10080               | 35                        | 09                    | 09                     | EYE FILLED WITH CLDS  |                |
| 3          | 092100Z | 12.0N   | 135.0E | 54-P-5                    | 994              | 30                 | 10130               | 30                        | 11                    | 08                     | EYE ILL DEFINED       |                |
| 4          | 100800Z | 13.4N   | 133.9E | 54-P-2                    | 998              | 50                 | 10100               | 35                        | 13                    | 07                     | CIRC DIA 30 MI        |                |
| 5          | 102000Z | 13.4N   | 132.4E | 54-R-15                   | --               | --                 | --                  | --                        | --                    | --                     | WALL CLDS DIA 20 MI   |                |
| 6          | 102140Z | 13.8N   | 132.7E | 54-P-5                    | 989              | 90                 | 9910                | --                        | 16                    | 05                     | TURBC SVR W QUAD      |                |
| 132        | 7       | 110140Z | 14.3N  | 131.7E                    | 54-P-5           | 989                | 100                 | 9890                      | --                    | 17                     | 07                    | CIRC DIA 25 MI |
| 8          | 110800Z | 14.7N   | 131.0E | 54-P-5                    | 980              | 70                 | 9630                | 70                        | 18                    | 12                     | CIRC DIA 15 MI        |                |
| 9          | 111400Z | 14.8N   | 130.3E | 54-R-10                   | --               | --                 | --                  | --                        | --                    | --                     |                       |                |
| 10         | 112000Z | 15.4N   | 128.6E | 54-T-40                   | --               | --                 | --                  | 60                        | --                    | --                     | TURBC LGT N&W QUADS   |                |
| 11         | 112200Z | 15.5N   | 129.2E | 54-P-15                   | 972              | 80                 | 9420                | --                        | 17                    | 12                     | CIRC DIA 40 MI        |                |
| 12         | 120030Z | 15.8N   | 129.0E | 54-P-15                   | 975              | 175                | 9480                | --                        | 16                    | 13                     | WALL CLDS ALL QUADS   |                |
| 13         | 121422Z | 16.9N   | 126.9E | 12-R-10                   | --               | --                 | --                  | --                        | --                    | --                     | WELL DEFINED EYE      |                |
| 14         | 122000Z | 17.3N   | 126.2E | 54-R-15                   | --               | --                 | --                  | --                        | --                    | --                     | CIRC DIA 10 MI        |                |
| 15         | 122200Z | 17.5N   | 126.0E | 54-P-5                    | 932              | 150                | 8180                | --                        | 17                    | 15                     | WALL CLDS ALL QUADS   |                |
| 16         | 130200Z | 17.9N   | 125.9E | 54-P-5                    | 916              | 125                | 7730                | --                        | 17                    | 16                     | CIRC DIA 08 MI        |                |
| 17         | 130433Z | 18.0N   | 125.7E | 54-R-5                    | --               | --                 | --                  | --                        | --                    | --                     | CLOSED EYE 08 MI DIA  |                |
| 18         | 130800Z | 18.3N   | 125.4E | 54-P-5                    | 905              | 145                | 7320                | 180                       | 20                    | 15                     | PERFECT EYE FORMATION |                |
| 19         | 131605Z | 18.7N   | 125.2E | 54-R-5                    | --               | --                 | --                  | --                        | --                    | --                     | DOUBLE WALL CLDS      |                |
| 20         | 132200Z | 19.3N   | 124.9E | 54-P-3                    | 914              | 100                | 7630                | 110                       | 17                    | 15                     | WALL CLDS ALL QUADS   |                |
| 21         | 132316Z | 19.5N   | 125.1E | 12-R-5                    | --               | --                 | --                  | --                        | --                    | --                     | WELL DEFINED CIRC EYE |                |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON CHARLOTTE (CONT'D)

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS  |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|----------------------|
| 22      | 140200Z | 19.7N | 124.8E | 54-P-5              | 914         | 125         | 7620          | --              | 18              | 15               | CIRC DIA 05 MI       |
| 23      | 140800Z | 20.4N | 124.6E | 54-P-5              | 916         | 175         | 7640          | --              | 17              | 15               | WALL CLDS ALL QUADS  |
| 24      | 141045Z | 20.6N | 124.4E | 12-R-10             | --          | --          | --            | --              | --              | --               | EYE DIA 09 MI        |
| 25      | 141400Z | 21.1N | 124.3E | 54-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 12 MI       |
| 26      | 142200Z | 21.5N | 124.3E | 54-P-2              | 932         | 150         | 8130          | 70              | 18              | 18               | CIRC DIA 07 MI       |
| 27      | 150200Z | 21.8N | 124.4E | 54-P-5              | 937         | --          | 8110          | --              | 17              | 13               | EYE BREAKING UP      |
| 28      | 150357Z | 22.1N | 124.6E | 12-R--              | --          | --          | --            | --              | --              | --               |                      |
| 29      | 150800Z | 22.5N | 124.7E | 54-P-5              | 940         | 95          | 8280          | 70              | 17              | 15               | EYE ELLIPTICAL       |
| 30      | 151359Z | 23.2N | 125.3E | 12-R-5              | --          | --          | --            | --              | --              | --               | DOUBLE WALL CLDS     |
| 31      | 151830Z | 23.9N | 125.7E | * *                 | --          | --          | --            | --              | --              | --               |                      |
| 32      | 152200Z | 24.3N | 125.8E | 54-P-5              | 956         | 85          | 8730          | 90              | 16              | 13               | CIRC DIA 60 MI       |
| 33      | 160150Z | 24.7N | 126.6E | 54-P--              | 955         | --          | --            | --              | --              | --               | TWO CELLS            |
| 34      | 160522Z | 25.0N | 127.1E | 54-P--              | 952         | --          | 9010          | 90              | 10              | 10               | EYE OBLONG           |
| 35      | 161100Z | 25.6N | 128.0E | 12-R-10             | --          | --          | --            | --              | --              | --               | WALL CLD STRONG NE   |
| 36      | 161412Z | 25.7N | 128.3E | 54-R-20             | --          | --          | --            | --              | --              | --               | EYE ELLIP DIA INDEF  |
| 37      | 162000Z | 26.3N | 129.0E | 54-R-25             | --          | --          | --            | --              | --              | --               | EYE NOT WELL DEFINED |
| 38      | 162115Z | 26.2N | 128.9E | 54-P-10             | 962         | 60          | 9070          | --              | 17              | 14               | EYE ILL DEFINED      |
| 39      | 170200Z | 26.8N | 129.4E | 54-P-5              | 970         | 90          | 9220          | 70              | 16              | 16               | CIRC DIA 60 MI       |
| 40      | 170800Z | 27.2N | 130.3E | 54-P-3              | 965         | 75          | 9190          | 80              | 15              | 15               | WALL CLDS ALL QUADS  |
| 41      | 171100Z | 27.3N | 130.8E | 12-R-5              | --          | --          | --            | --              | --              | --               | EYE ELLIPTICAL       |
| 42      | 171430Z | 27.8N | 131.3E | 54-R-2              | --          | --          | --            | --              | --              | --               | WALL CLDS ALL QUADS  |

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RECONNAISSANCE AIRCRAFT FIXES - TYPHOON CHARLOTTE (CONT'D)

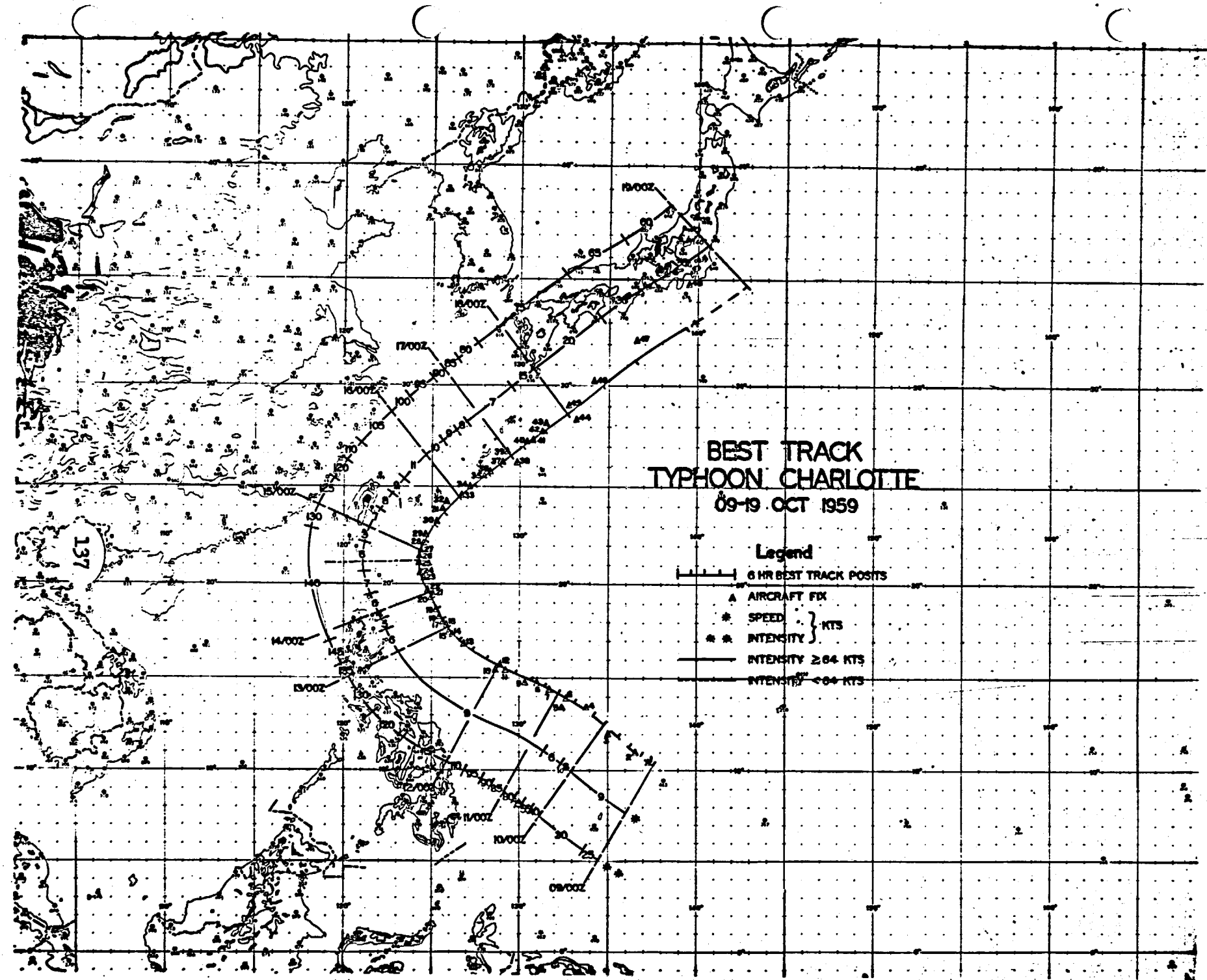
| FIX<br>NO. | TIME    | LAT.  | LONG.  | *UNIT<br>METHOD<br>& ACCY | MIN<br>SLP<br>MBS | MAX<br>SFC<br>WND | MIN<br>700MB<br>HGT | MAX<br>FLT<br>LVL<br>WND | 700MB<br>TEMP<br>(°C) | 700MB<br>DEWPT<br>(°C) | EYE CHARACTERISTICS    |
|------------|---------|-------|--------|---------------------------|-------------------|-------------------|---------------------|--------------------------|-----------------------|------------------------|------------------------|
| 43         | 172000Z | 28.1N | 131.5E | 54-P-5                    | 974               | --                | 9500                | 70                       | 22                    | 16                     | CIRC DIA 4.5 MI        |
| 44         | 172318Z | 28.4N | 133.1E | 12-P-5                    | --                | --                | --                  | --                       | --                    | --                     | EYE POORLY DEFINED     |
| 45         | 180200Z | 29.0N | 132.9E | 54-P-2                    | 970               | 60                | 9570                | 60                       | 16                    | 10                     | WALL CLDS N, E&S QUADS |
| 46         | 180800Z | 30.2N | 134.1E | 54-P-2                    | 970               | 90                | 9590                | 67                       | 19                    | 08                     | TURBC SVR N QUAD       |
| 47         | 181415Z | 32.1N | 136.5E | 54-R-1                    | --                | --                | --                  | 75                       | --                    | --                     | EYE ELLIPTICAL         |
| 48         | 182000Z | 34.8N | 139.5E | 54-R-15                   | --                | --                | --                  | --                       | --                    | --                     | CIRC, WALL CLDS TO N   |

