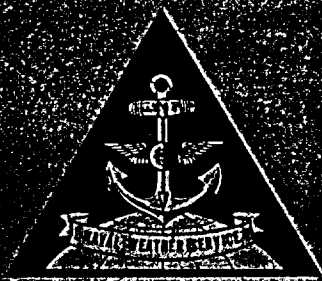
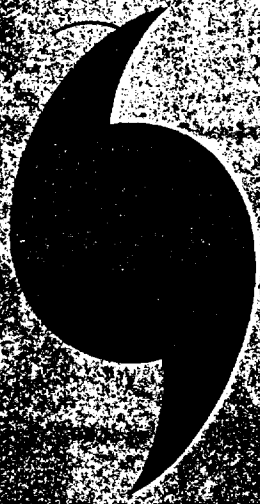


JTWC DIRECTOR

ANNUAL TYPHOON REPORT



1959



FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER

Guam, Mariana Islands

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SAN FRANCISCO, CALIFORNIA

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COMMANDING

1959

ANNUAL TYPHOON REPORT

Prepared and Edited
under the supervision of

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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, 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 FREDIA, 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 FRED A, 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 FRED A showed no noticeable deceleration prior to recurvature.

TROPICAL CYCLONES OF 1959

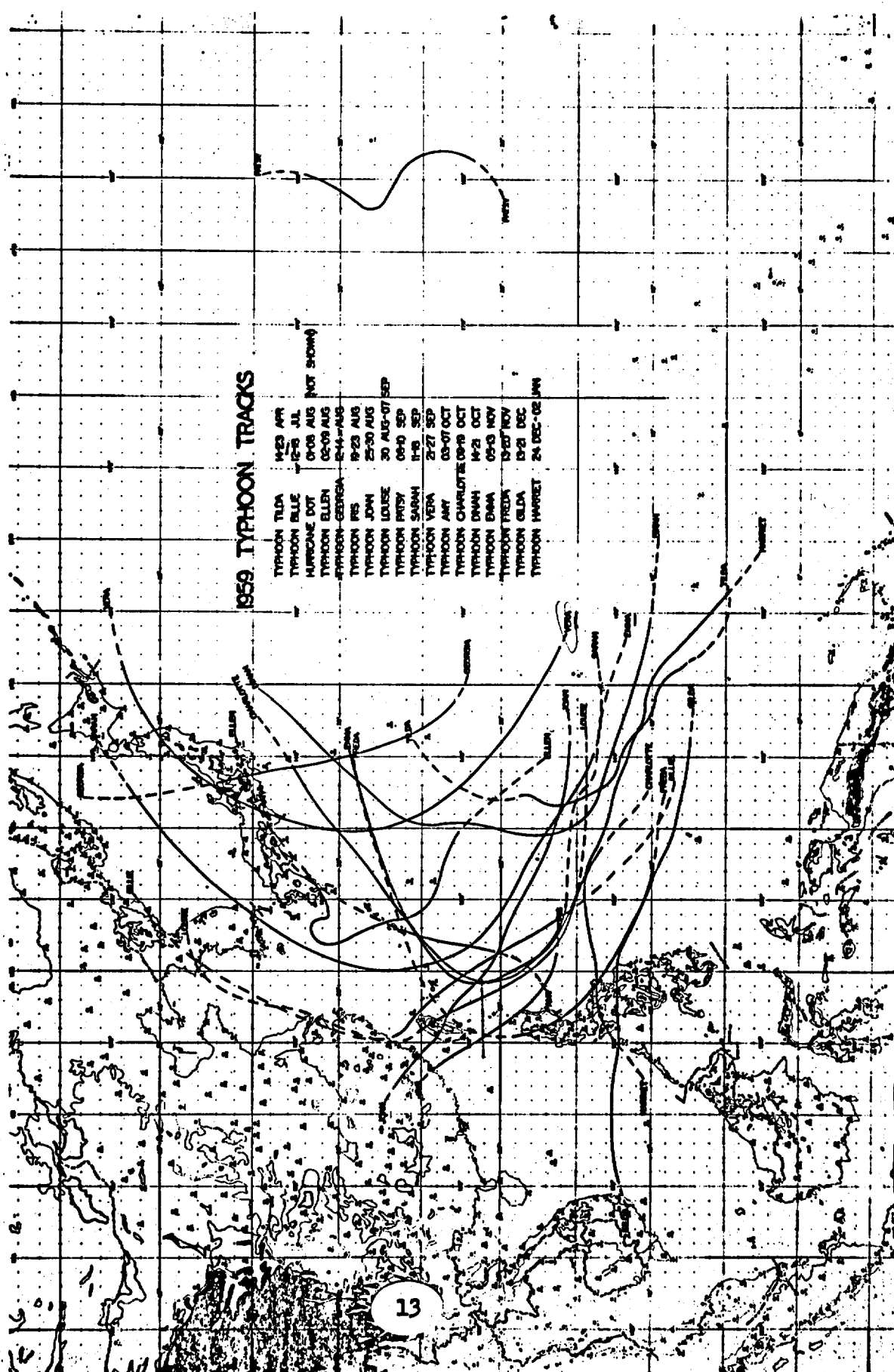
CYCLONE	PERIOD
01. Investigation	24 Feb
02. Tropical Storm RUBY (3)	27 Feb - 01 Mar
03. Tropical Storm SALLY (10)	04 Mar - 13 Mar
04. Typhoon TILDA	14 Apr - 23 Apr
05. Investigation	01 May
06. Investigation	11 May
* Tropical Depression VIOLET (2)	28 Jun - 29 Jun
* Tropical Storm WILDA (3)	04 Jul - 06 Jul
07. Tropical Depression ANITA (3)	05 Jul - 07 Jul
08. Typhoon BILLIE	09 Jul - 18 Jul
** Tropical Storm CLARA (7)	16 Jul - 22 Jul
09. Investigation	17 Jul
10. Investigation	20 Jul
11. Investigation	25 Jul
~~*** Hurricane DOT~~	~~01 Aug - 08 Aug~~
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)	~~05 Oct - 10 Oct~~
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