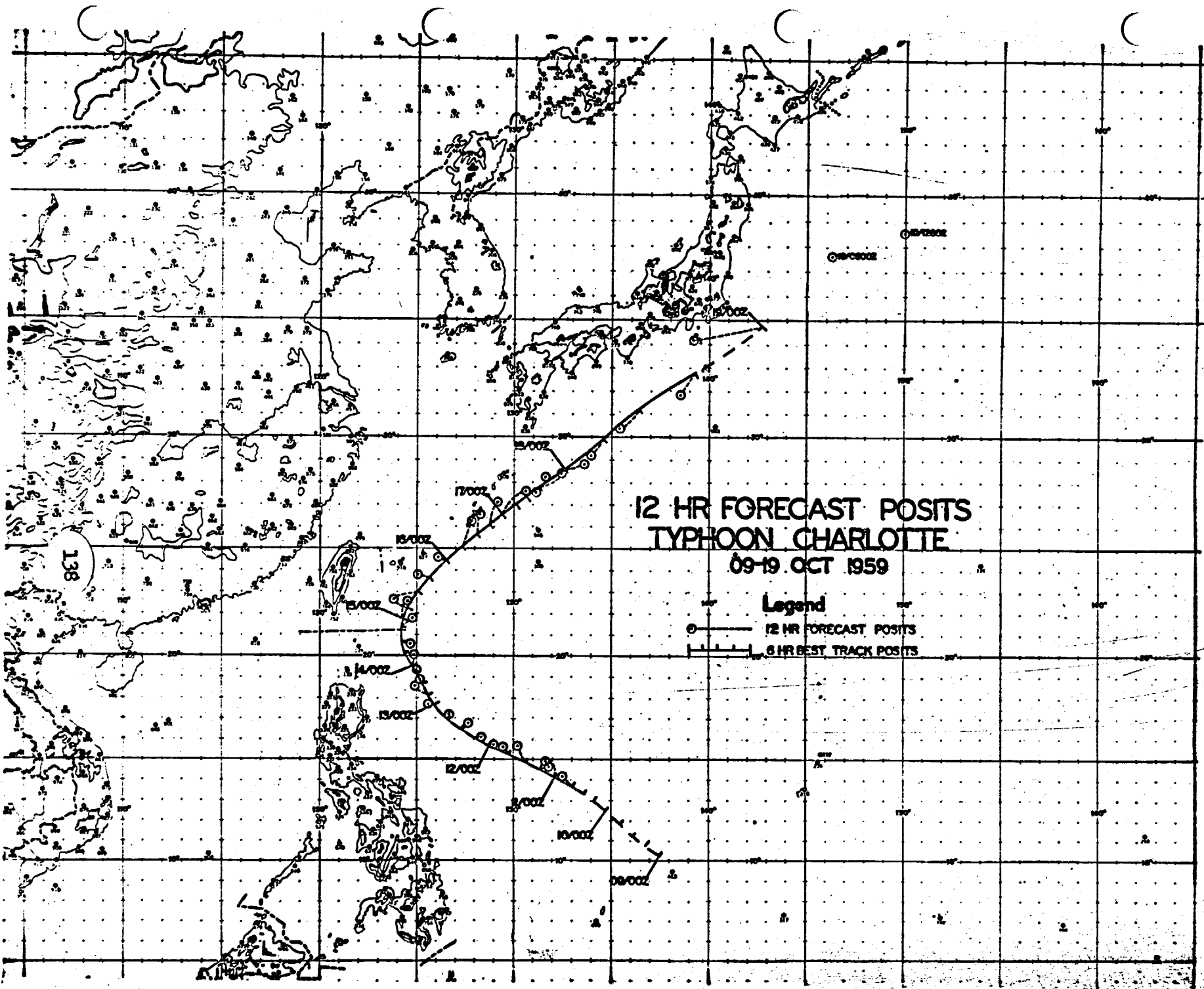
TYPHOON CHARLOTTE 09 - 19 OCT. 1959  
POSITION AND FORECAST VERIFICATION DATA

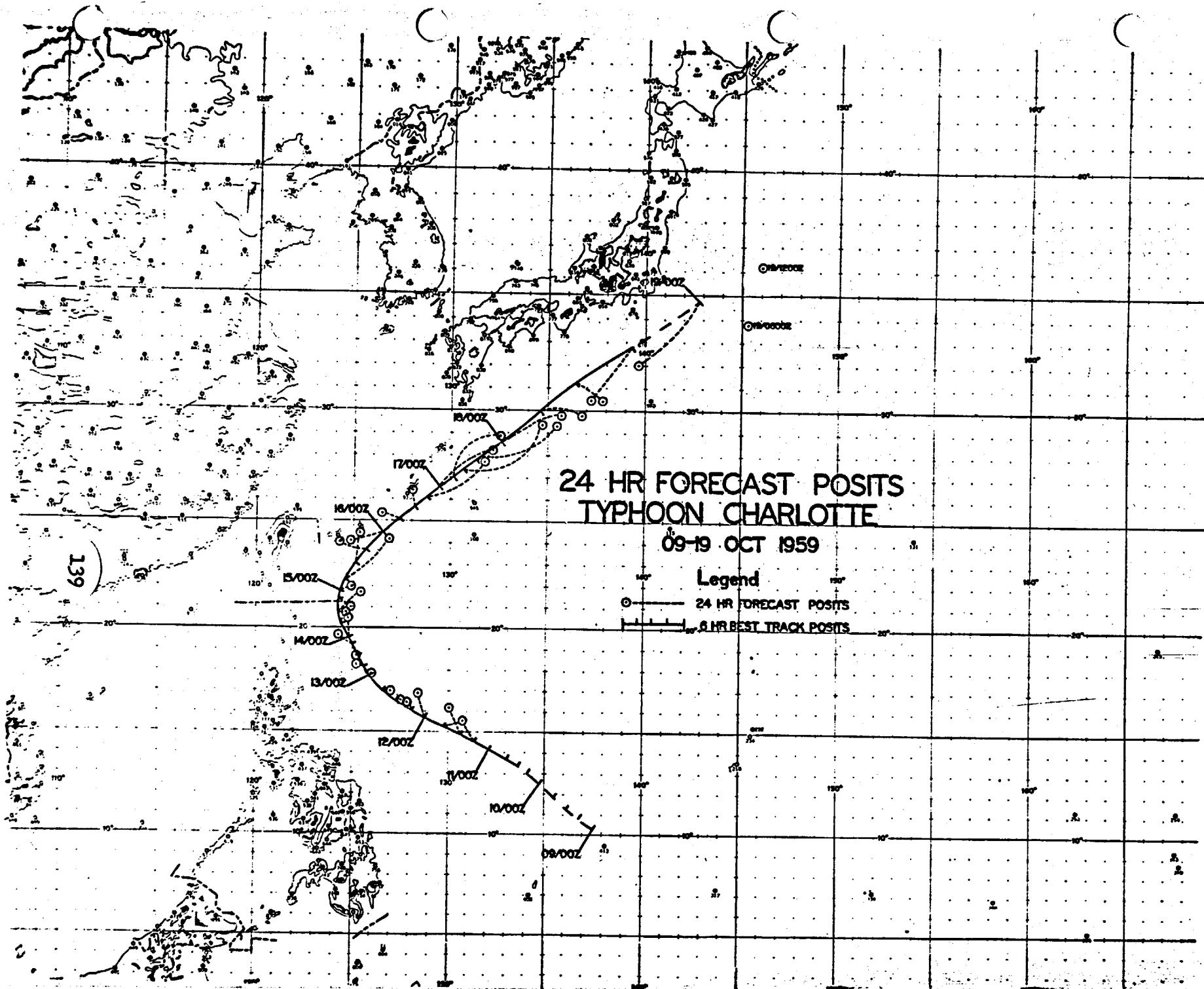
| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 090000Z | 10.2N          | 137.6E | - - - -     |          | - - - -     |          |
| 090600Z | 10.8N          | 136.9E | - - - -     |          | - - - -     |          |
| 091200Z | 11.4N          | 136.2E | - - - -     |          | - - - -     |          |
| 091800Z | 11.9N          | 135.5E | - - - -     |          | - - - -     |          |
| 100000Z | 12.5N          | 134.8E | - - - -     |          | - - - -     |          |
| 100600Z | 15.0N          | 134.1E | - - - -     |          | - - - -     |          |
| 101200Z | 15.4N          | 133.6E | - - - -     |          | - - - -     |          |
| 101800Z | 13.7N          | 133.1E | 310         | - 46     | - - - -     |          |
| 110000Z | 14.2N          | 132.2E | 325         | - 57     | - - - -     |          |
| 110600Z | 14.5N          | 131.4E | 260         | - 30     | 333         | - 66     |
| 111200Z | 14.9N          | 130.6E | 334         | - 48     | 338         | - 85     |
| 111800Z | 15.2N          | 129.8E | 326         | - 25     | 076         | - 62     |
| 120000Z | 15.6N          | 128.9E | 043         | - 07     | 343         | - 82     |
| 120600Z | 16.0N          | 128.1E | 062         | - 20     | 326         | - 36     |
| 121200Z | 16.5N          | 127.3E | 051         | - 29     | 255         | - 20     |
| 121800Z | 17.0N          | 126.6E | 056         | - 19     | 096         | - 28     |
| 130000Z | 17.7N          | 125.9E | 270         | - 18     | 050         | - 07     |
| 130600Z | 18.2N          | 125.6E | 291         | - 44     | 270         | - 20     |
| 131200Z | 18.7N          | 125.3E | 325         | - 14     | 269         | - 65     |
| 131800Z | 19.2N          | 125.0E | 324         | - 22     | 290         | - 105    |
| 140000Z | 19.5N          | 124.9E | 003         | - 36     | 339         | - 58     |
| 140600Z | 20.1N          | 124.6E | 119         | - 18     | 353         | - 45     |
| 141200Z | 20.7N          | 124.3E | 135         | - 20     | 043         | - 80     |
| 141800Z | 21.3N          | 124.3E | 045         | - 40     | 125         | - 37     |
| 150000Z | 21.7N          | 124.4E | 009         | - 53     | 052         | - 36     |
| 150600Z | 22.3N          | 124.7E | 300         | - 51     | 051         | - 116    |
| 151200Z | 23.0N          | 125.1E | 259         | - 75     | 003         | - 90     |
| 151800Z | 23.7N          | 125.7E | 284         | - 37     | 282         | - 90     |
| 160000Z | 24.5N          | 126.5E | 284         | - 23     | 283         | - 148    |
| 160600Z | 25.1N          | 127.4E | 020         | - 68     | 281         | - 53     |
| 161200Z | 25.6N          | 128.2E | 016         | - 55     | 351         | - 46     |
| 161800Z | 26.2N          | 128.8E | 015         | - 60     | 063         | - 185    |
| 170000Z | 26.5N          | 129.5E | 048         | - 85     | 056         | - 167    |
| 170600Z | 27.0N          | 130.1E | 059         | - 67     | 051         | - 172    |
| 171200Z | 27.4N          | 130.7E | 047         | - 70     | 062         | - 240    |
| 171800Z | 27.8N          | 131.4E | 060         | - 68     | 068         | - 222    |

TYPHOON CHARLOTTE 09 - 19 OCT 1959  
 POSITION AND FORECAST VERIFICATION DATA (CONT'D)

| DTG                            | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|--------------------------------|----------------|--------|-------------|----------|-------------|----------|
|                                | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 180000Z                        | 28.7N          | 132.7E | 086         | - 46     | 069         | - 172    |
| 180600Z                        | 30.0N          | 134.6E | 213         | - 54     | 095         | - 116    |
| 181200Z                        | 31.2N          | 136.4E | 227         | - 76     | 124         | - 93     |
| 181800Z                        | 32.8N          | 139.3E | 213         | - 72     | 215         | - 181    |
| 190000Z                        | 34.8N          | 142.8E | 258         | - 180    | 224         | - 232    |
| AVERAGE 12 HOUR FORECAST ERROR |                |        | 48.0 NM     |          |             |          |
| AVERAGE 24 HOUR FORECAST ERROR |                |        | 98.6 NM     |          |             |          |







# 24 HR FORECAST POSITS TYPHOON CHARLOTTE

09-19 OCT 1959

## Legend

- — 24 HR FORECAST POSITS
- - - ○ — 6 HR BEST TRACK POSITS

139

N. TYPHOON DINAH (14-21 OCTOBER 1959)

As previously mentioned in Section IV, forecasters of the JTWC have found the Stidd Diagram a valuable tool in first detecting tropical cyclones. The Stidd Diagram, included as page 30, shows the initial stages of development of Typhoon DINAH. DINAH first became a suspect area on 13 October in light of the higher than normal surface winds and multiple layers of clouds at Eniwetok, and the large 24-hour pressure falls at Ponape. As is evident from the Stidd Diagram, DINAH passed north of Ponape at approximately 1800Z on the 14th. Because of previous reconnaissance commitments on Typhoon CHARLOTTE, the first reconnaissance fix on DINAH was not made until 142230Z. The fix positioned DINAH approximately 600 miles southeast of Guam, and surface winds of 50 knots near the center were observed. Subsequent fixes indicated that DINAH was steadily intensifying, and at 151800Z DINAH was upgraded to a typhoon.

DINAH continued to intensify, and the maximum surface winds near the center were 125 knots as she passed 120 miles to the south of Agana, Guam at 161000Z. At that time, although intense, DINAH was still small area-wise. It was therefore not surprising that the maximum gust recorded on Nimitz Hill (the site of FWC/JTWC) was 42 knots. For the next 36 hours after passing Guam, DINAH moved to the west-northwest while gradually decelerating. Early on the 18th, at 15N - 135E, DINAH turned sharply northward and, at an average speed of 10 knots, moved almost due north until reaching

26 degrees north latitude. DINAH's abrupt turn to the north began just as Typhoon CHARLOTTE, moving northeastward, passed approximately 900 miles due north of DINAH. Upon reaching 26 degrees north on the 20th, DINAH began moving northeastward and accelerating. She also began to weaken and take on extratropical characteristics and at 211800Z when DINAH was 250 miles southeast of Tokyo, the final tropical warning was issued.

DINAH was characterized by her small eye averaging 20-25 miles. Over all her track followed late October climatology quite well. In the area south of Tokyo, the upper air center moved to the north as indicated by the 210800Z and 211400Z fixes, while surface and ship reports indicated the surface center to be moving in a north-easterly direction. This upper air center was caused by a slow moving trough aloft. Twenty nine warnings were issued on DINAH covering a period of eight days.

Typhoon DINAH expended her fury over the open ocean and no known damage has been reported.



RECONNAISSANCE AIRCRAFT FIXES - TYPHOON DINAH

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 142230Z | 09.7N | 154.3E | 54-P-10             | 997         | 50          | 10080         | 40              | 10              | 08               | CIRC DIA 15 MI      |
| 2       | 150200Z | 09.8N | 153.7E | 54-P-10             | 1000        | 60          | 10030         | 50              | 09              | 07               | EYE DIFFUSE         |
| 3       | 150730Z | 10.0N | 152.5E | 54-P-10             | 993         | 65          | 9920          | 50              | 11              | 09               | CIRC DIA 30 MI      |
| 4       | 151620Z | 10.1N | 150.1E | 54-R-8              | --          | --          | --            | --              | --              | --               | CIRC DIA 40 MI      |
| 5       | 152000Z | 10.2N | 149.0E | 54-P-8              | 981         | 95          | 9580          | 70              | 14              | 11               | CIRC DIA 22 MI      |
| 6       | 160200Z | 10.8N | 146.9E | 54-P-5              | 985         | 150         | 9480          | 75              | 13              | 07               | CIRC DIA 15 MI      |
| 7       | 160645Z | 11.0N | 145.5E | 54-P-2              | --          | 100         | 9180          | 85              | 13              | 12               | CIRC DIA 15 MI      |
| 8       | 160800Z | 11.1N | 145.1E | 54-P-2              | 958         | 150         | 9140          | 100             | 15              | 12               | CIRC DIA 08 MI      |
| 9       | 161410Z | 12.2N | 142.7E | 54-R-10             | --          | --          | --            | 120             | --              | --               | CIRC DIA 10 MI      |
| 10      | 162100Z | 12.7N | 140.9E | 54-P-5              | 947         | 150         | 8480          | --              | 15              | 11               | CIRC DIA 08 MI      |
| 11      | 170200Z | 13.1N | 140.0E | 54-T-15             | --          | --          | --            | --              | --              | --               |                     |
| 12      | 170800Z | 13.4N | 138.3E | 54-P-5              | 938         | 180         | 8430          | 105             | 21              | 13               | CIRC DIA 30 MI      |
| 13      | 171400Z | 13.8N | 136.7E | 54-R-5              | --          | --          | --            | 90              | --              | --               | CIRC DIA 30 MI      |
| 14      | 172340Z | 14.6N | 135.6E | 54-P-5              | 947         | 150         | 8560          | 90              | 18              | 13               | CIRC DIA 20 MI      |
| 15      | 180200Z | 14.9N | 135.4E | 54-P-5              | 947         | 150         | 8580          | 90              | 19              | 14               | CIRC DIA 20 MI      |
| 16      | 180800Z | 15.7N | 135.1E | 54-P-2              | 944         | 185         | 8540          | 110             | 20              | 10               | CIRC DIA 30 MI      |
| 17      | 181400Z | 16.3N | 134.8E | 54-R-5              | --          | --          | --            | 90              | --              | --               | CIRC DIA 12 MI      |
| 18      | 182100Z | 17.1N | 134.6E | 54-P-10             | 945         | 125         | 8480          | 95              | 20              | 15               | CIRC DIA 20 MI      |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON DINAH (CONT'D)

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 19      | 190200Z | 18.4N | 134.6E | 54-P-20             | 945         | 200         | 8660          | --              | 17              | 17               | CIRC DIA 30 MI      |
| 20      | 190800Z | 19.1N | 135.0E | 54-P-3              | 942         | 80          | 8350          | --              | 17              | 13               | CIRC DIA 30 MI      |
| 21      | 191400Z | 20.1N | 134.9E | 54-T--              | --          | --          | --            | --              | --              | --               | CIRC DIA 25 MI      |
| 22      | 192030Z | 21.1N | 135.2E | 54-P-2              | 918         | --          | 7710          | 125             | 18              | 13               | CIRC DIA 30 MI      |
| 23      | 200400Z | 23.3N | 135.3E | 54-P-10             | 913         | --          | 7600          | 130             | 18              | 13               | CIRC DIA 25 MI      |
| 24      | 200800Z | 23.8N | 135.2E | 54-P-1              | 914         | --          | 7660          | 140             | 18              | 14               | EYE ELLIP DIA 20 MI |
| 25      | 201230Z | 24.5N | 135.1E | 54-R-1              | --          | --          | --            | --              | --              | --               | EYE CIRCULAR        |
| 26      | 202115Z | 27.8N | 137.0E | 54-P-10             | 934         | 175         | 8160          | --              | 19              | 15               | EYE ELLIP 20X40 MI  |
| 27      | 210200Z | 29.4N | 138.6E | 54-P-10             | 935         | 125         | 8440          | --              | 21              | 16               | CIRC DIA 40 MI      |
| 28      | 210800Z | 32.0N | 139.5E | 54-P-30             | 992         | --          | 9590          | --              | 10              | 10               | EYE ILL DEFINED     |
| 29      | 212100Z | 36.1N | 145.8E | 54-P-10             | 985         | --          | 9310          | 65              | 06              | 06               | EYE ILL DEFINED     |

+ 57ms ↓  
in 64ms?

26

TYPHOON DINAH 14 - 21 OCT 1959  
POSITION AND FORECAST VERIFICATION DATA

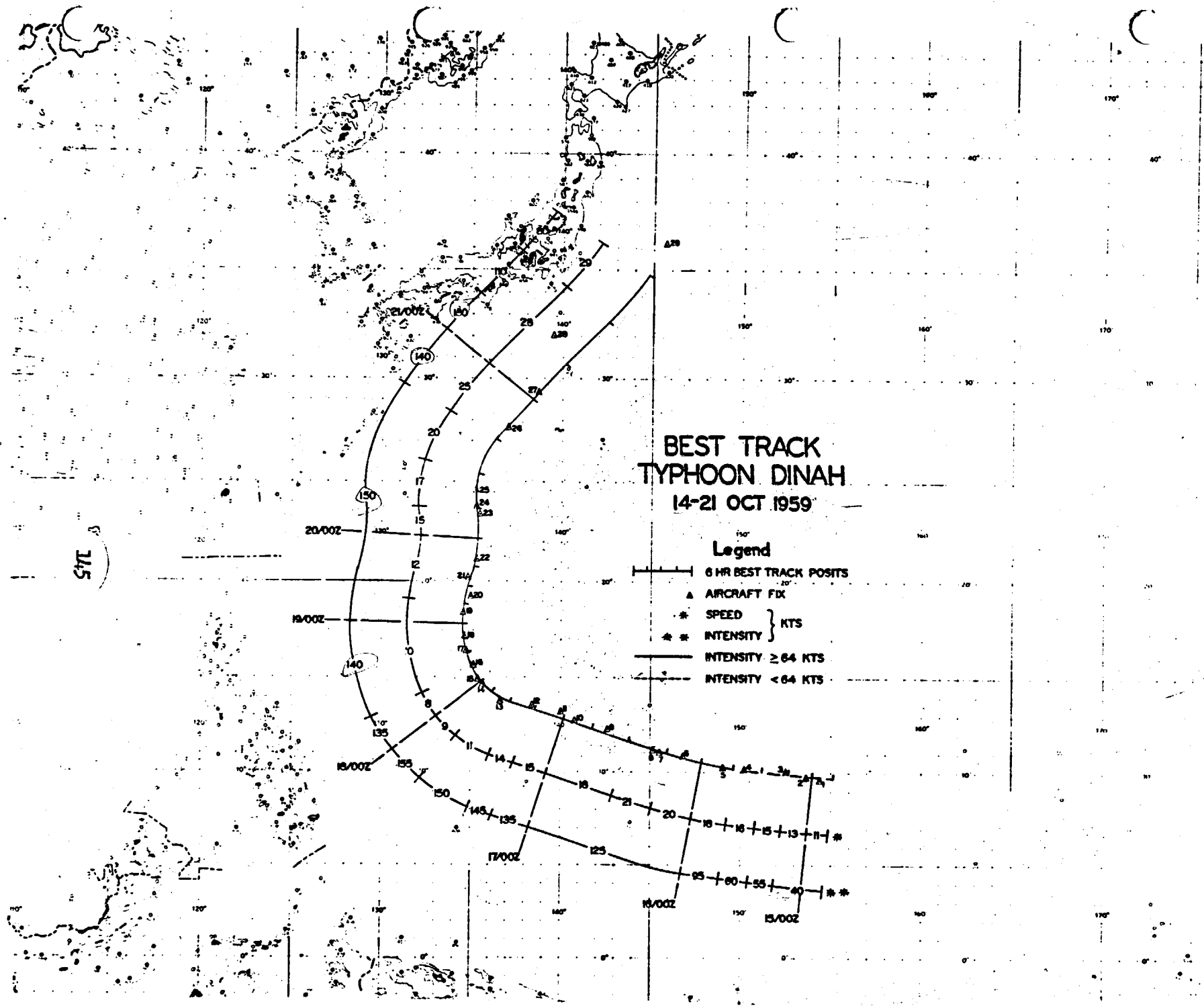
| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 141800Z | 09.7N          | 155.1E | -           | -        | -           | -        |
| 150000Z | 09.8N          | 154.0E | -           | -        | -           | -        |
| 150600Z | 09.9N          | 152.7E | 095         | - 28     | -           | -        |
| 151200Z | 10.0N          | 151.2E | 080         | - 45     | -           | -        |
| 151800Z | 10.1N          | 149.6E | 070         | - 58     | 090         | - 95     |
| 160000Z | 10.5N          | 147.9E | 085         | - 80     | 090         | - 127    |
| 160600Z | 11.0N          | 145.9E | 115         | - 50     | 095         | - 125    |
| 161200Z | 11.7N          | 143.9E | 285         | - 33     | 115         | - 174    |
| 161800Z | 12.3N          | 141.8E | 175         | - 41     | 125         | - 124    |
| 170000Z | 12.8N          | 140.1E | 030         | - 10     | 260         | - 12     |
| 170600Z | 13.3N          | 138.6E | 300         | - 57     | 165         | - 66     |
| 171200Z | 13.7N          | 137.2E | 300         | - 59     | 180         | - 19     |
| 171800Z | 14.2N          | 136.2E | 050         | - 05     | 315         | - 90     |
| 180000Z | 14.7N          | 135.5E | 270         | - 36     | 270         | - 102    |
| 180600Z | 15.4N          | 135.1E | 265         | - 148    | 260         | - 47     |
| 181200Z | 16.2N          | 134.9E | 220         | - 51     | 265         | - 94     |
| 181800Z | 17.0N          | 134.8E | 245         | - 34     | 265         | - 247    |
| 190000Z | 17.8N          | 134.7E | 220         | - 41     | 230         | - 128    |
| 190600Z | 18.8N          | 134.8E | 200         | - 37     | 240         | - 70     |
| 191200Z | 19.8N          | 134.9E | 270         | - 13     | 220         | - 83     |
| 191800Z | 20.8N          | 135.1E | 090         | - 12     | 210         | - 89     |
| 200000Z | 22.1N          | 135.2E | 120         | - 31     | 085         | - 19     |
| 200600Z | 23.6N          | 135.2E | 145         | - 65     | 115         | - 76     |
| 201200Z | 25.3N          | 135.3E | 100         | - 48     | 130         | - 131    |
| 201800Z | 27.1N          | 136.3E | 250         | - 36     | 150         | - 122    |
| 210000Z | 29.0N          | 138.2E | 250         | - 113    | 125         | - 50     |
| 210600Z | 30.7N          | 140.1E | 180         | - 25     | 240         | - 69     |
| 211200Z | 32.7N          | 142.5E | 130         | - 63     | 065         | - 162    |
| 211800Z | 34.8N          | 144.8E | 110         | - 134    | 140         | - 121    |

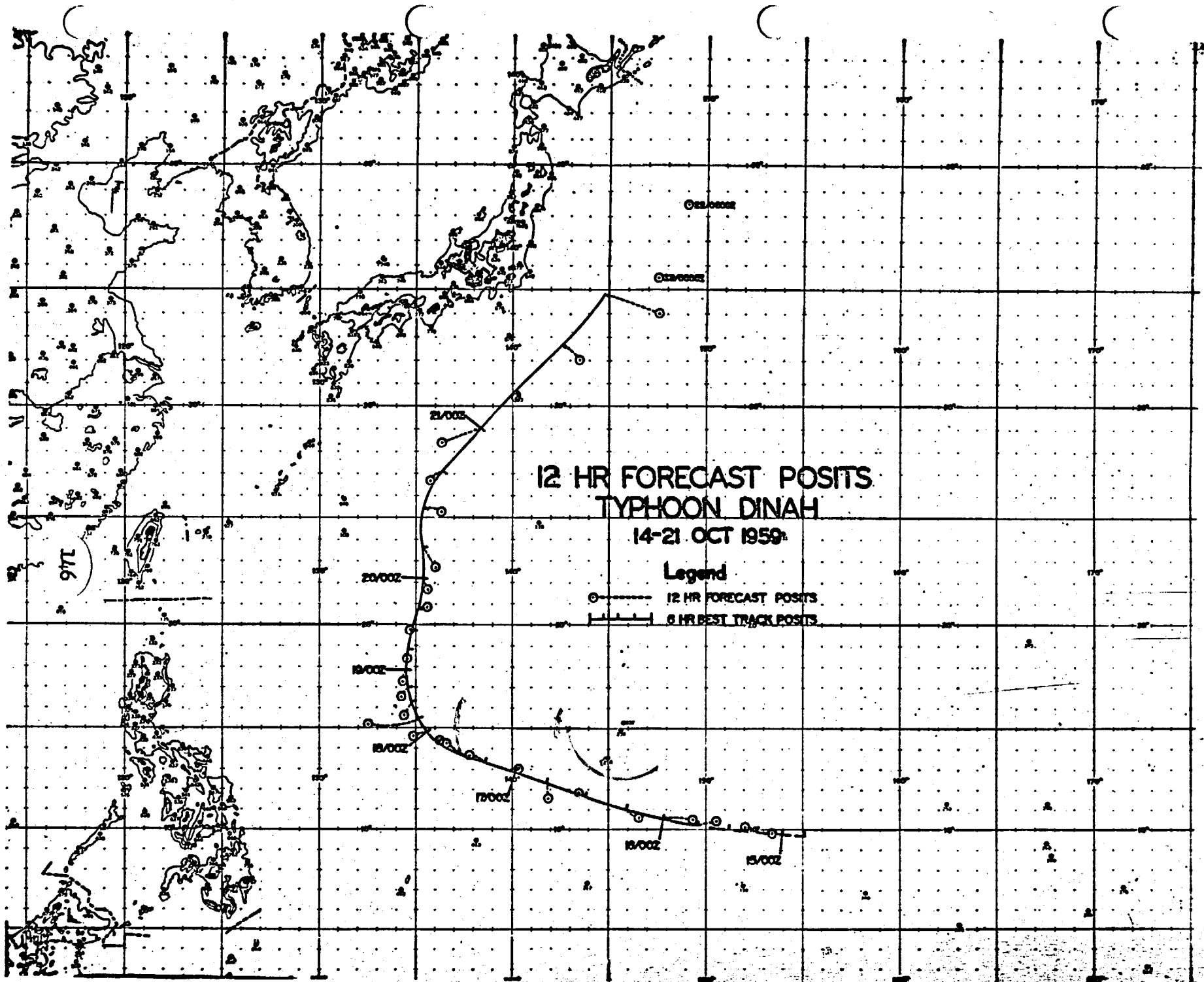
AVERAGE 12 HOUR ERROR      50.1 NM  
AVERAGE 24 HOUR ERROR      97.7 NM

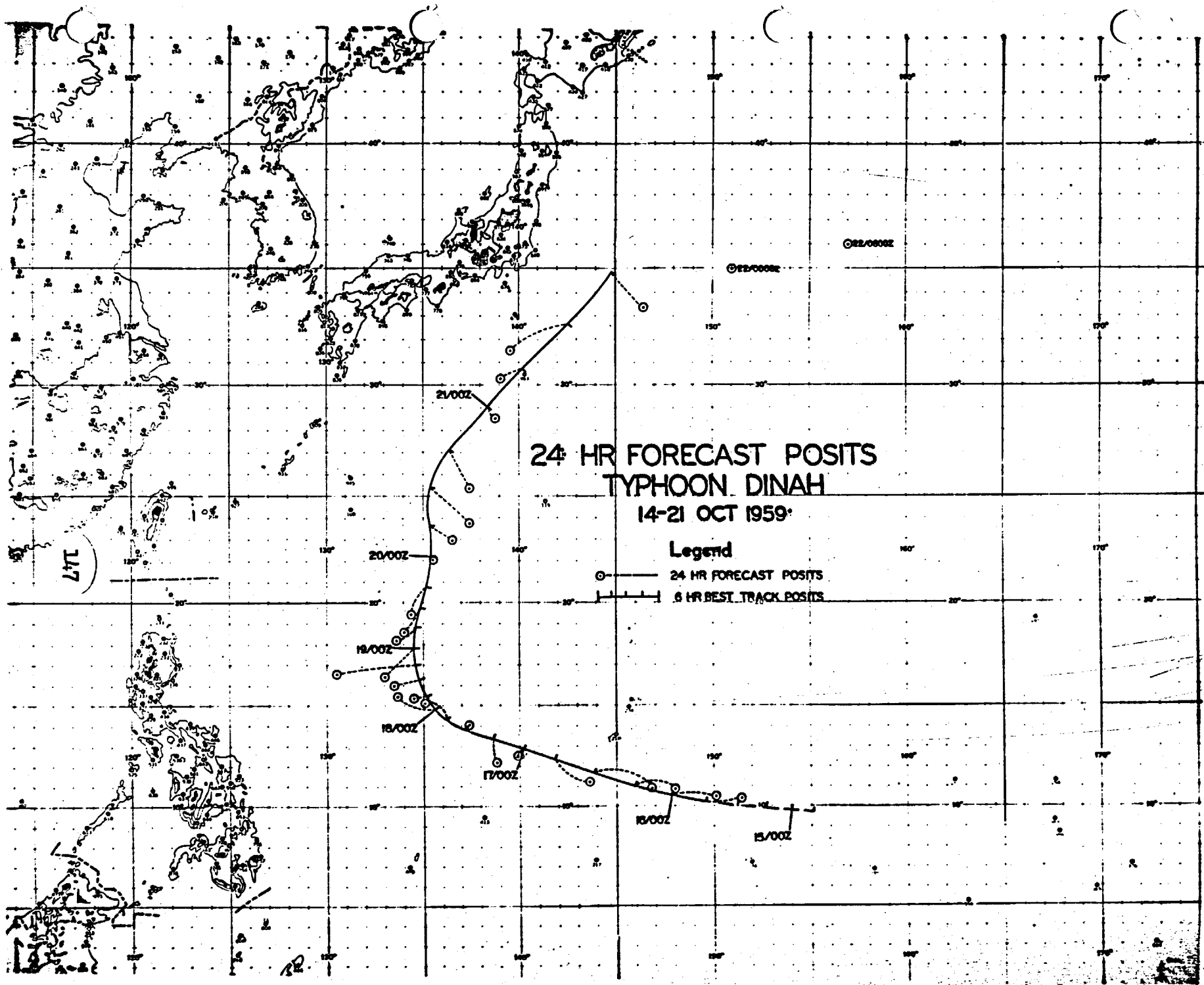
# BEST TRACK TYPHOON DINAH 14-21 OCT 1959

## Legend

- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \*\* INTENSITY } KTS
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS







O. TYPHOON EMMA (05-13 NOVEMBER 1959)

As a suspect area, Typhoon EMMA was first detected south of Kwajalein on 30 October. EMMA, as a large area of squally weather, was tracked for the next 6 days by reconnaissance aircraft. Finally on the 7th day (November 5th) a reconnaissance aircraft reported a definite closed surface circulation with wall clouds developing and surface winds near the center of 30 knots. Based on this information the first warning on Tropical Depression EMMA was issued at 050600Z. Moving to the west-northwest at a speed of 9 to 10 knots, EMMA passed approximately 20 miles south of Guam on the 6th. The pressure at Guam dropped to 995 millibars, but the sustained winds reached only 30 knots. It was not until 10 October, or 12 days after EMMA was first detected as a suspect area, that she finally reached typhoon intensity, approximately 800 miles west of Guam.

As a full-blown typhoon EMMA recurved gradually to the north at an average speed of 11 knots. She apparently reached peak intensity on 11 November with maximum surface winds near the center of 110 knots and a sea level pressure of 962 millibars. As EMMA reached 23 degrees north she came under the influence of strong westerlies aloft, and accelerated rapidly to the northeast. At 121800Z EMMA passed within 35 miles of Okinawa and caused considerable damage on the island. Kadena Air Base reported maximum sustained winds of 55 knots with gusts to 85 knots, while the Ryukyu Weather Bureau station, located on a hill near Naha, reported a maximum gust of 106 knots. Following her passage to the south and east of Okinawa, EMMA continued to accelerate and began to weaken rapidly. The final tropical warning was

issued at 131800Z at which time EMMA was moving east-northeasterly at 35 knots.

One interesting fact concerning EMMA was the out-of-phase vertical slope which persisted for a considerable period of time i.e., from the time EMMA passed Guam on 6 October until she reached typhoon intensity on the 10th. During this period both the surface and 700 millibar centers were carefully tracked by reconnaissance, and it was observed that the 700 millibar center was consistently located about 45 miles to the west-southwest of the surface center. Although a November typhoon, EMMA followed late October climatology very closely. Thirty-five warnings were issued covering a period of 9 days.

For damage caused by Typhoon EMMA see Section VI, "Destructive Effects of Typhoons."



RECONNAISSANCE AIRCRAFT FIXES - TYPHOON EMMA

| FLX<br>NO. | TIME    | LAT.  | LONG.  | *UNIT<br>METHOD<br>& ACCY | MIN<br>SLP<br>MBS | MAX<br>SFC<br>WND | MIN<br>700MB<br>HGT | MAX<br>FLT<br>LVL<br>WND | 700MB<br>TEMP<br>(°C) | 700MB<br>DEWPT<br>(°C) | EYE CHARACTERISTICS |
|------------|---------|-------|--------|---------------------------|-------------------|-------------------|---------------------|--------------------------|-----------------------|------------------------|---------------------|
| 1          | 050730Z | 12.1N | 148.1E | 54-P-5                    | 1003              | 30                | 10090               | 30                       | 12                    | 10                     | EYE ILL DEFINED     |
| 2          | 060000Z | 12.9N | 145.8E | 54-P-5                    | 993               | 30                | --                  | 32                       | 25                    | 18                     | EYE ILL DEFINED     |
| 3          | 060200Z | 12.7N | 145.4E | 54-P-1                    | 993               | 30                | 9990                | 36                       | 13                    | 08                     | EYE WELL DEFINED    |
| 4          | 060800Z | 13.0N | 144.4E | 54-P-5                    | 993               | 30                | 9910                | 42                       | 16                    | 10                     | CIRC DIA 75 MI      |
| 5          | 061400Z | 12.7N | 142.3E | 54-T-25                   | --                | --                | --                  | 35                       | --                    | --                     |                     |
| 6          | 070200Z | 13.5N | 140.9E | 54-P-10                   | 996               | 45                | 10010               | 35                       | 13                    | 07                     | EYE ILL DEFINED     |
| 7          | 070700Z | 14.0N | 139.7E | 54-P-5                    | 994               | 55                | 10010               | 30                       | 10                    | 08                     | EYE ILL DEFINED     |
| 8          | 071400Z | 13.8N | 138.1E | 54-T-15                   | --                | --                | --                  | --                       | --                    | --                     | 700MB WIND FIX      |
| 9          | 072130Z | 14.3N | 137.9E | 54-P-5                    | 994               | 55                | 10020               | 45                       | 14                    | 13                     | EYE ILL DEFINED     |
| 10         | 080200Z | 14.5N | 137.6E | 54-P-5                    | 995               | 40                | 10010               | 45                       | 14                    | 11                     | EYE ELLIP 75X40MI   |
| 11         | 080800Z | 14.9N | 137.5E | 54-P-5                    | 995               | 50                | 10000               | 42                       | 16                    | 12                     | EYE ILL DEFINED     |
| 12         | 082100Z | 15.4N | 134.5E | 54-P-5                    | 985               | 35                | 9980                | 30                       | 14                    | 00                     | EYE OPEN            |
| 13         | 090200Z | 15.3N | 133.3E | 54-P-10                   | 988               | 45                | 9930                | 30                       | 14                    | 04                     | EYE OPEN            |
| 14         | 090900Z | 15.6N | 131.9E | 54-P-5                    | 989               | 55                | 9860                | 48                       | 14                    | 10                     | EYE ILL DEFINED     |
| 15         | 092200Z | 16.0N | 129.9E | 54-P-5                    | 986               | 50                | 9730                | --                       | 12                    | 12                     | EYE ELLIP 20X30 MI  |
| 16         | 100100Z | 15.8N | 129.1E | 54-P-5                    | 980               | 80                | 9640                | 65                       | 15                    | 14                     | CIRC DIA 20 MI      |
| 17         | 100800Z | 16.4N | 128.1E | 54-P-15                   | 983               | 75                | 9560                | 65                       | 14                    | 10                     | EYE ILL DEFINED     |
| 18         | 101125Z | 16.6N | 127.0E | 12-R-10                   | --                | --                | --                  | --                       | --                    | --                     | CIRC DIA 65 MI      |
| 19         | 102000Z | 17.6N | 126.2E | 54-R-10                   | --                | --                | --                  | 70                       | --                    | --                     | EYE ELLIP 30X40 MI  |
| 20         | 102200Z | 17.9N | 125.6E | 54-P-2                    | 966               | 80                | 9210                | 100                      | 15                    | 11                     | CIRC DIA 60 MI      |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON EMMA (CONT'D)

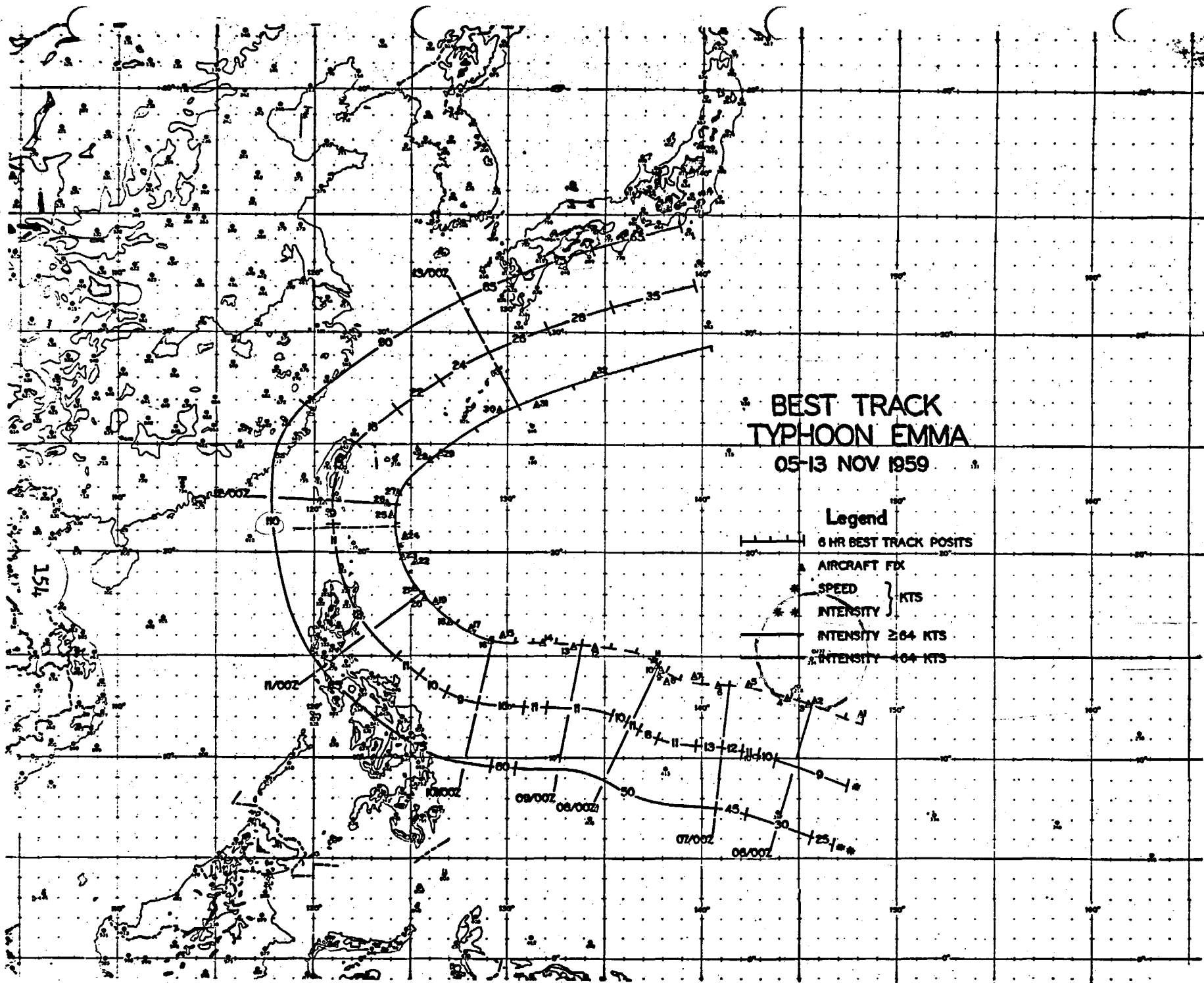
| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 21      | 110200Z | 18.2N | 125.1E | 54-P-2              | 970         | 75          | 9260          | 60              | 15              | 11               | CIRC DIA 75 MI      |
| 22      | 110730Z | 19.5N | 125.2E | 54-P-5              | 966         | 130         | 9180          | 105             | 15              | 13               | CIRC DIA 60 MI      |
| 23      | 111125Z | 19.8N | 124.6E | 12-R-25             | --          | --          | --            | --              | --              | --               | CIRC DIA 25 MI      |
| 24      | 111415Z | 20.8N | 124.8E | 54-T-35             | --          | --          | --            | 95              | --              | --               |                     |
| 25      | 112210Z | 21.9N | 124.0E | 54-P-2              | 962         | 70          | 9040          | 110             | 17              | 13               | CIRC DIA 60 MI      |
| 26      | 120100Z | 22.3N | 123.8E | 54-P-2              | 959         | 75          | 8980          | 115             | 19              | 14               | CIRC DIA 60 MI      |
| 27      | 120234Z | 22.8N | 124.4E | 54-P-3              | --          | --          | --            | --              | --              | --               | EYE ILL DEFINED     |
| 28      | 121048Z | 24.2N | 126.0E | 12-R-0              | --          | --          | --            | --              | --              | --               | CIRC DIA 60 MI      |
| 29      | 121400Z | 24.5N | 126.5E | 54-R-10             | --          | --          | --            | 85              | --              | --               | CIRC DIA 50 MI      |
| 30      | 122256Z | 26.6N | 129.7E | 12-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 70 MI      |
| 31      | 130213Z | 26.9N | 131.5E | 54-P-2              | 974         | 65          | --            | --              | --              | --               | EYE ILL DEFINED     |
| 32      | 130842Z | 28.1N | 134.5E | 54-R-5              | 986         | --          | --            | --              | --              | --               | EYE ILL DEFINED     |