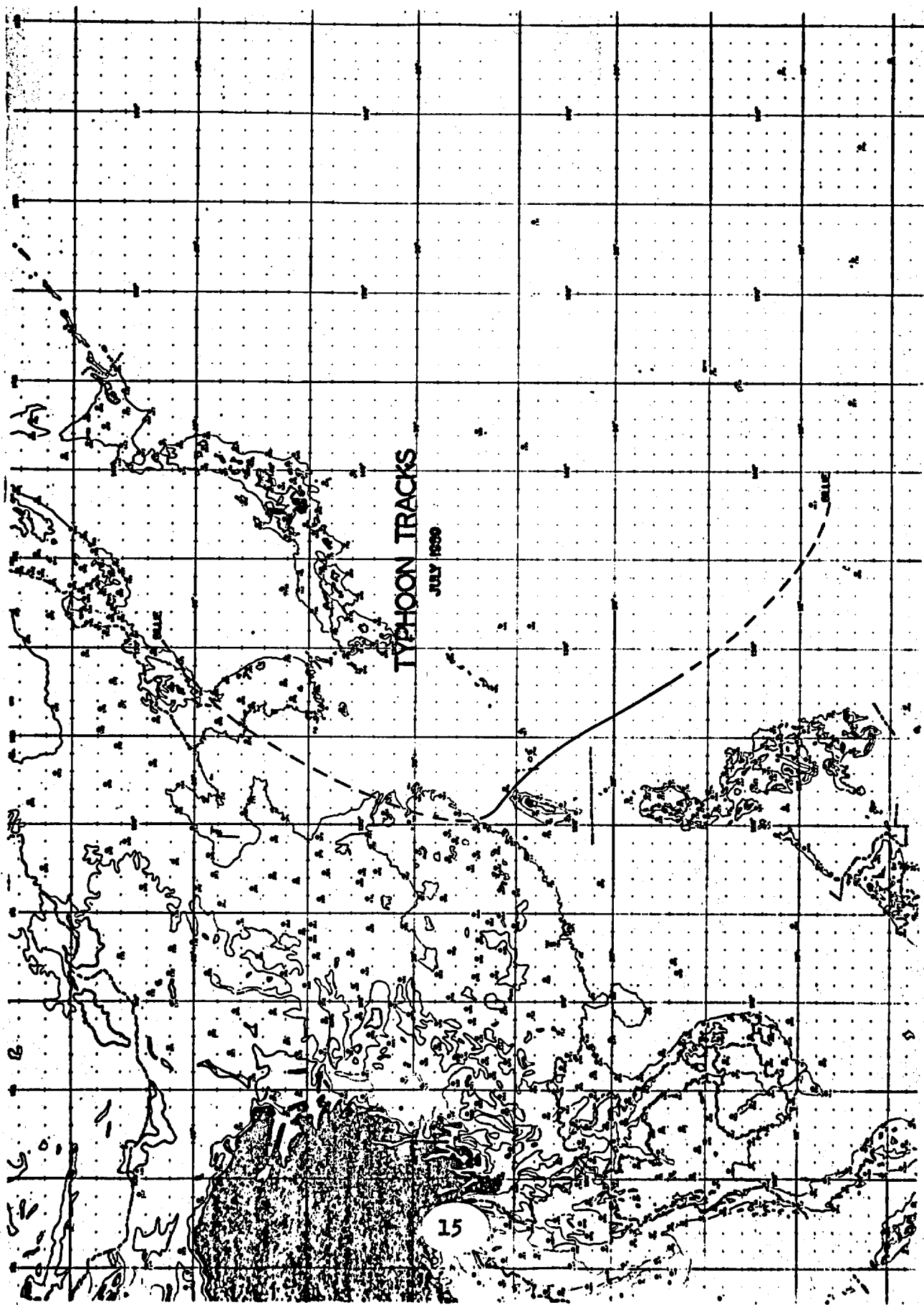
TYPHOON TULIA	14-23 APR
TYPHOON BLUE	12-18 JUL
HURRICANE DOT	04-08 AUG
TYPHOON ELLEN	02-09 AUG
TYPHOON GEORGE	02-14 AUG
TYPHOON JOHN	19-23 AUG
TYPHOON LOUISE	25-30 AUG
TYPHOON MARY	30 AUG-07 SEP
TYPHOON SARAH	09-10 SEP
TYPHOON VERA	11-16 SEP
TYPHOON AMY	27-28 SEP
TYPHOON CHARLOTTE	03-07 OCT
TYPHOON DANAH	08-19 OCT
TYPHOON EMMA	14-21 OCT
TYPHOON FREDR	05-10 NOV
TYPHOON GILDA	15-20 NOV
TYPHOON HURDET	19-21 DEC
	24 DEC-02 JAN