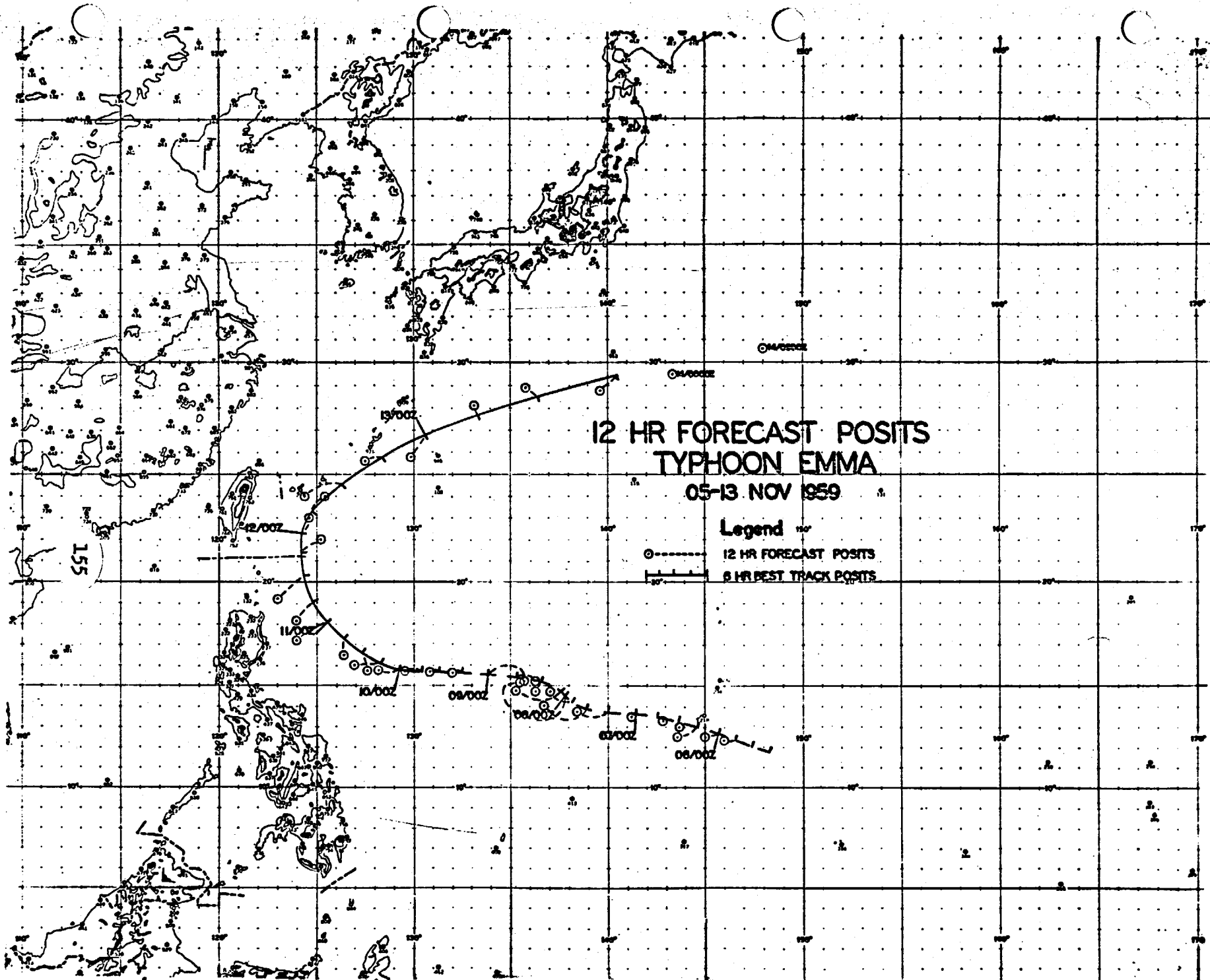
TYPHOON EMMA 05 - 13 NOV. 1959  
 POSITION AND FORECAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 050600Z | 11.8N          | 148.2E | -           | -        | -           | -        |
| 051200Z | 12.0N          | 147.3E | -           | -        | -           | -        |
| 051800Z | 12.3N          | 146.5E | -           | -        | -           | -        |
| 060000Z | 12.7N          | 145.6E | -           | -        | -           | -        |
| 060600Z | 12.9N          | 144.7E | -           | -        | -           | -        |
| 061200Z | 13.2N          | 143.7E | -           | -        | -           | -        |
| 061800Z | 13.4N          | 142.6E | -           | -        | -           | -        |
| 070000Z | 13.6N          | 141.3E | -           | -        | -           | -        |
| 070600Z | 13.7N          | 140.0E | 273         | - 101    | -           | -        |
| 071200Z | 13.9N          | 138.9E | 273         | - 121    | -           | -        |
| 071800Z | 14.2N          | 138.2E | 298         | - 75     | 272         | - 162    |
| 080000Z | 14.5N          | 137.8E | 285         | - 137    | 270         | - 236    |
| 080600Z | 14.7N          | 137.6E | 273         | - 135    | 282         | - 211    |
| 081200Z | 15.1N          | 136.6E | 230         | - 30     | 283         | - 240    |
| 081800Z | 15.3N          | 135.2E | 103         | - 61     | 272         | - 144    |
| 090000Z | 15.5N          | 133.9E | 279         | - 102    | 111         | - 44     |
| 090600Z | 15.5N          | 132.5E | 275         | - 30     | 274         | - 146    |
| 091200Z | 15.6N          | 131.3E | 270         | - 28     | 272         | - 180    |
| 091800Z | 15.7N          | 130.3E | 275         | - 47     | 292         | - 87     |
| 100000Z | 15.8N          | 129.2E | 273         | - 66     | 275         | - 72     |
| 100600Z | 16.1N          | 128.3E | 276         | - 78     | 268         | - 98     |
| 101200Z | 16.6N          | 127.4E | 164         | - 46     | 259         | - 130    |
| 101800Z | 17.2N          | 126.4E | 195         | - 40     | 247         | - 147    |
| 110000Z | 18.0N          | 125.5E | 240         | - 103    | 170         | - 131    |
| 110600Z | 19.0N          | 124.9E | 224         | - 74     | 197         | - 134    |
| 111200Z | 20.2N          | 124.4E | 232         | - 103    | 230         | - 240    |
| 111800Z | 21.2N          | 124.2E | 049         | - 70     | 228         | - 185    |
| 120000Z | 22.2N          | 124.2E | 029         | - 60     | 237         | - 231    |
| 120600Z | 23.3N          | 124.8E | 036         | - 48     | 042         | - 126    |
| 121200Z | 24.3N          | 126.2E | 258         | - 104    | 354         | - 78     |
| 121800Z | 25.7N          | 128.2E | 260         | - 38     | 353         | - 73     |

TYPHOON EMMA 05 - 13 NOV. 1959  
 POSITION AND FORECAST VERIFICATION DATA (CONT'D)

| DTG                   | STORM POSITION |          | 12 HR ERROR |          | 24 HR ERROR |          |
|-----------------------|----------------|----------|-------------|----------|-------------|----------|
|                       | LAT.           | LONG.    | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 130000Z               | 26.8N          | 130.5E   | 210         | - 66     | 264         | - 260    |
| 130600Z               | 27.7N          | 133.3E   | 340         | - 29     | 256         | - 125    |
| 131200Z               | 28.4N          | 136.3E   | 315         | - 40     | 246         | - 159    |
| 131800Z               | 29.4N          | 140.3E   | 228         | - 42     | 288         | - 95     |
| AVERAGE 12 HOUR ERROR |                | 69.4 NM  |             |          |             |          |
| AVERAGE 24 HOUR ERROR |                | 149.4 NM |             |          |             |          |

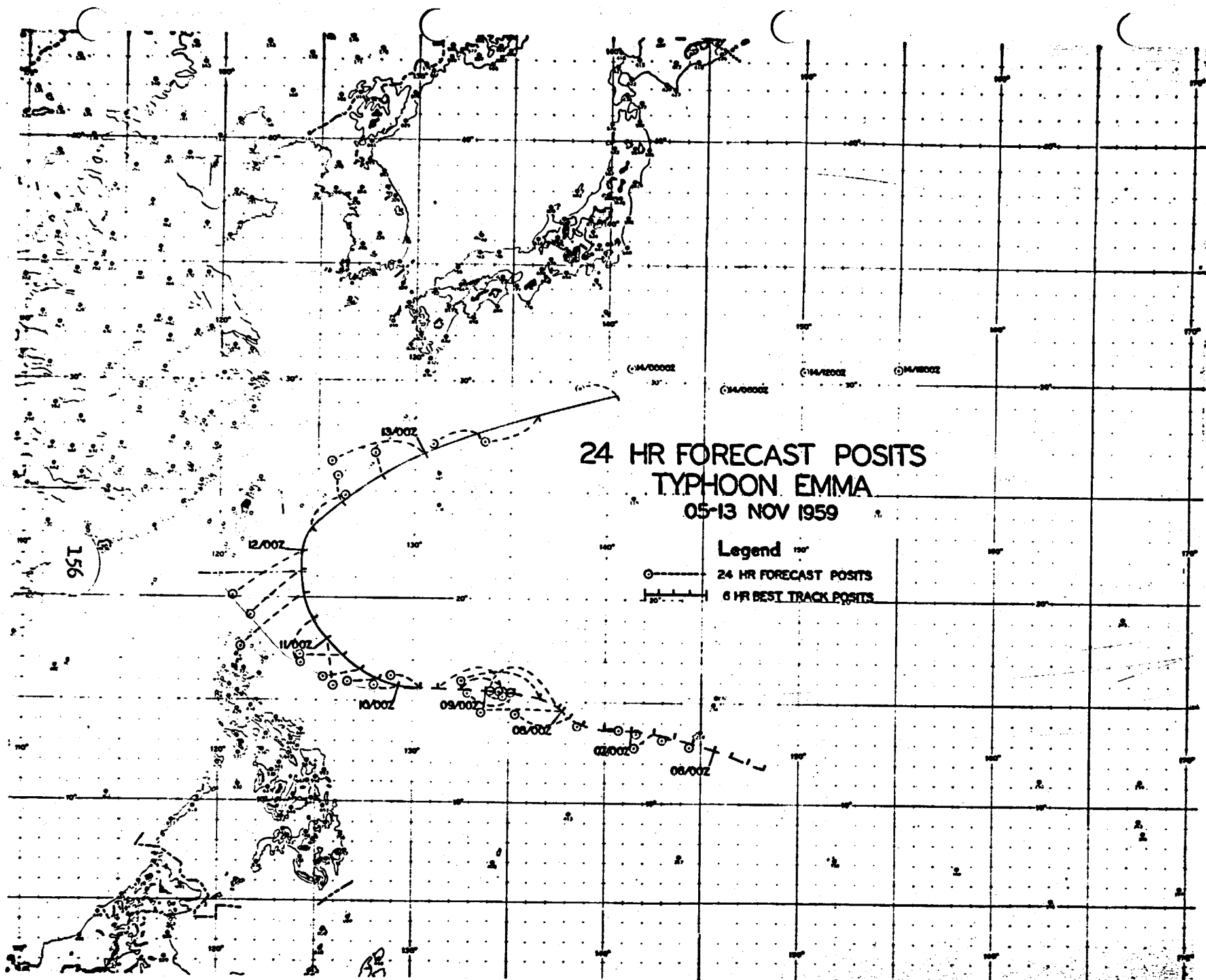




12 HR FORECAST POSITS  
TYPHOON EMMA  
05-13 NOV 1959

Legend  
○----- 12 HR FORECAST POSITS  
○----- 6 HR BEST TRACK POSITS

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24 HR FORECAST POSITS  
TYPHOON EMMA  
05-13 NOV 1959

Legend

- 24 HR FORECAST POSITS
- - - - - 6 HR BEST TRACK POSITS

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BR

P. TYPHOON FREDA (13-20 NOVEMBER 1959)

On 9 November, following in the wake of Typhoon EMMA, FREDA first became evident as a weak tropical low on the Intertropical Convergence Zone south of Ponape. This diffuse low pressure area drifted slowly to the west-northwest, and on the 12th was located near Ulithi with what appeared to be a double surface center. The lowest reported pressure at that time was 1004 millibars at Ulithi. All reconnaissance aircraft were committed to Typhoon EMMA, so the suspect area was watched very closely utilizing all available data. By 121800Z the pressure at both Yap and Ulithi had dropped to 1001 millibars, multiple layers of clouds prevailed at both stations, and the surface winds at Ulithi had increased to 25 knots from the east-southeast. It was now almost a certainty that what had formerly been only a diffuse tropical low was now a cyclone of perhaps storm intensity. Reconnaissance was urgently requested, and a fix was made by a B-50 of the 54th Weather Reconnaissance Squadron at 130120Z. Based upon the fix, which positioned the center 110 miles southwest of Yap, the first warning on Tropical Storm FREDA was issued.

Subsequent reconnaissance fixes indicated that FREDA had moved somewhat erratically during the first 12 hours. However, thereafter she curved gradually northwestward at a steady 10 to 12 knots. A report from the U.S. Coast Guard Loran Station on Catanduanes Island in the eastern Philippines, which was confirmed by a reconnaissance fix, showed that FREDA moved directly over the Island at 160200Z. The wind measuring gear at the Coast Guard Station was carried away at 130 knots, and the Coast Guard observers estimated the maximum



gusts to have been 165 knots. Shortly after passing over Catanduanes Island, FREDA gradually began to decelerate and weaken due to the proximity of land masses. Easterly flow aloft indicated that FREDA would move across Luzon into the South China Sea, passing just north of Clark Air Base. However, a polar high which moved into the South China Sea apparently blocked any pronounced westerly movement. As a result, FREDA passed just to the east of Baler, Luzon and moved over Luzon from southeast to northwest. The Manila area suffered only minor damage due to FREDA. The mountains of central Luzon further weakened FREDA, and she was downgraded to a tropical storm at 171800Z. The zonal westerlies extended as far south as 22 degrees north. Therefore, as FREDA passed across the extreme south tip of Taiwan, she recurved sharply. FREDA passed directly over Okinawa at approximately 190800Z with maximum gusts of 52 knots being reported at Kadena Air Base. Thereafter she weakened rapidly and the final tropical warning was issued at 200000Z.

In considering climatology, Typhoon FREDA was unusual in that she recurved. In mid-November, for typhoons which move as far west as the 130th meridian, the normal climatological track does not show recurvature, rather westward movement across the Philippines and into the South China Sea. Twenty-nine warnings were issued covering a period of 8 days.

For damage caused by Typhoon FREDA see Section VI "Destructive Effects of Typhoons".

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON FREDA

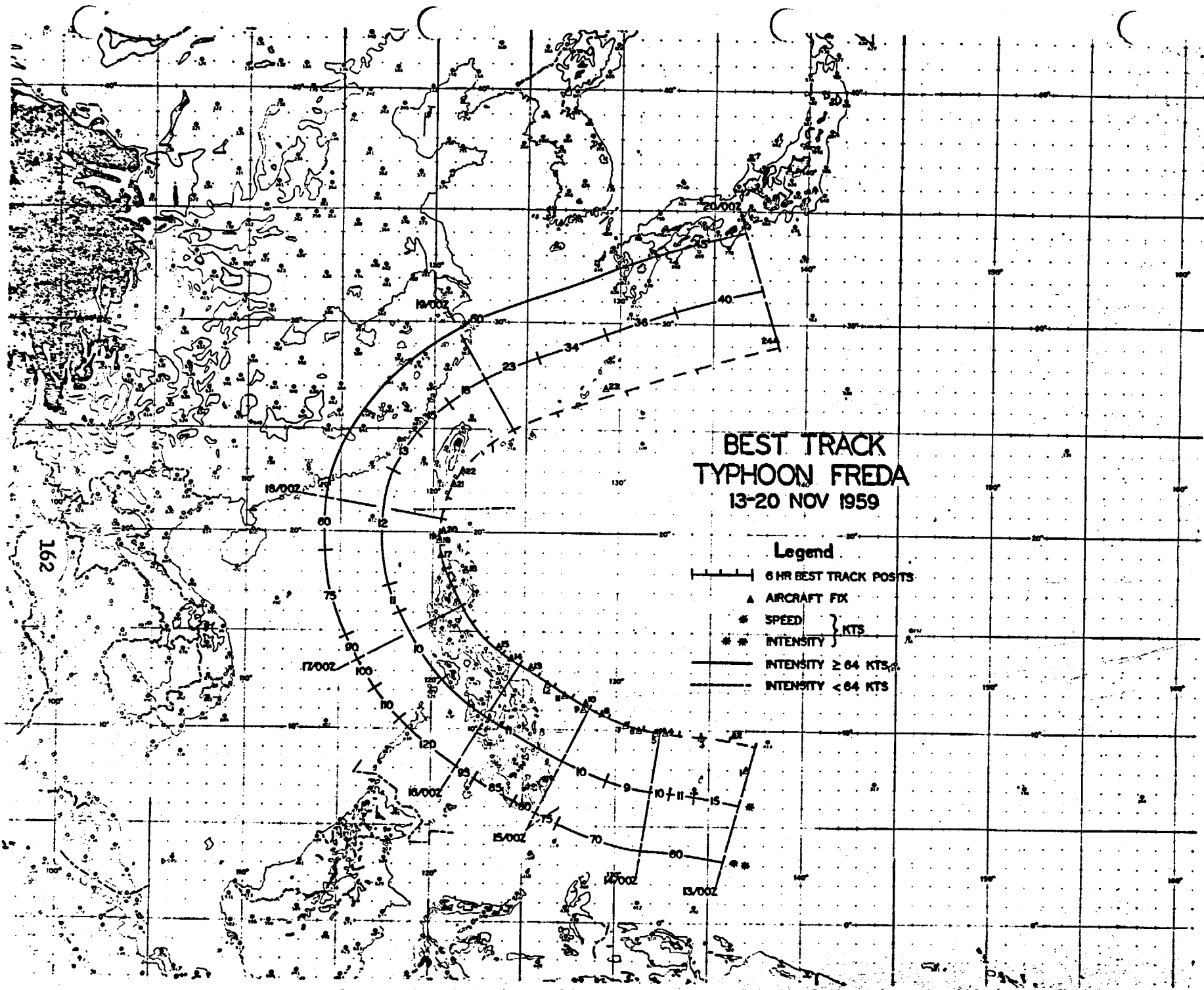
| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS   |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|-----------------------|
| 1       | 130120Z | 08.0N | 137.0E | 54-P-5              | 996         | 70          | 10060         | 65              | 12              | 12               | EYE ELLIP 50X30 MI    |
| 2       | 130900Z | 09.8N | 136.3E | 54-P-5              | 999         | 50          | 9990          | 50              | 09              | 09               | EYE ELLIP 15X20 MI    |
| 3       | 131147Z | 09.6N | 134.6E | 54-P-5              | 993         | --          | 9900          | 40              | 10              | 08               | SPIRAL BANDS SC       |
| 4       | 132115Z | 09.9N | 132.7E | 54-P-8              | 986         | 65          | 9800          | 60              | 14              | 06               | EYE ILL DEFINED       |
| 5       | 140200Z | 09.8N | 132.1E | 54-P-10             | 985         | 75          | 9780          | 65              | 15              | 10               | CIRC DIA 40 MI        |
| 6       | 140845Z | 10.0N | 131.2E | 54-P-2              | 980         | 70          | 9530          | 75              | 14              | 11               | CIRC DIA 30 MI        |
| 157     | 141221Z | 10.1N | 130.5E | 54-R-20             | --          | --          | --            | --              | --              | --               | CIRC DIA 40 MI        |
| 158     | 142030Z | 10.8N | 129.2E | 54-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 35 MI        |
| 9       | 142130Z | 11.0N | 128.2E | 54-P-5              | 973         | 80          | 9450          | --              | 16              | 11               | CIRC DIA 35 MI        |
| 10      | 150000Z | 11.3N | 128.3E | 54-P-5              | 978         | 100         | 9380          | --              | 16              | 12               | CIRC DIA 40 MI        |
| 11      | 150800Z | 11.8N | 127.2E | 54-P-5              | 968         | 90          | 9280          | 70              | 18              | 13               | CIRC DIA 50 MI        |
| 12      | 151400Z | 12.3N | 126.3E | 54-R-10             | --          | --          | --            | 90              | --              | --               | CIRC DIA 40 MI        |
| 13      | 152200Z | 13.2N | 125.3E | 54-P-2              | 944         | 125         | 8530          | 95              | 20              | 08               | CIRC DIA 60 MI        |
| 14      | 160200Z | 13.7N | 124.3E | 54-P-0              | 936         | 100         | 8590          | --              | 17              | 12               | CIRC DIA 40 MI        |
| 15      | 160800Z | 14.1N | 123.6E | 54-P-0              | 951         | 125         | 8680          | --              | 16              | 12               | CIRC DIA 40 MI        |
| 16      | 170800Z | 18.1N | 121.9E | 54-T-12             | --          | 75          | --            | --              | --              | --               | FLT LVL CNTR W OF EYE |
| 17      | 171400Z | 18.9N | 120.4E | 54-T-5              | --          | --          | --            | --              | --              | --               |                       |
| 18      | 172000Z | 19.8N | 120.3E | 54-P-1              | --          | --          | 9780          | 70              | 13              | 08               | CIRC DIA 40 MI        |
| 19      | 172215Z | 19.7N | 120.3E | 54-P-15             | 995         | 80          | 9800          | 75              | 13              | 07               | CIRC DIA 75 MI        |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON FREDA (CONT'D)