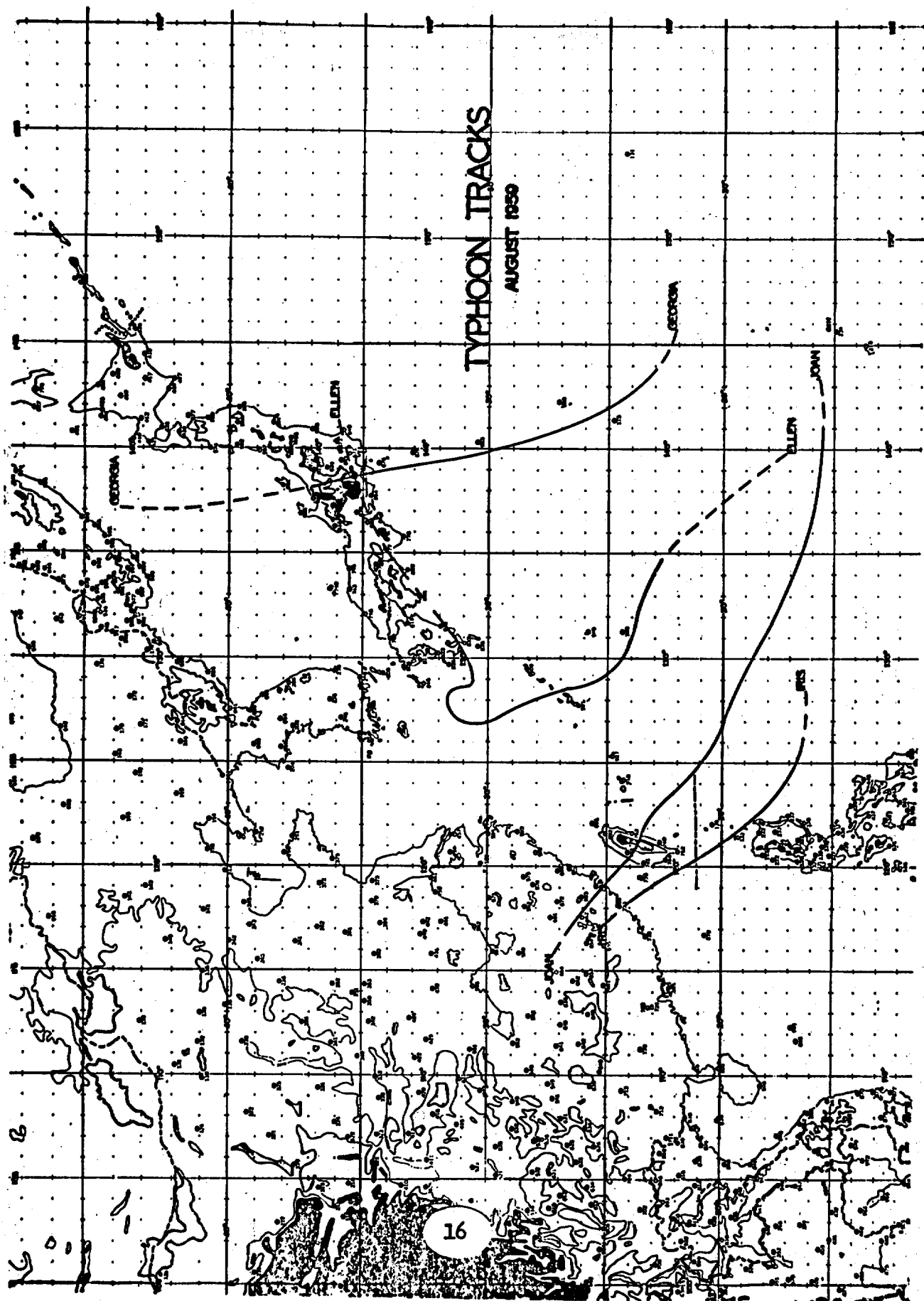
TYPHOON TRACKS

APRIL 1959

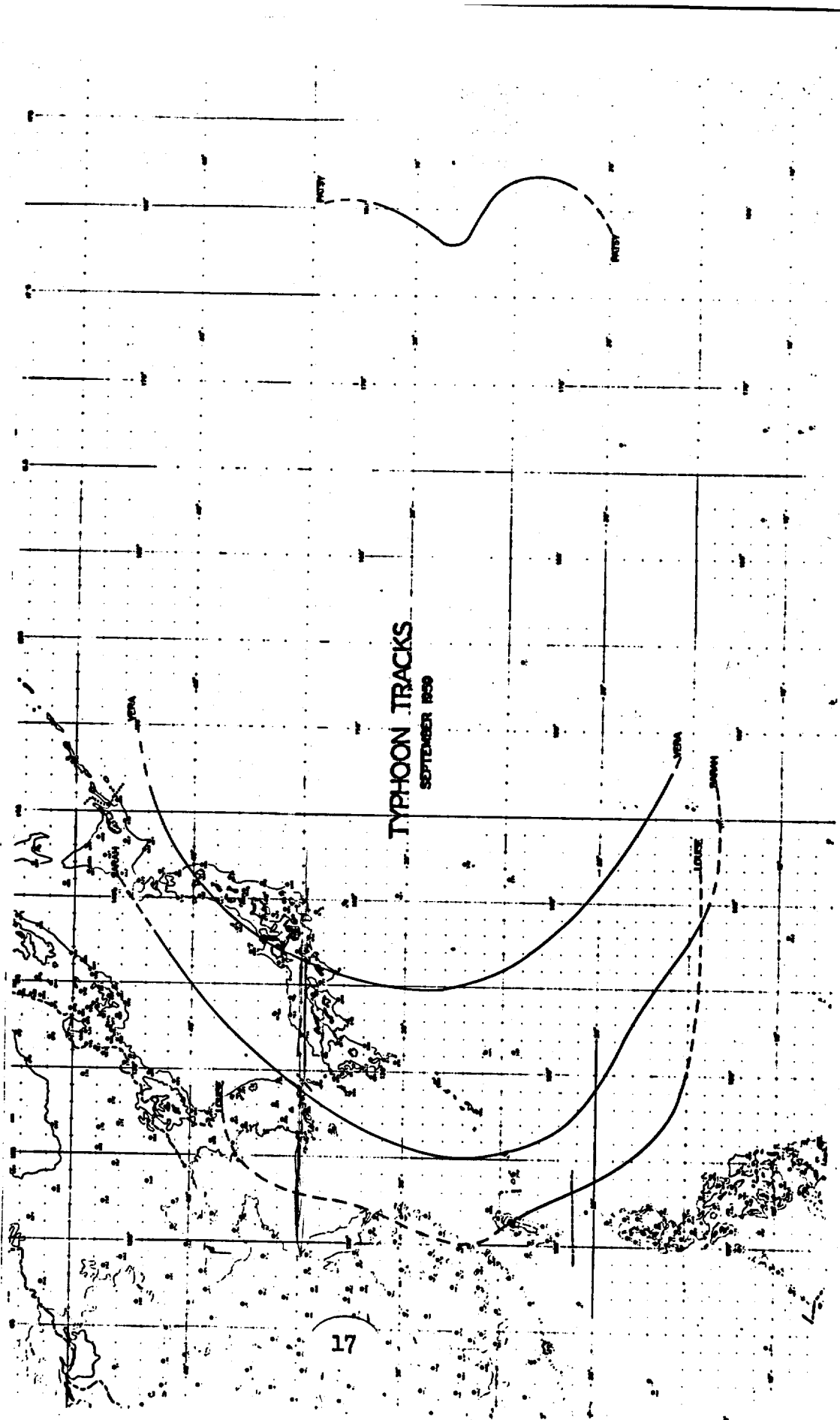
TJDA

TJDA





11A



TYPHOON TRACKS

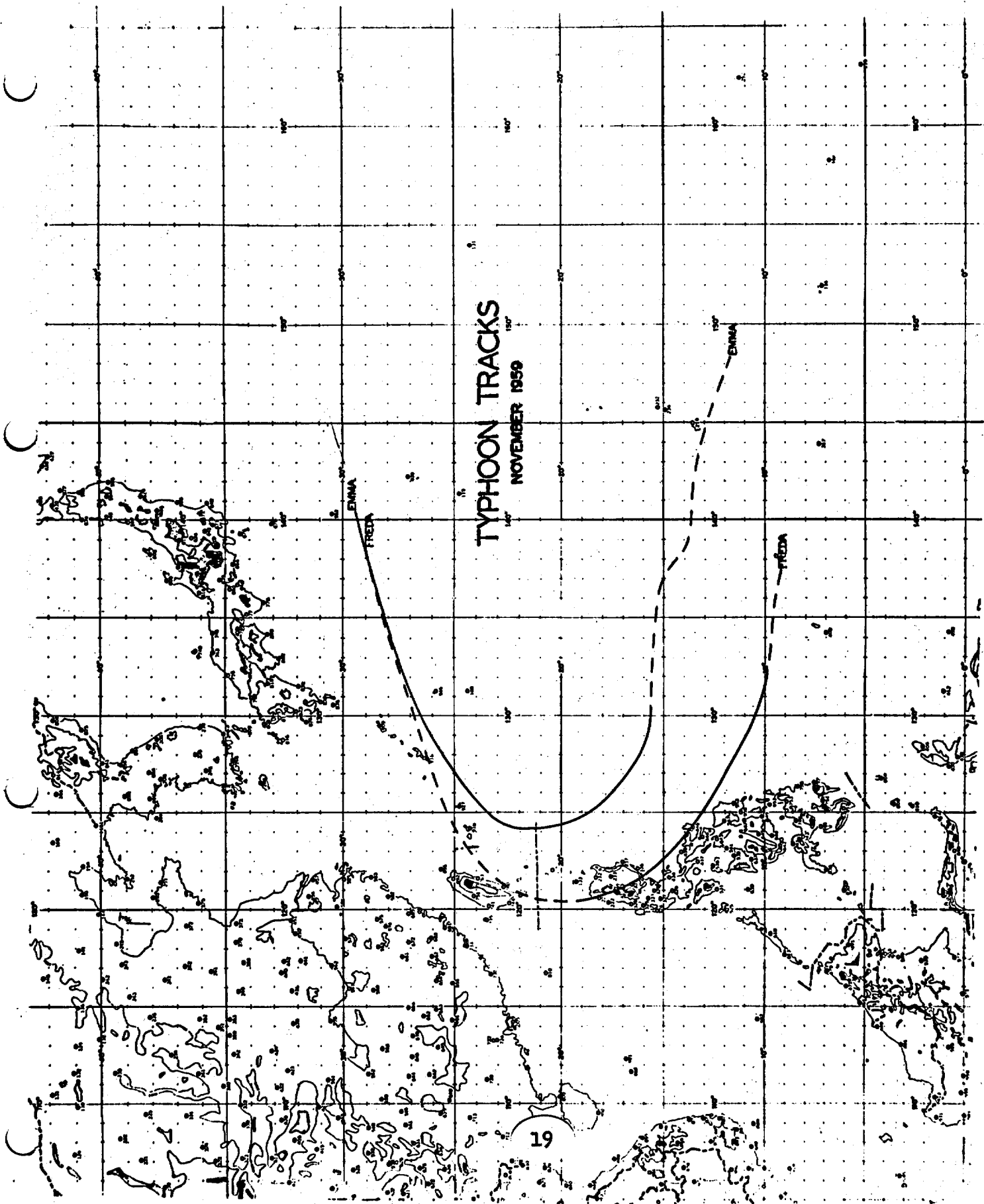
OCTOBER 1959

CHARLOTTE
INMAN

CHARLOTTE

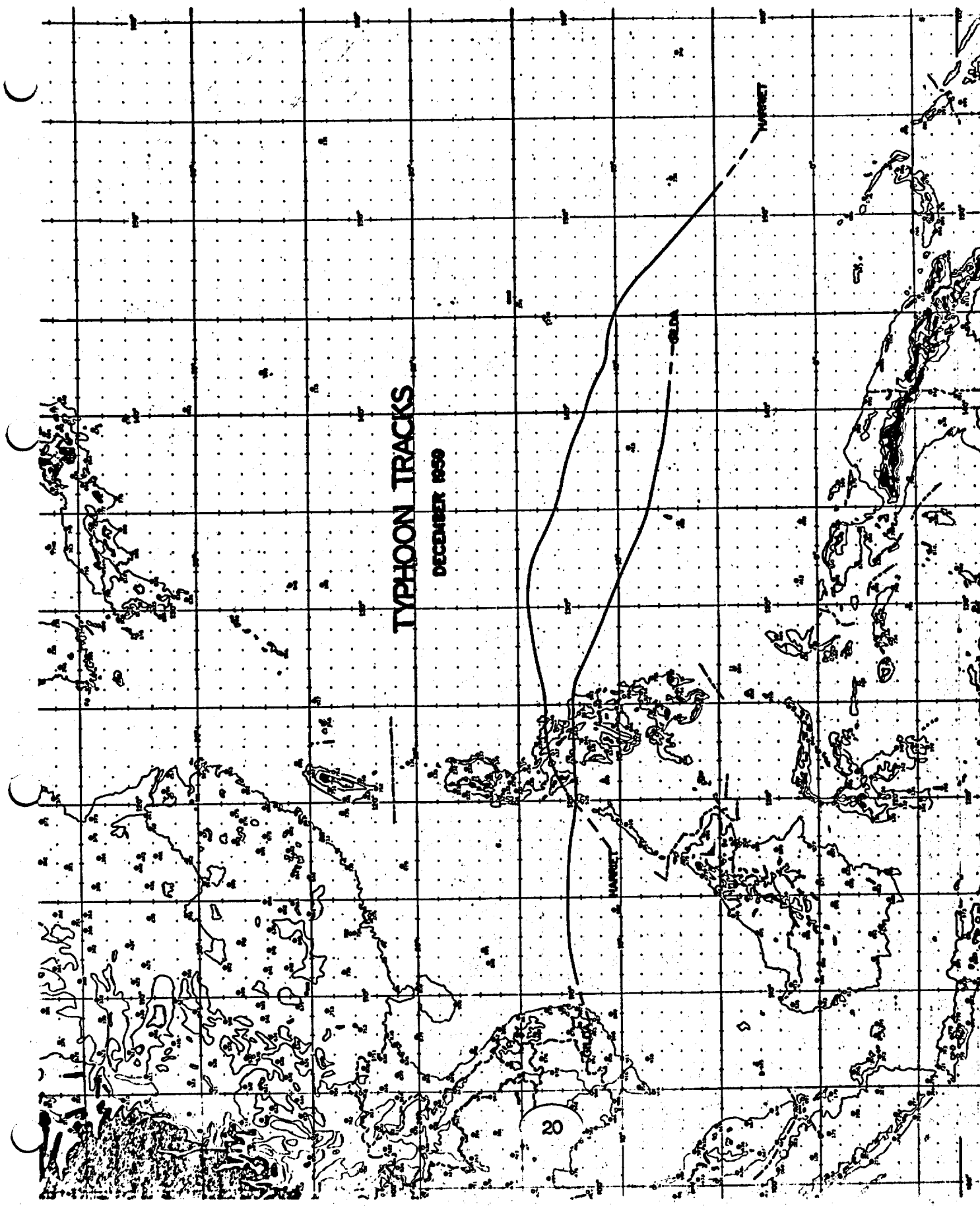
ORUM

TYPHOON TRACKS
NOVEMBER 1959



TYPHOON TRACKS

DECEMBER 1959



TYPHOON SUMMATION DATA SHEET

	FROM RECON			FROM WARNING BULLETIN				FROM RECON									
	MAX	OBSVD	SFC WND	MAX	RADIUS	LOOKT WND	MAX	RADIUS	50KT WND	MAX	TEMP	MAX	MIN	MIN	SLP	(MBS)	
											(C)	(C)	DP	HGT			
TYPHOON																	
TILDA	175 (70)		130	—	—	150				23	23	23	8080		964		
HILLIE	100 (75)		80	—	—	100				27	21	21	9270		968		
ELLEN	110 (78)		100	—	—	150				20	20	16	9120		964		
GEORGIA	120 (81)		120	20	20	175				20	20	17	8960		953		
IRIS	100 (77)		90	—	—	100				19	19	11	9130		966		
JOAN	200 (142)		170	90	90	300				25	25	16	6850		891		
LOUISE	125 (78)		125	60	60	225				24	24	24	9120		964		
PATSY	150 (82)		120	—	—	60				22	22	15	9250		960		
SARAH	170 (110)		165	75	75	225				26	26	15	7510		905		
VERA	175 (117)		165	75	75	250				30	30	23	7180		896		
AMY	95 (65)		65	—	—	60				18	18	16	9670		977		
CHARLOTTE	175 (130)		145	75	75	180				22	22	18	7320		905		
DINAH	200 (122)		155	50	50	175				21	21	17	7600		913		
EMMA	130 (87)		110	75	75	250				25	25	18	8980		959		
FREDA	125 (102)		120	75	75	180				20	20	13	8530		936		
GILDA	165 (122)		150	50	50	125				22	22	18	7540		914		
HARRIET	150 (111)		130	50	50	150				21	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.