| FIX<br>NO. | TIME    | LAT.  | LONG.  | *UNIT<br>METHOD<br>& ACCY | MIN<br>SLP<br>MBS | MAX<br>SFC<br>WND | MIN<br>700MB<br>HGT | MAX<br>FLT<br>LVL<br>WND | 700MB<br>TEMP<br>(°C) | 700MB<br>DEWPT<br>(°C) | EYE CHARACTERISTICS   |
|------------|---------|-------|--------|---------------------------|-------------------|-------------------|---------------------|--------------------------|-----------------------|------------------------|-----------------------|
| 20         | 180259Z | 20.0N | 120.6E | 56-P-1                    | 990               | 40                | --                  | --                       | --                    | --                     | EYE ELLIP 40X20 MI    |
| 21         | 180900Z | 22.4N | 121.1E | 54-P-1                    | 991               | 55                | 9860                | 60                       | 11                    | 10                     | CIRC DIA 80 MI        |
| 22         | 181400Z | 23.0N | 121.7E | 54-P-3                    | 996               | --                | 9860                | 80                       | 11                    | 10                     | CIRC DIA 90 MI        |
| 23         | 191104Z | 27.0N | 129.2E | 12-R-2                    | --                | --                | --                  | --                       | --                    | --                     | DIA 20MI N-S 15MI E-W |
| 24         | 192125Z | 29.3N | 138.3E | 12-P-10                   | 993               | 25                | 10000               | --                       | 06                    | 03                     | EYE OPEN S-E          |

TYPHOON FREDA 13 - 20 NOV. 1959  
 POSITION AND FORECAST VERIFICATION DATA

| DTG                   | STORM POSITION |         | 12 HR ERROR |          | 24 HR ERROR |          |
|-----------------------|----------------|---------|-------------|----------|-------------|----------|
|                       | LAT.           | LONG.   | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 130000Z               | 09.1N          | 137.5E  | -           | -        | -           | -        |
| 130600Z               | 09.4N          | 136.1E  | -           | -        | -           | -        |
| 131200Z               | 09.6N          | 134.6E  | 165         | - 76     | -           | -        |
| 131800Z               | 09.7N          | 133.4E  | 085         | - 90     | -           | -        |
| 140000Z               | 09.8N          | 132.4E  | 055         | - 46     | 168         | - 64     |
| 140600Z               | 10.0N          | 131.5E  | 010         | - 13     | 095         | - 112    |
| 141200Z               | 10.2N          | 130.6E  | 240         | - 14     | 010         | - 12     |
| 141800Z               | 10.6N          | 129.6E  | 200         | - 20     | 246         | - 35     |
| 150000Z               | 11.0N          | 128.7E  | 190         | - 33     | 210         | - 37     |
| 150600Z               | 11.6N          | 127.7E  | 220         | - 37     | 191         | - 52     |
| 151200Z               | 12.1N          | 126.7E  | 268         | - 41     | 189         | - 78     |
| 151800Z               | 12.7N          | 125.8E  | 225         | - 37     | 214         | - 74     |
| 160000Z               | 13.3N          | 124.8E  | 263         | - 18     | 247         | - 71     |
| 160600Z               | 13.9N          | 123.9E  | 245         | - 18     | 217         | - 66     |
| 161200Z               | 14.6N          | 123.0E  | 295         | - 32     | 230         | - 32     |
| 161800Z               | 15.4N          | 122.3E  | 210         | - 30     | 233         | - 49     |
| 170000Z               | 16.3N          | 121.7E  | 162         | - 54     | 275         | - 96     |
| 170600Z               | 17.2N          | 121.3E  | 070         | - 47     | 220         | - 95     |
| 171200Z               | 18.2N          | 120.8E  | 070         | - 36     | 223         | - 136    |
| 171800Z               | 19.4N          | 120.5E  | 060         | - 131    | 078         | - 70     |
| 180000Z               | 20.6N          | 120.4E  | 360         | - 34     | 108         | - 74     |
| 180600Z               | 21.8N          | 120.7E  | 190         | - 14     | 250         | - 193    |
| 181200Z               | 22.9N          | 121.5E  | 210         | - 21     | 150         | - 60     |
| 181800Z               | 24.0N          | 122.6E  | 270         | - 23     | 230         | - 57     |
| 190000Z               | 25.0N          | 124.3E  | 220         | - 63     | 250         | - 85     |
| 190600Z               | 25.9N          | 126.6E  | 230         | - 70     | 265         | - 96     |
| 191200Z               | 26.9N          | 130.2E  | 255         | - 50     | 245         | - 211    |
| 191800Z               | 28.0N          | 134.1E  | 340         | - 15     | 250         | - 309    |
| 200000Z               | 29.0N          | 138.5E  | 255         | - 68     | 255         | - 281    |
| AVERAGE 12 HOUR ERROR |                | 41.9 NM |             |          |             |          |
| AVERAGE 24 HOUR ERROR |                | 97.8 NM |             |          |             |          |

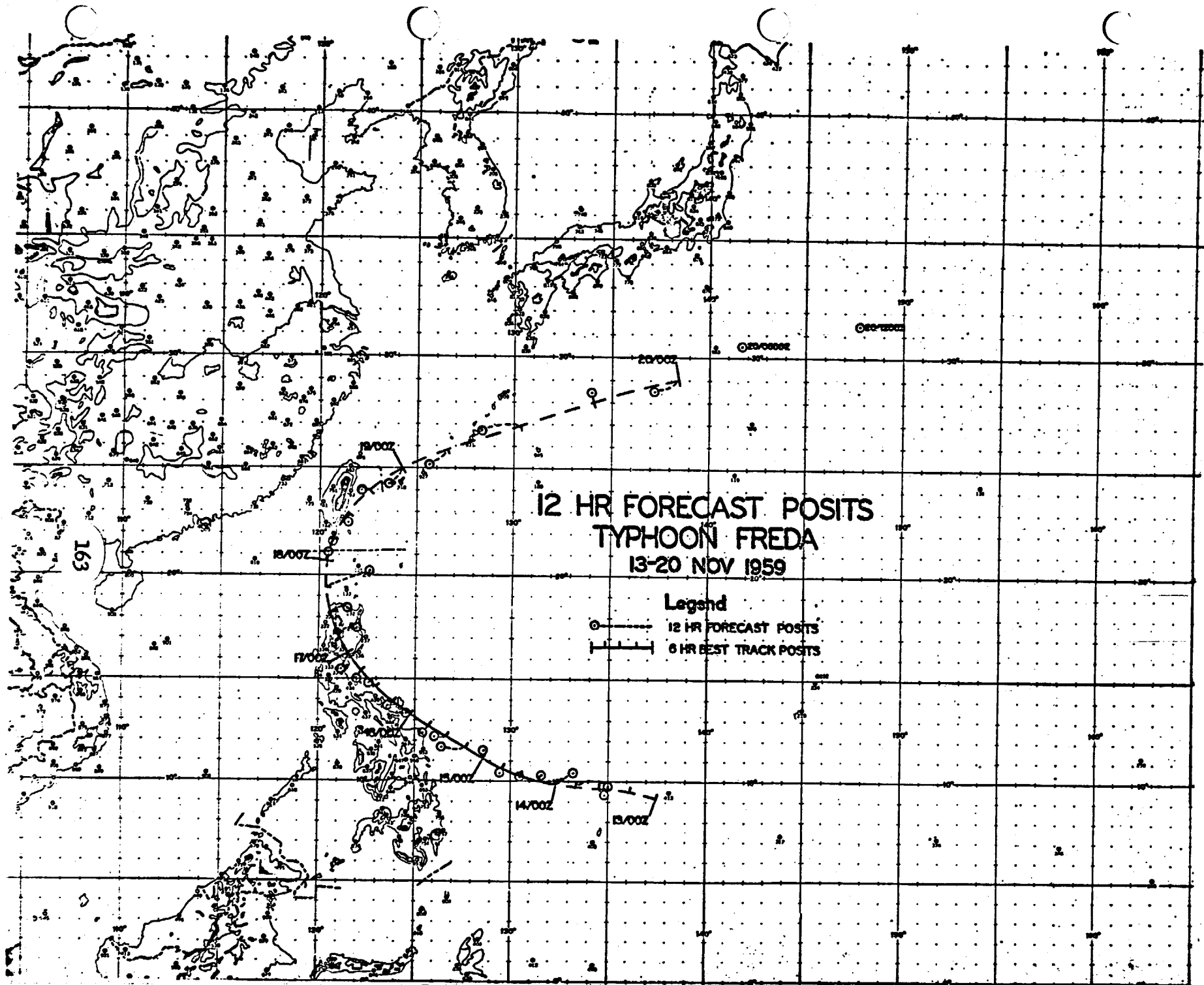


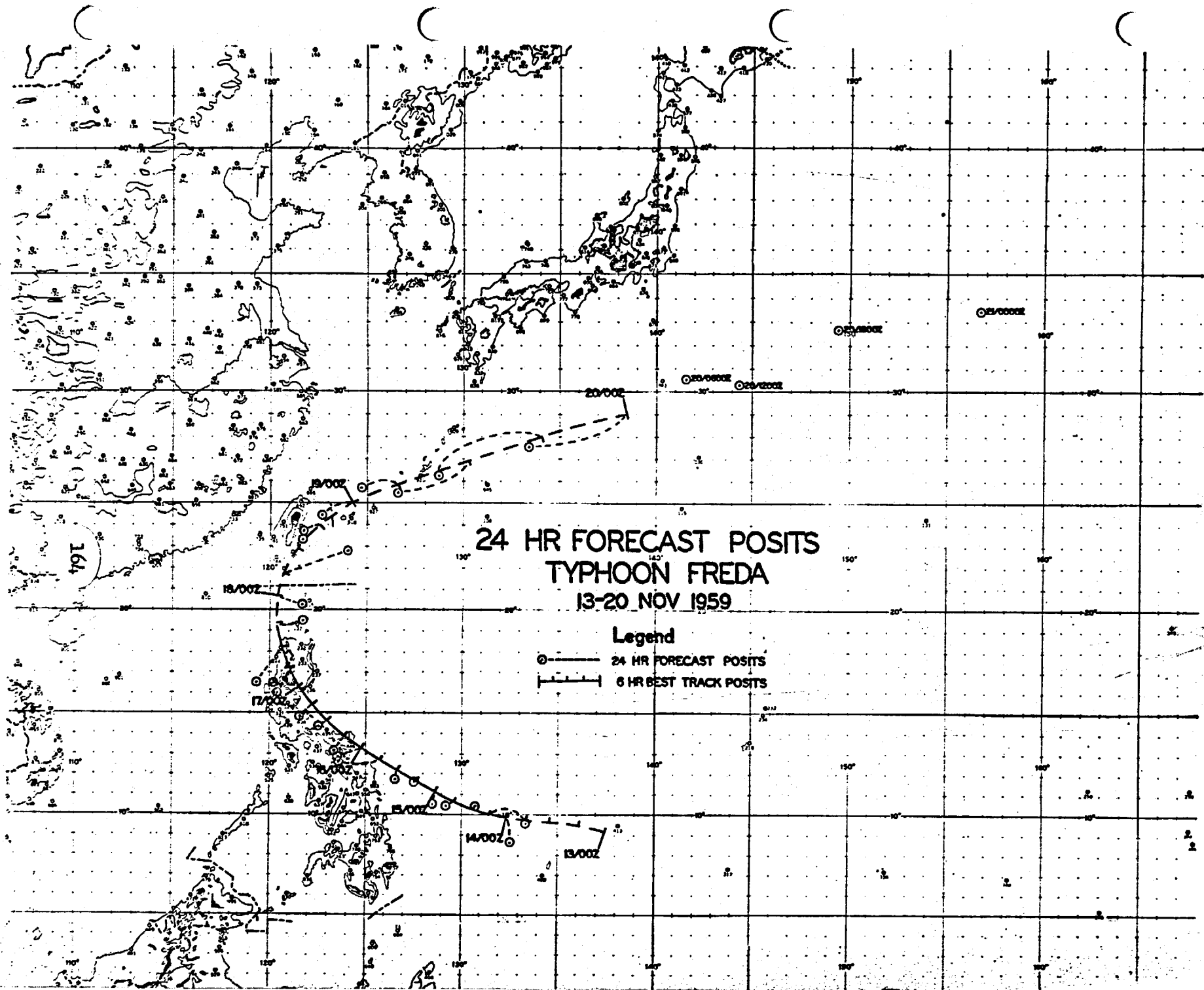
**BEST TRACK  
TYPHOON FREDA  
13-20 NOV 1959**

**Legend**

- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \*\* INTENSITY }
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS

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Q. TYPHOON GILDA (13-21 DECEMBER 1959)

On 10 December, surface and winds aloft reports from Truk indicated the possibility of a tropical cyclone developing to the southeast of the Island. Reconnaissance was requested, and at 110330Z a weak center was fixed approximately 400 miles south-southeast of Guam. The next fix, at 120152Z, indicated that the tropical low had remained almost stationary during the previous 24 hours and had intensified only slightly. On the following day, within less than three hours, two separate centers were fixed. One, with a central pressure of 1002 millibars, was centered just south of Ifalik Atoll. The other, located some 80 miles to the northwest of Ifalik, had a central pressure of 1000 millibars. Twelve hours later, at 132130Z, a fix confirmed the fact that the two lows had rapidly consolidated into a full-blown typhoon with a central pressure of 977 millibars. Warning number 1 on Typhoon GILDA was issued shortly after the receipt of the fix.

For the next three days GILDA moved to the west-northwest at an average speed of 11 knots while continuing to intensify. At the end of this three day period (approximately 161800Z) GILDA began to decelerate rapidly. At the same time a weak trough aloft in the westerlies moved into the Luzon Straits. This trough, coupled with the aforementioned deceleration, led to a forecast of recurvature. However, the trough did not deepen appreciably or extend far enough south to cause recurvature. Then, at approximately 180000Z, GILDA began moving almost due west and started to accelerate rapidly. Two



days later, at approximately 200000Z, GILDA began to decelerate rapidly and by 200600Z was moving at 12 knots toward Viet Nam on a track which was slightly south of west. The final warning, issued at 210000Z, contained a forecast for rapid dissipation over Viet Nam to the northeast of Saigon.

Typhoon GILDA was typical of December climatology. The path was very similar to that of Typhoon GLORIA in 1952. The abrupt westward movement on the 18th came unexpectedly and could not have been forecast from the sparse upper air data available. At approximately 190800Z GILDA passed directly over the U.S. Coast Guard Loran Station on Talampalan Island in the western Philippines. Coast Guard observers estimated the maximum sustained wind to have been 80 knots with gusts to 140 knots. Thirty warnings were issued covering a period of 9 days.

For damage caused by Typhoon GILDA see Section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON GILDA

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 110330Z | 06.8N | 146.0E | 54-P--              | --          | --          | --            | --              | --              | --               | -----               |
| 2       | 120152Z | 06.6N | 145.9E | 54-P-5              | 1001        | 25          | 10160         | 25              | 12              | 08               | EYE ILL DEFINED     |
| 3       | 130024Z | 07.6N | 143.1E | 54-R-2              | 1002        | --          | 10020         | 45              | 10              | 10               | WALL CLDS NE QUAD   |
| 4       | 130314Z | 07.6N | 142.9E | 54-P--              | 1000        | 50          | --            | --              | --              | --               | -----               |
| 5       | 132130Z | 07.4N | 140.8E | 54-P-5              | 977         | 80          | 9660          | 75              | 13              | 09               | CIRC DIA 10 MI      |
| 6       | 140200Z | 07.4N | 140.2E | 54-P-5              | 980         | 80          | 9570          | 80              | 14              | 12               | CIRC DIA 20 MI      |
| 7       | 140800Z | 07.7N | 139.2E | 54-P-5              | 969         | 100         | 9210          | 70              | 17              | 12               | CIRC DIA 20 MI      |
| 8       | 141400Z | 08.0N | 138.4E | 54-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 10 MI      |
| 9       | 142135Z | 08.0N | 137.0E | 54-P-5              | 945         | 100         | 8360          | 110             | 17              | 14               | CIRC DIA 12 MI      |
| 10      | 150000Z | 08.4N | 136.6E | 54-P-10             | 938         | 100         | 8300          | 110             | 17              | 14               | CIRC DIA 12 MI      |
| 11      | 150800Z | 08.4N | 135.6E | 54-P-8              | 932         | 150         | 8300          | 120             | 16              | 12               | CIRC DIA 12 MI      |
| 12      | 151400Z | 08.7N | 134.7E | 54-R-10             | --          | --          | --            | --              | --              | --               | -----               |
| 13      | 152200Z | 09.3N | 132.6E | 54-P-20             | 933         | 125         | 8180          | 130             | 18              | 12               | CIRC DIA 20 MI      |
| 14      | 160140Z | 09.6N | 132.4E | 54-P-10             | 926         | 150         | 8120          | 125             | 20              | 13               | CIRC DIA 20 MI      |
| 15      | 160800Z | 10.1N | 130.9E | 54-P-15             | 914         | 150         | 7540          | 135             | 22              | 16               | CIRC DIA 15 MI      |
| 16      | 161345Z | 10.8N | 129.8E | 54-R-20             | --          | --          | --            | --              | --              | --               | WIDE SPREAD RAIN    |
| 17      | 162200Z | 11.3N | 128.6E | 54-P-10             | 920         | 135         | 7980          | 120             | 17              | 13               | WALL CLDS ALL QUADS |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON GILDA (CONT'D)

| FIX<br>NO | TIME    | LAT.  | LONG.  | *UNIT<br>METHOD<br>& ACCY | MIN<br>SLP<br>MBS | MAX<br>SFC<br>WIND | MIN<br>700MB<br>HGT | MAX<br>FLT<br>LVL<br>WIND | 700MB<br>TEMP<br>(°C) | 700MB<br>DEWPT<br>(°C) | EYE CHARACTERISTICS |
|-----------|---------|-------|--------|---------------------------|-------------------|--------------------|---------------------|---------------------------|-----------------------|------------------------|---------------------|
| 18        | 170200Z | 11.5N | 128.2E | 54-P-10                   | 933               | 165                | 8030                | 110                       | 17                    | 14                     | CIRC DIA 17 MI      |
| 19        | 170800Z | 11.5N | 127.8E | 54-P-5                    | --                | 90                 | 8280                | 115                       | 15                    | 15                     | CIRC DIA 15 MI      |
| 20        | 171130Z | 11.5N | 127.6E | 54-R-10                   | --                | --                 | --                  | --                        | --                    | --                     | -----               |
| 21        | 172000Z | 12.2N | 126.3E | 54-R-15                   | --                | --                 | --                  | --                        | --                    | --                     | -----               |
| 22        | 172300Z | 12.2N | 125.8E | 54-P-10                   | 939               | 150                | 8310                | 90                        | 18                    | 15                     | ELLIP DIA 15 MI     |
| 23        | 180810Z | 12.0N | 124.3E | 54-P-2                    | --                | --                 | --                  | 80                        | --                    | --                     | -----               |
| 24        | 182000Z | 12.2N | 122.1E | 54-R-5                    | --                | --                 | --                  | --                        | --                    | --                     | -----               |
| 891<br>25 | 182300Z | 12.3N | 121.3E | 54-P-1                    | 978               | 80                 | --                  | 60                        | --                    | --                     | CIRC DIA 25 MI      |
| 26        | 190100Z | 12.2N | 121.1E | 54-P-1                    | --                | 100                | --                  | 30                        | --                    | --                     | CIRC DIA 25 MI      |
| 27        | 191945Z | 12.7N | 117.6E | 54-RT-5                   | --                | --                 | --                  | --                        | --                    | --                     | ELLIP DIA 22 MI     |
| 28        | 192300Z | 12.6N | 116.9E | 54-P-5                    | 984               | 150                | 9660                | 70                        | 21                    | 18                     | CIRC DIA 30 MI      |
| 29        | 200200Z | 12.6N | 116.3E | 54-P-5                    | 985               | 150                | 9680                | 70                        | 18                    | 15                     | ELLIP DIA 30 MI     |

TYPHOON GILDA 13 - 21 DEC. 1959  
 POSITION AND FORECAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 130000Z | 07.1N          | 143.4E | -           | -        | -           | -        |
| 130600Z | 07.2N          | 142.9E | -           | -        | -           | -        |
| 131200Z | 07.3N          | 142.3E | -           | -        | -           | -        |
| 131800Z | 07.3N          | 141.5E | -           | -        | -           | -        |
| 140000Z | 07.4N          | 140.5E | -           | -        | -           | -        |
| 140600Z | 07.6N          | 139.5E | 108         | - 23     | -           | -        |
| 141200Z | 07.8N          | 138.5E | 137         | - 34     | -           | -        |
| 141800Z | 08.0N          | 137.5E | 180         | - 12     | 110         | - 56     |
| 150000Z | 08.1N          | 136.6E | 360         | - 06     | 135         | - 61     |
| 150600Z | 08.3N          | 135.8E | 270         | - 06     | 225         | - 25     |
| 151200Z | 08.5N          | 134.9E | 292         | - 21     | 270         | - 19     |
| 151800Z | 08.8N          | 133.9E | 270         | - 06     | 230         | - 16     |
| 160000Z | 09.3N          | 132.7E | 131         | - 36     | 195         | - 20     |
| 160600Z | 09.9N          | 131.5E | 201         | - 26     | 148         | - 45     |
| 161200Z | 10.4N          | 130.2E | 135         | - 43     | 135         | - 102    |
| 161800Z | 10.9N          | 129.2E | 256         | - 11     | 193         | - 64     |
| 170000Z | 11.2N          | 128.4E | 351         | - 55     | 155         | - 47     |
| 170600Z | 11.5N          | 127.8E | 350         | - 86     | 282         | - 64     |
| 171200Z | 11.7N          | 127.3E | 327         | - 47     | 343         | - 136    |
| 171800Z | 12.0N          | 126.6E | 020         | - 12     | 348         | - 137    |
| 180000Z | 12.2N          | 125.7E | 047         | - 38     | 003         | - 56     |
| 180600Z | 12.2N          | 124.7E | 045         | - 68     | 062         | - 80     |
| 181200Z | 12.2N          | 123.5E | 036         | - 55     | 050         | - 119    |
| 181800Z | 12.2N          | 122.4E | 049         | - 49     | 055         | - 167    |
| 190000Z | 12.2N          | 121.2E | 057         | - 74     | 045         | - 121    |
| 190600Z | 12.2N          | 120.1E | 121         | - 32     | 055         | - 99     |
| 191200Z | 12.3N          | 118.9E | 245         | - 11     | 060         | - 136    |
| 191800Z | 12.5N          | 117.8E | 165         | - 15     | 143         | - 55     |
| 200000Z | 12.6N          | 116.7E | 248         | - 36     | 115         | - 46     |
| 200600Z | 12.6N          | 115.5E | 123         | - 12     | 165         | - 25     |
| 201200Z | 12.6N          | 114.3E | 355         | - 31     | 115         | - 60     |
| 201800Z | 12.6N          | 112.8E | 013         | - 33     | 070         | - 24     |

TYPHOON GILDA 13 - 21 DEC. 1959  
 POSITION AND FORECAST VERIFICATION DATA (CONT'D)

| DTG                   | STORM POSITION |         | 12 HR ERROR   | 24 HR ERROR   |
|-----------------------|----------------|---------|---------------|---------------|
|                       | LAT.           | LONG.   | DEG. DISTANCE | DEG. DISTANCE |
| 210000Z               | 12.4N          | 111.4E  | 010 - 60      | 010 - 70      |
| 210600Z               | 12.1N          | 110.1E  | 354 - 43      | 004 - 64      |
| 211200Z               | 11.8N          | 109.1E  | 338 - 72      | 357 - 124     |
| 211800Z               | 11.6N          | 108.5E  | - - -         | 325 - 108     |
| AVERAGE 12 HOUR ERROR |                | 35.1 NM |               |               |
| AVERAGE 24 HOUR ERROR |                | 74.0 NM |               |               |

# BEST TRACK TYPHOON GILDA 13-21 DEC 1959

## Legend

6 HR BEST TRACK POSITS

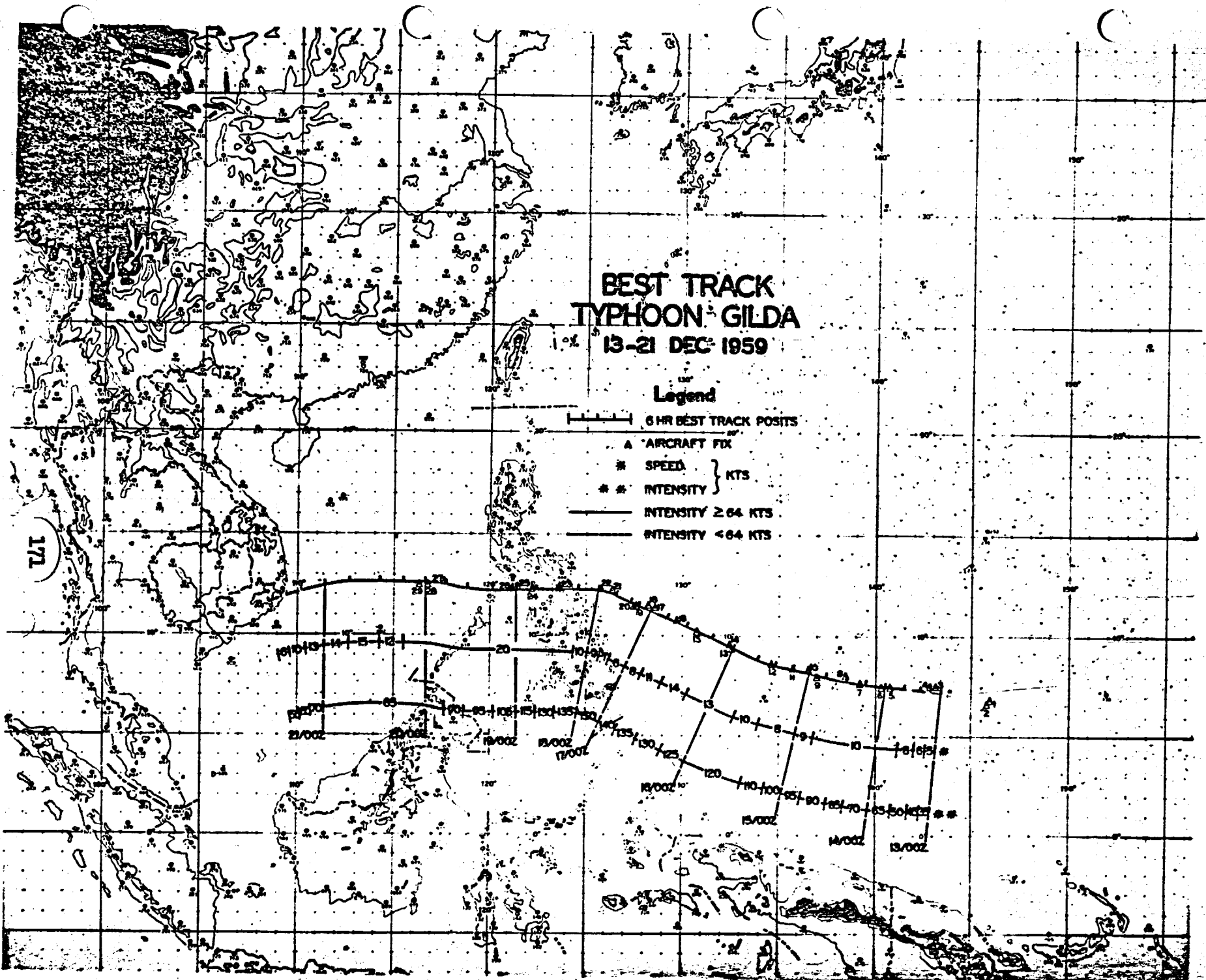
▲ AIRCRAFT FIX

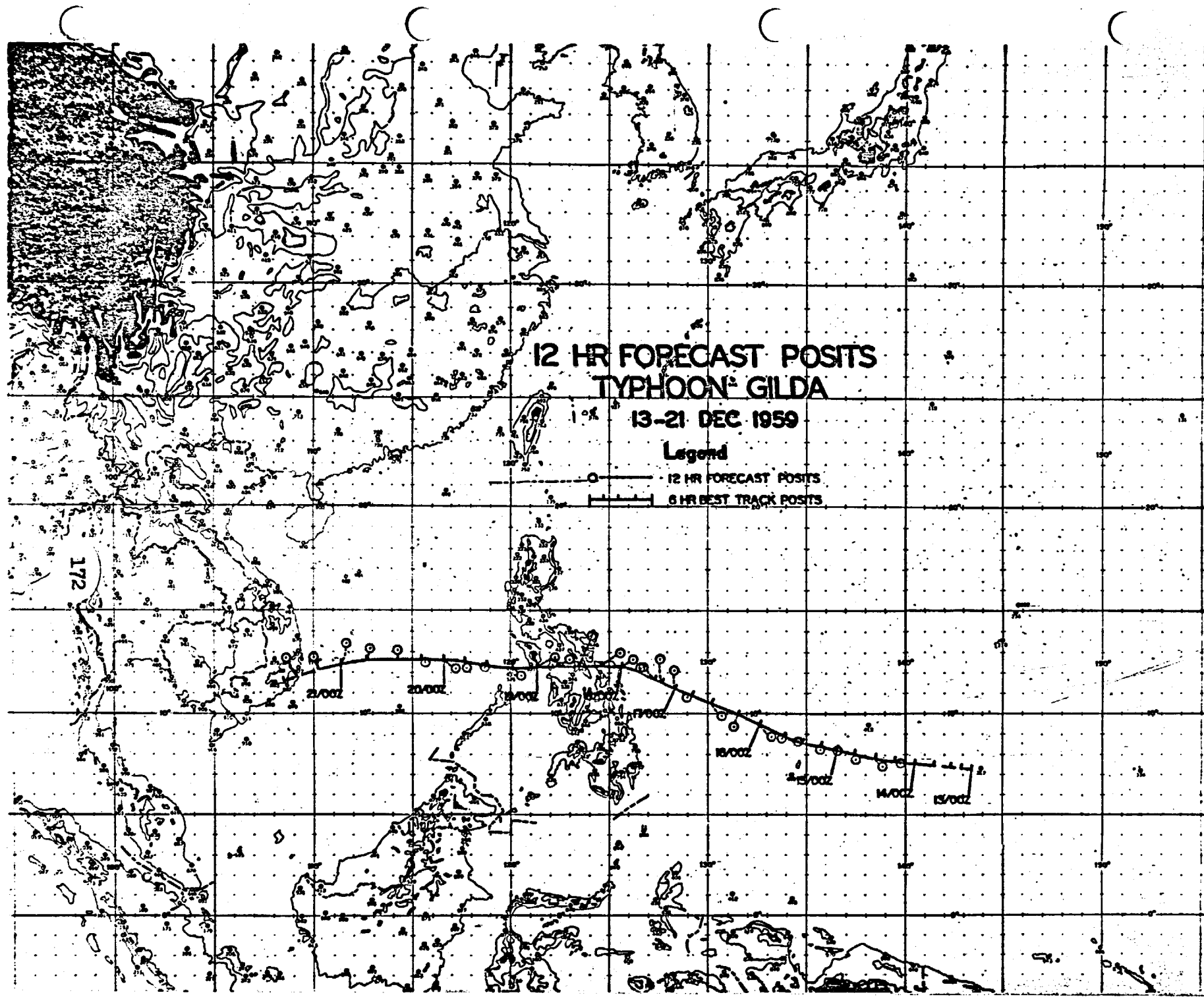
\* SPEED } KTS

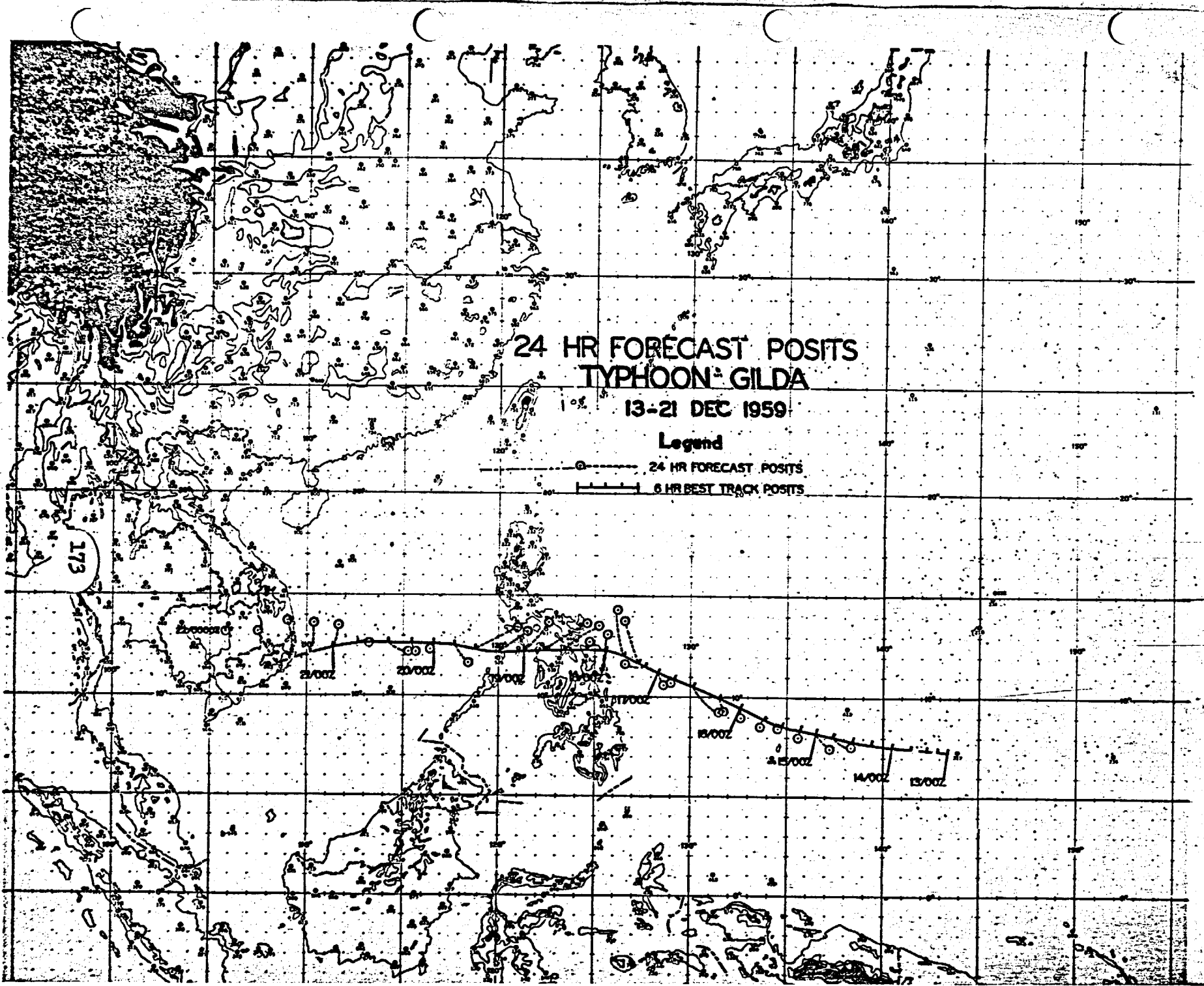
\*\* INTENSITY }

— INTENSITY ≥ 64 KTS

— INTENSITY < 64 KTS









R. TYPHOON HARRIET (24 DECEMBER 1959 - 02 JANUARY 1960)

On 22 December a 1002 millibar tropical low was evident to the southeast of Truk. Reconnaissance aircraft were sent to investigate, and throughout the 23rd reported increasing precipitation and wall clouds forming around the center. The next day at 0215Z a definite eye was located approximately 300 miles southeast of Truk and based on this fix, JTWC issued warning number 1 on Tropical Storm HARRIET.