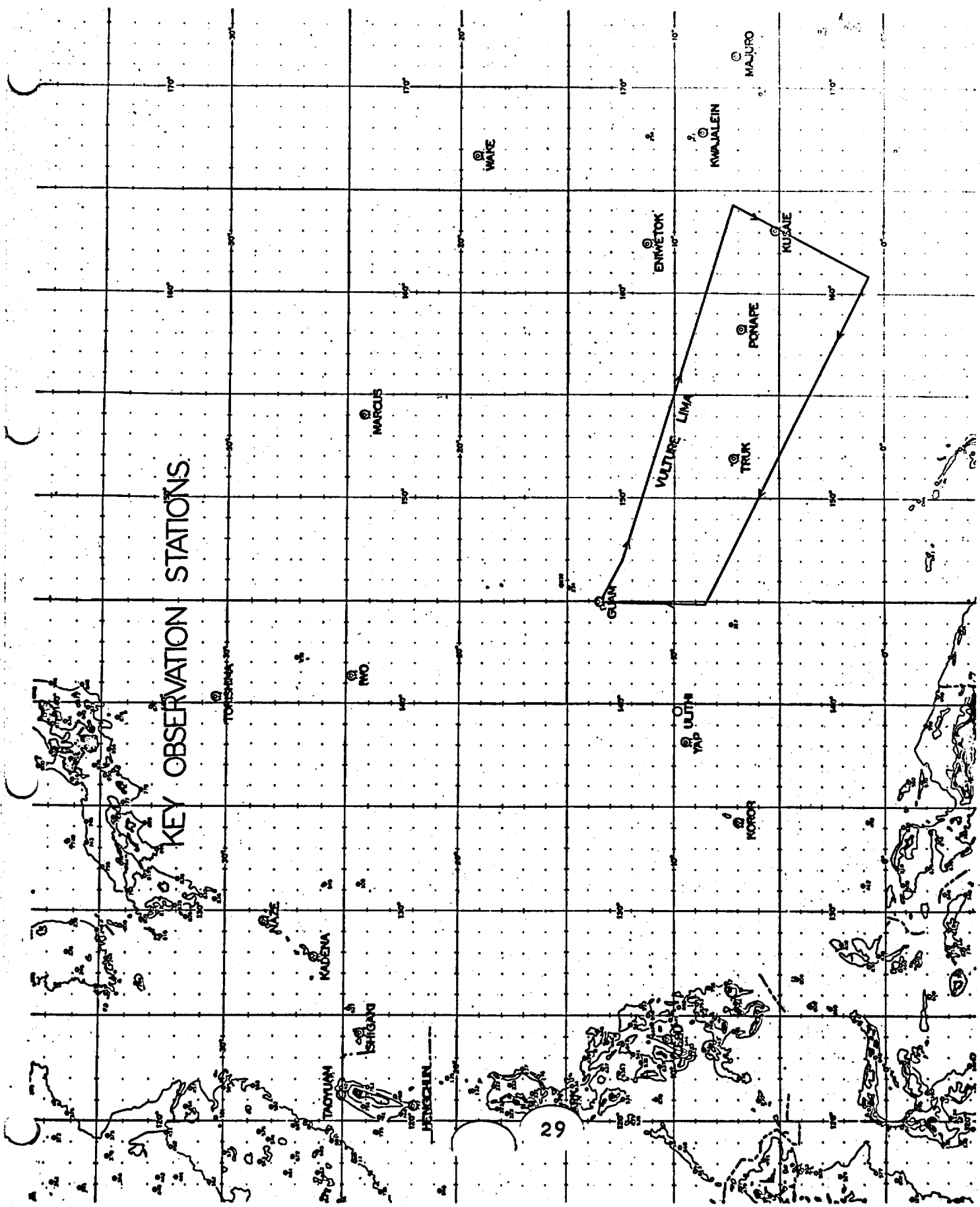
Additional units of the Air Force and Navy also provided the Joint Typhoon Warning Center with typhoon fixes which proved to be of invaluable assistance. The 56th Weather Reconnaissance Squadron made 21 fixes on diversions from fixed tracks; the 11th and 12th Tactical Reconnaissance Squadrons made 54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