Movement was erratic until 250000Z when HARRIET was upgraded to a typhoon. She then started moving toward the northwest at the steady speed of 10 knots. This track moved HARRIET to a point 200 miles south of Guam, at which time Guam's upper winds backed to the east. As a result, Typhoon HARRIET turned abruptly westward, gradually veering 6 hours later to a west-northwesterly course at 17 knots. On 28 December HARRIET appeared to be coming under the influence of a trough in the westerlies. However, the trough was not strong enough to produce recurvature and once again HARRIET turned abruptly toward the west. At 281800Z, some 500 miles east of Catanduanes Island, HARRIET reached her maximum intensity with surface winds of 130 knots near the center. At the same time a 1062 millibar high centered over Siberia was gradually spreading southward over the Philippines, and this blocked the typhoon from any northward movement. Slow deceleration then commenced and the cold air associated with the high gradually weakened HARRIET. Steering rapidly dropped to the 500 millibar level and a west-southwesterly

movement began. At approximately 312130Z the typhoon passed directly over Catanduanes Island with winds well in excess of 100 knots. Movement over the Philippines further weakened HARRIET, steering dropped to the 700 millibar level, and at 010000Z she was downgraded to a tropical storm. By 020000Z January 1960, HARRIET was dissipating rapidly over the South China Sea and JTWC issued the final warning.

Typhoon HARRIET was one of those rare December storms extending into the New Year. Her early path followed December climatology quite closely, but the southwesterly movement was unusual. No similar climatological path has been recorded in the past 10 years. HARRIET was also characterized by her comparatively small eye, averaging only 25 miles. Thirty-seven warnings were issued covering a period of 10 days.

For damage caused by Typhoon HARRIET see Section VI, "Destructive Effects of Typhoons."

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON HARRIET

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACQY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEWPT (°C) | EYE CHARACTERISTICS |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|---------------------|
| 1       | 230520Z | 03.2N | 153.5E | 54-P-15             | 994         | 40          | 9860          | —               | 25              | 25               | CIRC DIA 30 MI      |
| 2       | 240215Z | 02.8N | 153.8E | 54-P-5              | 993         | 65          | 9910          | 30              | 14              | 11               | CIRC DIA 25 MI      |
| 3       | 240630Z | 03.6N | 153.3E | 54-P-5              | 993         | 70          | 9920          | 40              | 15              | 12               | CIRC DIA 25 MI      |
| 4       | 242030Z | 04.5N | 152.2E | 54-P-5              | 984         | 60          | 9820          | 50              | 16              | 13               | CIRC DIA 35 MI      |
| 5       | 250200Z | 04.9N | 151.4E | 54-P-5              | 982         | 85          | 9720          | 50              | 14              | 12               | CIRC DIA 10 MI      |
| 6       | 250345Z | 05.1N | 151.2E | 54-P-5              | 979         | 55          | 9670          | 50              | 15              | 14               | CIRC DIA 15 MI      |
| 7       | 252045Z | 06.7N | 148.4E | 54-P-5              | 975         | 85          | 9480          | 50              | 18              | 14               | CIRC DIA 25 MI      |
| 8       | 260315Z | 07.8N | 148.0E | 54-P-5              | 975         | 85          | 9540          | 50              | 18              | 14               | CIRC DIA 20 MI      |
| 9       | 260700Z | 08.4N | 147.2E | 54-P-5              | 981         | 100         | 9640          | 60              | 18              | 15               | CIRC DIA 20 MI      |
| 10      | 261400Z | 09.8N | 145.7E | 54-R-5              | --          | --          | --            | --              | --              | --               | CIRC DIA 50 MI      |
| 11      | 262045Z | 10.3N | 143.6E | 54-P-10             | 978         | 65          | 9460          | 60              | 18              | 10               | CIRC DIA 20 MI      |
| 12      | 270215Z | 10.7N | 142.3E | 54-P-5              | 983         | 50          | 9630          | --              | 17              | 12               | NOT WELL DEFINED    |
| 13      | 270800Z | 11.4N | 140.7E | 54-P-2              | 976         | 65          | 9410          | 90              | 15              | 08               | CIRC DIA 25 MI      |
| 14      | 281400Z | 12.1N | 139.0E | 54-R-10             | --          | --          | --            | --              | --              | --               | ELLIP NNE/SSW 25 MI |
| 15      | 280030Z | 13.0N | 136.4E | 54-P-5              | 950         | 120         | 8750          | 80              | 18              | 16               | ELLIP 15X20 MI      |
| 16      | 280200Z | 13.1N | 135.9E | 54-P-5              | 936         | 120         | 8590          | 120             | 18              | 16               | ELLIP 15X20 MI      |
| 17      | 280800Z | 13.4N | 134.4E | 54-P-5              | 926         | 150         | 8140          | 90              | 21              | 18               | CIRC DIA 12 MI      |
| 18      | 281615Z | 13.8N | 132.9E | 54-R--              | --          | --          | --            | --              | --              | --               | ELLIP N/S 20X15 MI  |
| 19      | 282200Z | 14.6N | 131.3E | 54-P-15             | 930         | --          | 8800          | 95              | 19              | 19               | ELLIP N/S 25X15 MI  |

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON HARRIET (CONT'D)

| FIX NO. | TIME    | LAT.  | LONG.  | *UNIT METHOD & ACCY | MIN SLP MBS | MAX SFC WND | MIN 700MB HGT | MAX FLT LVL WND | 700MB TEMP (°C) | 700MB DEPTH (°C) | EYE CHARACTERISTICS    |
|---------|---------|-------|--------|---------------------|-------------|-------------|---------------|-----------------|-----------------|------------------|------------------------|
| 20      | 290200Z | 14.5N | 130.3E | 54-P-2              | 956         | 100         | 8940          | 80              | 19              | 16               | ELLIP N/S 20X15 MIL    |
| 21      | 290915Z | 14.4N | 129.4E | 54-P-1              | 940         | 150         | 8500          | 112             | 17              | 12               | CIRC DIA 20 MIL        |
| 22      | 291400Z | 13.8N | 128.4E | 54-R-25             | --          | --          | --            | --              | --              | --               | CIRC DIA 25 MIL        |
| 23      | 292000Z | 14.5N | 128.0E | 54-T-30             | --          | --          | --            | --              | --              | --               |                        |
| 24      | 292200Z | 14.3N | 127.8E | 54-P-10             | 946         | 150         | 8530          | 110             | 17              | 14               | CIRC DIA 25 MIL        |
| 25      | 300200Z | 14.2N | 127.5E | 54-P-10             | 965         | 150         | 8680          | 110             | 16              | 16               | CIRC DIA 25 MIL        |
| 26      | 301100Z | 14.0N | 126.3E | 54-R-10             | --          | --          | --            | --              | --              | --               | CONTIN RAIN TURBLG LGT |
| 27      | 301615Z | 13.6N | 125.1E | 54-R-1              | --          | --          | --            | --              | --              | --               | CIRC DIA 35 MIL        |
| 28      | 302000Z | 13.7N | 124.7E | 54-R-15             | --          | --          | --            | --              | --              | --               | CIRC DIA 45 MIL        |
| 29      | 310000Z | 13.8N | 124.1E | 54-P-1              | 955         | --          | --            | 90              | --              | --               | EYE DIFFUSE            |
| 30      | 311529Z | 13.5N | 121.8E | VW-R-3              | --          | --          | --            | --              | --              | --               | CIRC DIA 15 MIL        |
| 31      | 312315Z | 13.0N | 121.1E | 54-P--              | --          | 80          | --            | 45              | --              | --               |                        |
| 32      | 010800Z | 12.0N | 119.8E | 54-P-3              | --          | 60          | --            | 50              | 12              | 10               | EYE DIFFUSE            |
| 33      | 012000Z | 11.0N | 118.2E | 54-R-10             | --          | --          | --            | --              | --              | --               | CIRC DIA 30 MIL        |
| 34      | 020020Z | 10.3N | 117.2E | 54-P-10             | --          | 40          | 10200         | --              | 14              | 10               | CIRC DIA 30 MIL        |

TYPHOON HARRIET 24 DEC - 02 JAN 1959 - 60  
 POSITION AND FORCAST VERIFICATION DATA

| DTG     | STORM POSITION |        | 12 HR ERROR |          | 24 HR ERROR |          |
|---------|----------------|--------|-------------|----------|-------------|----------|
|         | LAT.           | LONG.  | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 240000Z | 02.9N          | 154.1E | - - - -     |          | - - - -     |          |
| 240600Z | 03.3N          | 153.5E | - - - -     |          | - - - -     |          |
| 241200Z | 03.6N          | 152.9E | 122         | - 85     | - - - -     |          |
| 241800Z | 04.1N          | 152.4E | 127         | - 85     | - - - -     |          |
| 250000Z | 04.7N          | 151.7E | 129         | - 96     | 127         | - 180    |
| 250600Z | 05.4N          | 150.9E | 134         | - 33     | 128         | - 201    |
| 251200Z | 06.0N          | 150.2E | 153         | - 29     | 130         | - 218    |
| 251800Z | 06.7N          | 149.3E | 199         | - 28     | 138         | - 91     |
| 260000Z | 07.5N          | 148.3E | 189         | - 57     | 155         | - 76     |
| 260600Z | 08.3N          | 147.4E | 218         | - 55     | 186         | - 67     |
| 261200Z | 09.3N          | 146.2E | 185         | - 27     | 171         | - 111    |
| 261800Z | 10.2N          | 144.6E | 110         | - 61     | 175         | - 85     |
| 270000Z | 10.5N          | 142.9E | 049         | - 80     | 096         | - 86     |
| 270600Z | 11.2N          | 141.3E | 193         | - 45     | 078         | - 146    |
| 271200Z | 11.8N          | 139.8E | 178         | - 40     | 050         | - 193    |
| 271800Z | 12.4N          | 138.1E | 150         | - 66     | 036         | - 102    |
| 280000Z | 12.9N          | 136.4E | 157         | - 62     | 145         | - 88     |
| 280600Z | 13.3N          | 135.0E | 156         | - 21     | 146         | - 107    |
| 281200Z | 13.8N          | 133.8E | 090         | - 44     | 178         | - 105    |
| 281800Z | 14.2N          | 132.5E | 240         | - 20     | 176         | - 44     |
| 290000Z | 14.5N          | 130.9E | 090         | - 08     | 308         | - 25     |
| 290600Z | 14.5N          | 129.8E | 040         | - 54     | 007         | - 43     |
| 291200Z | 14.4N          | 129.0E | 331         | - 71     | 345         | - 76     |
| 291800Z | 14.3N          | 128.2E | 343         | - 45     | 049         | - 125    |
| 300000Z | 14.2N          | 127.4E | 306         | - 32     | 354         | - 162    |
| 300600Z | 14.0N          | 126.5E | 326         | - 35     | 001         | - 127    |
| 301200Z | 13.9N          | 125.7E | 084         | - 48     | 310         | - 55     |
| 301800Z | 13.9N          | 124.9E | 082         | - 70     | 319         | - 52     |
| 310000Z | 13.8N          | 124.1E | 153         | - 34     | 084         | - 64     |
| 310600Z | 13.7N          | 123.3E | 222         | - 34     | 090         | - 104    |
| 311200Z | 13.6N          | 122.5E | 270         | - 08     | 170         | - 45     |
| 311800Z | 13.3N          | 121.6E | 232         | - 75     | 243         | - 94     |

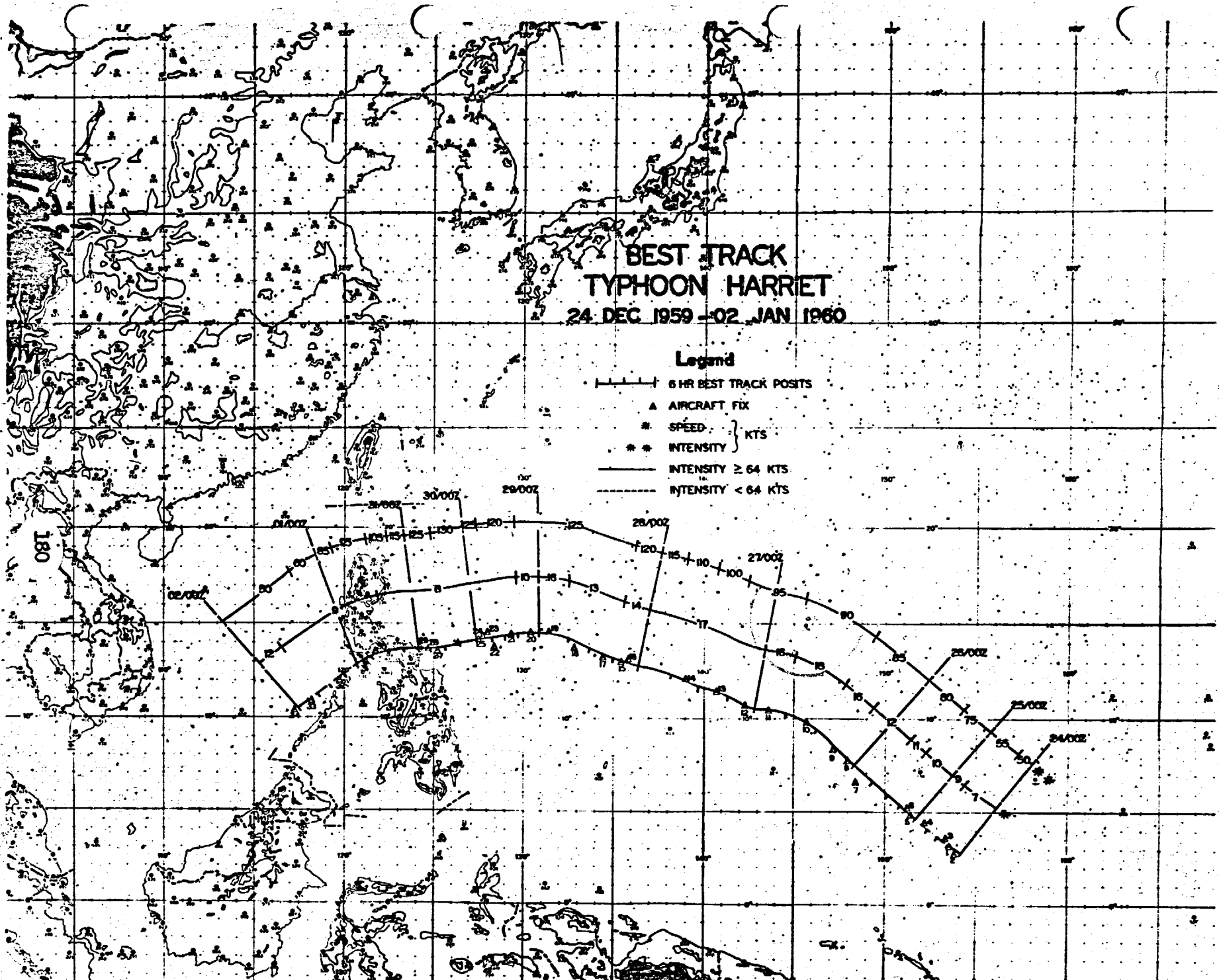
TYNICOON HARBOR 24 DEC - 02 JAN 1959 - 60  
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

| DTG                   | STORM POSITION |          | 12 HR ERROR |          | 24 HR ERROR |          |
|-----------------------|----------------|----------|-------------|----------|-------------|----------|
|                       | LAT.           | LONG.    | DEG.        | DISTANCE | DEG.        | DISTANCE |
| 010000Z               | 12.9N          | 120.7E   | 242         | - 16     | 335         | - 35     |
| 010600Z               | 12.4N          | 120.0E   | 352         | - 49     | 261         | - 114    |
| 011200Z               | 11.8N          | 119.2E   | 347         | - 81     | 314         | - 51     |
| 011800Z               | 11.2N          | 118.5E   | 360         | - 10     | 351         | - 119    |
| 020000Z               | 10.5N          | 117.4E   | 067         | - 22     | 349         | - 139    |
| AVERAGE 12 HOUR ERROR |                | 46.5 NM  |             |          |             |          |
| AVERAGE 24 HOUR ERROR |                | 100.9 NM |             |          |             |          |

**BEST TRACK  
TYPHOON HARRIET  
24 DEC 1959 -02 JAN 1960**

**Legend**

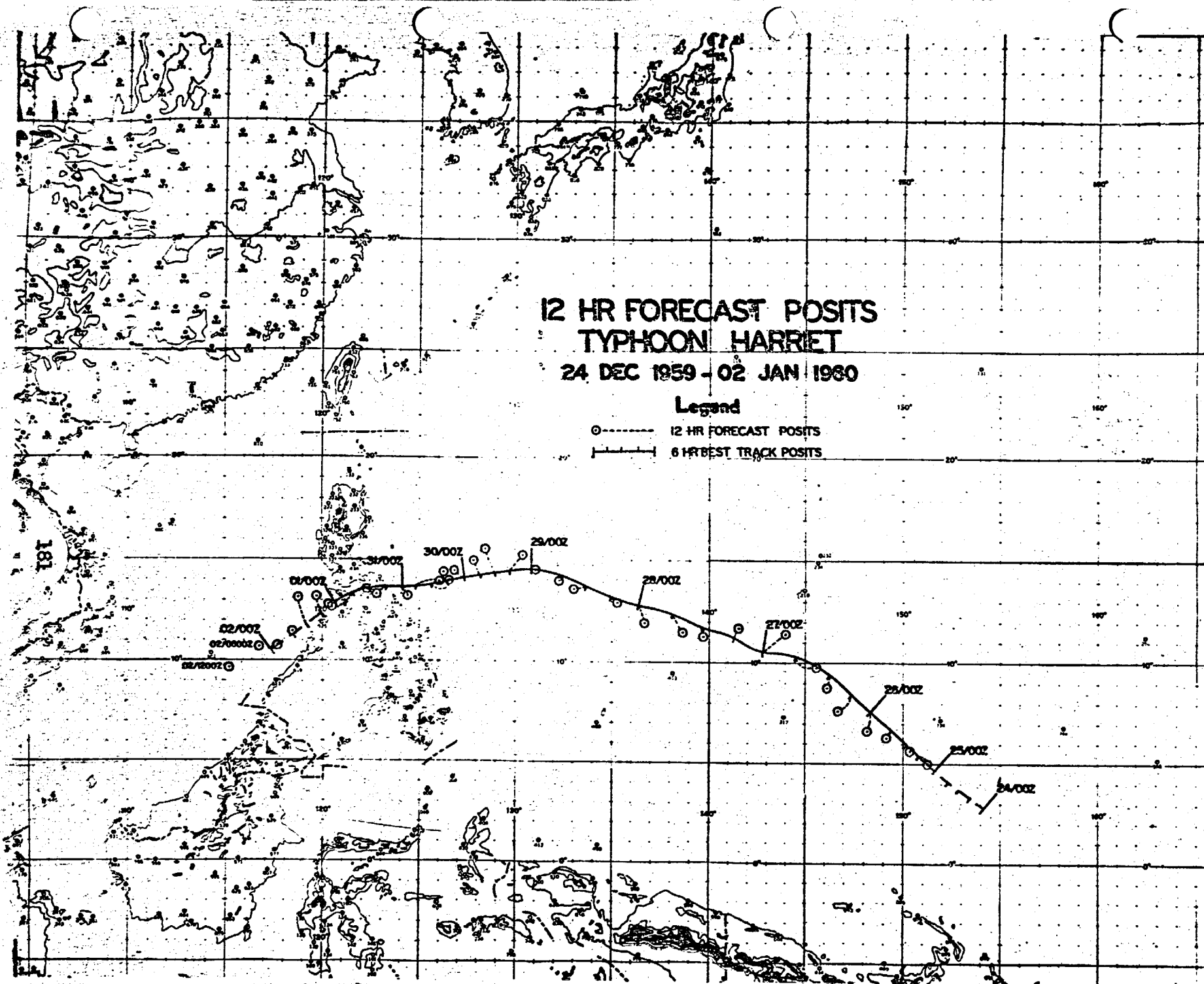
- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- \* SPEED } KTS
- \*\* INTENSITY }
- INTENSITY ≥ 64 KTS
- - - INTENSITY < 64 KTS



**12 HR FORECAST POSITS**  
**TYPHOON HARRIET**  
**24 DEC 1959 - 02 JAN 1960**

**Legend**

- 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS





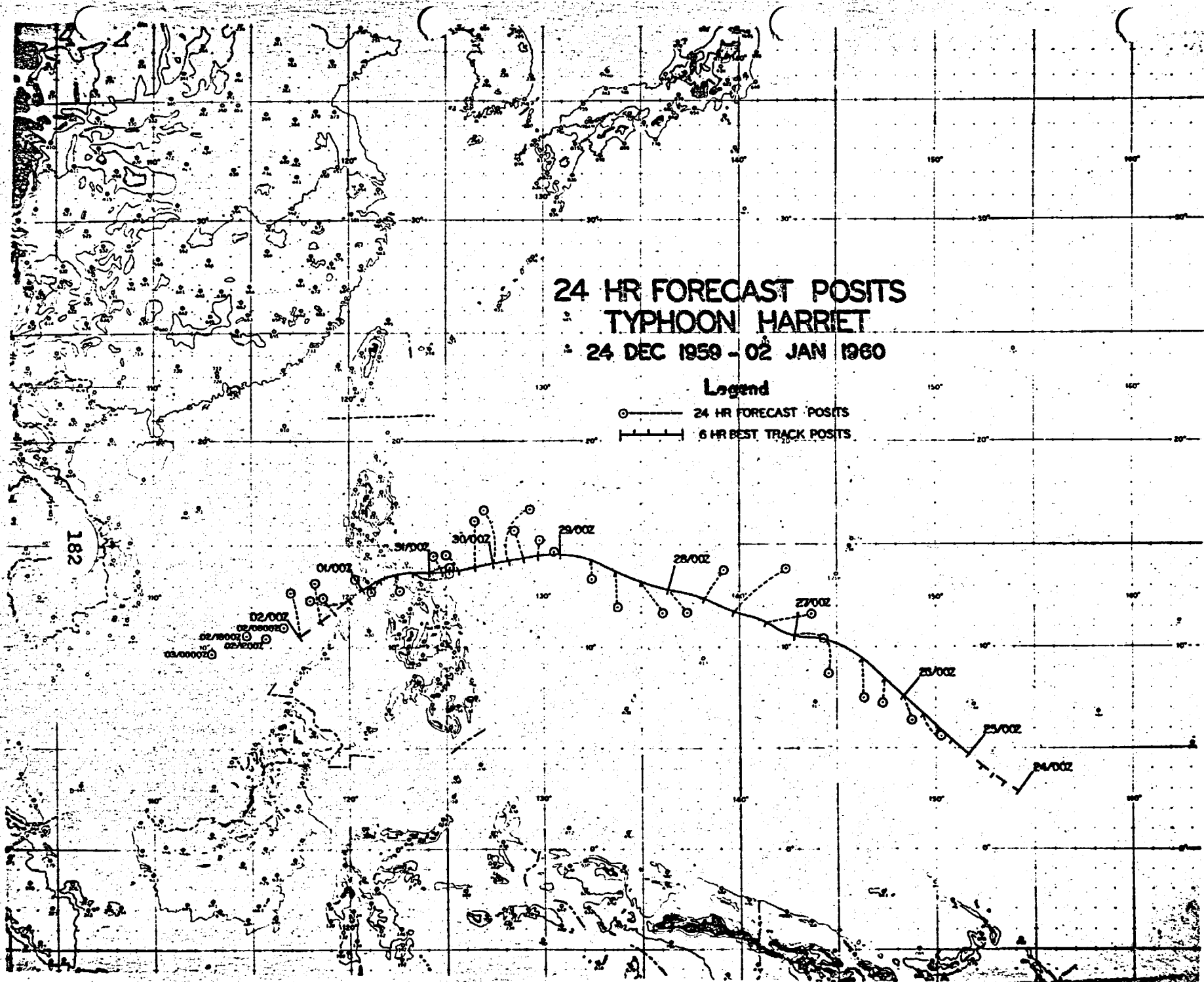
24 HR FORECAST POSITS  
TYPHOON HARRIET

24 DEC 1959 - 02 JAN 1960

Legend

○ — 24 HR FORECAST POSITS

— 6 HR BEST TRACK POSITS



**SECTION VI**

**DESTRUCTIVE EFFECTS OF TYPHOONS**

## SECTION VI

### DESTRUCTIVE EFFECTS OF TYPHOONS

The 1959 Typhoon Season will long be remembered as one of the most destructive in history. Of a total of 17 typhoons during the Season, 13 hit heavily populated areas, each leaving behind a trail of death and destruction.

Reports from Okinawa, Japan, the Republic of Korea, Taiwan, and the Philippine Islands place the total known dead at approximately 7,570 persons, the number of missing at 1,700, and the number of injured at more than 60,000. Millions of others were left homeless.

The four typhoons which caused the greatest destruction, and the areas most seriously affected were: BILLIE (Taiwan and the Ryukyu Islands), GEORGIA (Japan), SARAH (Okinawa, Korea and Japan) and VERA (Japan).

Information regarding the damage and loss of life caused by each destructive typhoon is presented in the following paragraphs. It is emphasized that complete, detailed records of the destructive effects of typhoons are not maintained by JTWC. The greater part of the data regarding damage has been obtained from articles which appeared in the "Pacific Stars and Stripes" and in the "Guam Daily News."

The destructive typhoons of 1959 were BILLIE, ELLEN, GEORGIA, IRIS, JOAN, LOUISE, SARAH, VERA, CHARLOTTE, EMMA, FRED, GILDA and HARRIET.

1. BILLIE. Areas Affected: Taiwan, Ryukyu Islands,  
Southern Japan.

Taiwan: BILLIE left one dead, more than 100 persons homeless, and about \$500,000 worth of property damage in Taiwan's eastern areas. Also, one-third of Taipei was flooded, leaving 10,000 persons homeless in the city.

The following is a description of the damage sustained in the capital city:

Extensive areas of Taipei were flooded long after the typhoon struck.

Hundreds of shanty-type dwellings were destroyed.

Muddy waters invaded thousands of more substantial homes in outlying areas.

Numerous persons were forced to hurriedly evacuate during the night.

Parts of Chuncshan road, the city's main thoroughfare, were submerged for several days.

Ryukyu Islands: The typhoon lashed Ishigaki, in the southern Ryukyu chain, leaving 16 homes destroyed, 49 partially destroyed, crops seriously damaged and four vessels missing.

Southern Japan: The dead from a week of torrential rains on the fringes of the typhoon rose to 45, with 75 injured, 16 missing and more than 65,000 homes destroyed, damaged or flooded.

2. ELLEN. Area Affected: Southern Japan.

Southern Japan: Typhoon ELLEN battered Southern Japan

leaving at least 11 persons killed, 11 injured, and more than 4,000 homes flooded. Heavy flooding and wind damage on the southern islands of Kyushu were reported.

Several mountain areas on Kyushu reported as much as 35 inches of rainfall. Also, thousands of acres of rice paddies were flooded in parts of Kyushu and Shikoku and many roads were washed away or inundated.

3. GEORGIA. Area Affected: Central Japan.

Central Japan: Typhoon GEORGIA left a total of 246 dead or missing and 1,031 injured in Japan. Hardest hit on Japan's main island were Nagano with 48 dead and 51 missing, and Yamanashi, with 40 dead and 57 missing, according to the National Rural Police.

The typhoon left more than 50,000 families homeless, tore down miles of communications lines, and washed out bridges and roads. It also caused the worst damage in Japan's history to the railway transport network.

Total damage by ELLEN and GEORGIA is estimated at \$50 million, with approximately 205,000 acres of farmland flooded.

4. IRIS. Areas Affected: Philippines, Red China.

Philippines: Typhoon IRIS left death in its wake as it hit the Batan Islands off the northern tip of Luzon. Rough seas churned by the typhoon's winds were blamed for at least two, and possibly three, shipwrecks in the Philippines.

A Philippine inter-island ship, reportedly with over 100 persons aboard sank in storm-tossed waters off Palawan Island

in the central west Philippines. Only 11 survivors were found.

At least five persons were missing when a motorboat capsized in choppy seas off Quezon province in Southern Luzon.

A Chinese fishing vessel reported itself in distress almost directly in the typhoon's path. No immediate help was in sight at the time, and no further word was heard from the vessel.

Red China: China disclosed that typhoon IRIS killed 720 and left 996 missing in a savage sweep through Fukien province.

5. JOAN. Areas Affected: Taiwan, Red China.

Taiwan: Typhoon JOAN smashed Taiwan leaving at least 11 persons killed and \$3 million in crop damage. Housing also was hard hit by the storm as JOAN flattened or destroyed 3,308 houses.

The heaviest crop and fruit damage was reported in Pingtung and Nantou counties. Pingtung's ripening banana and papaya crops were blown off trees, and at least 12,000 acres of rice fields were destroyed by the storm. In central Taiwan's rich Nantou banana growing county, 20,000 banana trees worth an estimated \$555,000 were destroyed. Cotton, orange and tangerine crops were also dealt severe blows.

Red China: China announced 3 dead and 57 injured from typhoon JOAN.

6. LOUISE. Area Affected: Taiwan.

Taiwan: Typhoon LOUISE slammed through Taiwan leaving 6 dead, 167 injured, and an estimated 6,100 homeless. Heaviest damage was in the Hualien area where it hit with great force.

7. SARAH. Areas Affected: Ryukyu Islands, Korea, Southern Japan.

Ryukyu Islands: Typhoon SARAH left a trail of death and destruction on Miyako Jima Island in the Ryukyus. There were 7 deaths, 88 injuries and more than 6,000 homes were destroyed. SARAH's winds and heavy seas also smashed the fishing pier and 2,200 feet of seawall. Electric power lines were knocked down and the island was left without electric power for a considerable period. All crops were ruined. Damage was estimated at \$2 million.

Korea: Korea's worst typhoon in 50 years left 669 dead, 259 missing and thousands injured and homeless. The homeless were officially listed at 782,126 persons.

In addition to the casualty list, the Ministry of Social Affairs reported property losses exceeded \$100 million. The loss included 14,000 homes destroyed and 2,800 fishing vessels sunk. Another 2,600 vessels were badly damaged and 313,000 acres of farmland were flooded. Reports from U.S. authorities said military installations in the Pusan and Taegu areas suffered \$900,000 damage, with damage to Pusan port exceeding \$100,000.

The Pusan area of Korea was hit the hardest. Police reported 25,834 persons homeless from floods and tidal waves. An estimated 15,379 homes were washed away, damaged or destroyed.

Southern Japan: Skirting Kyushu, SARAH flooded communities and sank fishing boats. She killed 24 persons and injured 186. On Honshu and Kyushu 1,188 houses were either demolished or partially destroyed.

8. VERA. Area Affected: Japan.

Japan: Typhoon VERA will long be remembered as Japan's greatest storm disaster. National police said 4,580 persons were confirmed dead with 658 missing. Another 32,285 persons were injured and 1,596,855 left homeless. Damage was estimated in excess of \$261 million. Vast areas of crops were ruined, sea walls broken, rivers flooded from accompanying torrential rains, ships beached, houses smashed and communications seriously damaged.

Four days after the disaster thousands were still marooned on rooftops, bodies floated in flooded districts and throngs of refugees were without food and adequate shelter.

VERA dealt a staggering blow to Japan's economy. Food and crops, many ready for harvest, were seriously affected. Railway service in some areas was not expected to resume for at least a month. Damage to roads, bridges and communications was tremendous. More than 200 vessels were sunk.

Some examples of VERA's brutal fury:

In less than three hours on 26 September, VERA turned Nagoya, a modern city, into a complete shambles. The harbor was described as a "sea of dead" and Nagoya lost all function as a harbor.

At Handa, southeast of Nagoya, 300 persons perished when gigantic waves battered the town destroying more than 250 homes.

Sixty persons were buried alive at Kawakami in Nara Prefecture when a landslide crushed 12 houses.

Roofs of 1,000 houses were ripped off a small village in Nagano Prefecture.



Flood waters completely cut off Kuwana City in Mie Prefecture. More than 400 were believed dead or missing.

The 7,142-ton Australian Passenger-freight ship Changsha ran aground at Yokkaichi with 44 passengers aboard. (See page 195).

Along with the immediate effects of the typhoon, there were also numerous long-range problems with which to deal. For example, there was the problem of food. Authorities said that the daily ration of food for the affected citizens had been sharply reduced and hunger was widespread.

Dysentery and other epidemics became rampant in flooded southern Nagoya. Health authorities said that more than 170 dysentery cases were reported in the city's southern district, despite frantic disinfection work. Several cases of gangrene and tetanus were reported in the same district.

Flood waters that surged over the Nagoya harbor in typhoon VERA's wake contaminated drinking water, and water supplies dwindled very rapidly.

Although the majority of homeless victims found refuge in ward offices and schools, the shelter problem became more acute than before.

Refugees streaming toward the shelter of ward offices and schools were drenched by post-typhoon rain. Most of the pitiful handfuls of clothing and bedding they managed to salvage from their flooded homes were water-soaked.

In conclusion, VERA goes down in history as the most destructive of typhoons in the number of lives lost and amount of property damage.

9. CHARLOTTE. Area Affected: Okinawa.

Okinawa: Typhoon CHARLOTTE left 46 persons dead, 24 injured and 1,038 homeless on Okinawa. Also, 275 homes and 11 public buildings were destroyed and 618 homes were damaged.

A total of 24 inches of rain fell on the island. The rain, coupled with high winds, left 75 per cent of the island's rice crops in ruins and destroyed 16 per cent of the sugar cane and other crops.

Damage to military installations on the island amounted to \$300,000, which included mostly power lines, water supplies, and other utilities. The only buildings damaged were temporary structures.

Landslides caused by the heavy rains crumpled homes and buried victims trapped inside under tons of dirt and rock in Ogimi, Takazato, Taiho, Tsuda and Hidashi. Parts of Naha were flooded under 5 feet of water as the Asato river overflowed its banks.

10. EMMA. Area Affected: Okinawa.

Okinawa: EMMA left at least 2 persons dead, demolished 46 houses and 4 government buildings, and heavily damaged 108 other buildings on the island of Okinawa. Communications were interrupted and crops were seriously damaged. Naha had its low lying areas flooded and merchandise and shop fixtures suffered heavy damage.

Officials listed eight vessels sunk and eight others missing while unconfirmed reports said 47 ships were sunk or damaged during the storm. Numerous ships at sea were caught by the storm and were forced to radio for help. The 8,713-ton Nikkai Maru sank some 250 miles south of Okinawa; 35 of the 38 crew members were rescued.

11. FREDA. Area Affected: Philippines.

Philippines: Typhoon FREDA left 58 persons dead, missing or injured and more than 7,600 families homeless in the Philippines.

Crop damage was reported heavy in the farming region of southern Luzon. Reports estimated damage to crops and private property to be in the vicinity of \$2.5 million.

Torrential rains and strong winds battered Manila, flooding one-third of the capital and downing telephone wires. Two vessels were driven aground and a single-engine plane crashed as a result of FREDA's strong winds.

12. GILDA. Area Affected: Philippines.

Philippines: Typhoon GILDA slashed through the central Philippines leaving at least 23 dead and some 60,000 homeless. Property damage was estimated in excess of \$1.5 million.

Authorities in the provinces on GILDA's path reported heavy damage to houses, crops and public work projects. In Samar alone, the first province to be hit by the typhoon, officials reported about \$500,000 worth of agricultural plants, houses and communications lines were destroyed.

13. HARRIET. Area Affected: Philippines.

Philippines: Typhoon HARRIET smashed into southeastern Luzon leaving at least five dead and more than 12,000 homeless. The storm also caused considerable damage to public and private property. Communications were disrupted and extensive damage to southern Luzon's citrus, abaca, coconut and rice crops was reported. Unofficial esti-

mates of the damage placed it conservatively at \$2.5 million.

On 31 December, HARRIET passed directly over the island of Catanduanes causing severe damage. The following is a vivid description of the passage of the typhoon's eye over the Coast Guard Loran Station located on the island. All wind speeds in the following account are estimated:

"(a) 301630Z: (NE, 75 kts, 993 mb) Heavy driving rains came in squalls. The barometer was falling rapidly. Coconuts and palm leaves were blowing loose and littering the station.

(b) 301800Z: (NE, 90 to 100 kts, 992 mb) Continuous driving rain and winds. Station personnel took refuge in signal-power building. Tar paper commenced tearing off of the signal-power building roof. Water seeping through roof and walls of the building, flooding the cable trenches and floors.

(c) 301900Z: (NNE, 100 to 115 kts, 985 mb) Continuous heavy rain and winds, increasing in intensity. Barometer dropping rapidly.

(d) 302000Z: (NNE, 115 to 130 kts, 984 mb) Continuous heavy rain and winds. Barometer continues to drop.

(e) 302100Z: (NNE, 150 to 160 kts, 974 mb) Continuous heavy rain and increasing winds. Barometer dropping rapidly. Signal-power building leaking at this time.

(f) 302125Z: (NE, 160 kts, 967 mb) Secured all electrical power to station. The heavy gusting winds caused pressure waves throughout the interior of the building. The ceiling was lifting and falling and was coming off throughout the building.

(g) 302145Z: (NE, 160 plus kts, 949 mb) This was the last read-

ing of the barometer before it broke. Continuous heavy rain and increasing winds.

(h) 302155Z: The NE corner of the roof was observed to rise approximately one foot from the edge of the building and a few seconds later, the entire roof, including rafters, was blown away. Personnel took shelter under what debris was available to prevent personnel injuries from flying debris and equipment inside the building.

(i) 310100Z: (E, 85 to 100 kts) Heavy rain with winds gusting to 100 kts, slowly diminishing and shifting to SE.

(j) 310130Z: (SE, 75 to 85 kts) All hands returned to lower station to commence clearing quarters of water and sand. Only minor injuries were suffered by two of the personnel. The rest of this day was spent clearing living quarters and galley of water, sand, and broken glass. A hot meal was enjoyed by everyone and sleep came easily on wet and sandy mattresses. By 310800Z, winds had diminished to approximately 30 kts."



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