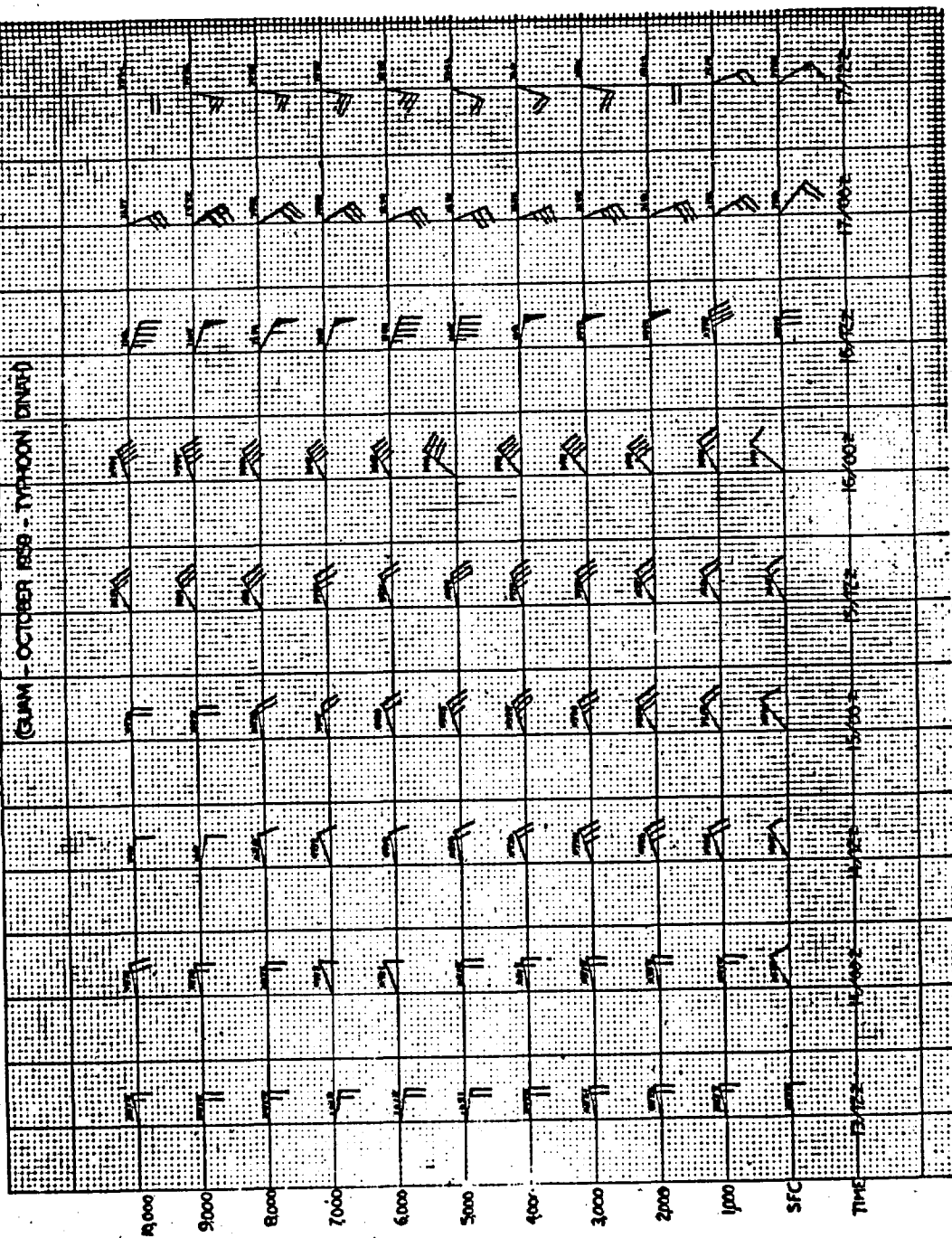
STIDD DIAGRAM

(FIRST INDICATIONS OF DINAH)

OCTOBER 1959

TIME	GUAM 212	TRUK 334	PONAPE 348	ENIWETOK 250
13/18Z	77 091 12 012 75 012 -14	76 081 15 005 76 005 -10	75 054 15 012 74 012 -48	82 064 10 002 77 002 -27
13/21Z	79 102 15 010 75 010 -11	78 088 15 007 77 007 -17	79 075 15 010 75 010 -40	84 075 10 010 77 010 -28
14/00Z	81 110 15 007 77 007 -11	86 081 15 007 77 007 -27	85 078 15 003 76 003 -34	79 081 10 003 77 003 -27
14/03Z	86 095 15 007 75 007 +8	87 058 15 007 78 007 -33	80 047 15 007 75 007 -34	0 NODAT
14/06Z	83 079 15 007 75 007 ±0	86 054 15 007 79 007 -27	77 047 10 007 74 007 -34	82 064 10 007 77 007 -7
14/09Z	79 082 10 007 76 007 -9	83 064 18 007 78 007 -31	75 058 15 012 74 012 -33	0 NODAT
14/12Z	79 097 15 015 75 015 -13	89 085 15 019 88 019 -20	74 064 12 004 74 004 -31	83 081 10 004 76 004 -4
14/15Z	60 064 12 007 76 007 -11	80 054 15 029 77 029 -34	75 044 14 020 74 020 -34	81 068 10 007 76 007 -3
14/18Z	79 069 12 007 77 007 -22	81 044 15 012 76 012 -37	76 047 15 002 74 002 -9	82 054 10 002 75 002 -10
14/21Z	80 076 15 008 76 008 -26	80 047 15 003 77 003 -41	78 061 15 019 74 019 -14	83 075 10 010 78 010 ±0
15/00Z	82 081 15 010 76 010 -23	84 054 15 007 79 007 -27	84 071 15 008 76 008 -7	83 088 10 014 77 014 +7
15/03Z	86 069 15 019 75 019 -26	80 037 15 019 76 019 -21	82 051 15 020 75 020 +4	84 061 10 029 76 029 0
15/06Z	85 053 15 012 74 012 -24	82 018 15 017 76 017 -36	0 NODAT	81 051 10 010 75 010 -13
15/09Z	82 064 12 007 76 007 -18	81 024 15 007 76 007 -40	74 068 12 017 75 017 +10	0 NODAT
15/12Z	80 078 10 013 77 013 -19	79 044 15 019 76 019 -41	80 078 15 010 74 010 +14	82 078 10 010 76 010 -3

TIME CROSS SECTION WINDS Aloft



WARNING FORECAST WORKSHEET

(TD) (TS) (TYPHOON): ____ . WARNING #: ____ . SYN TIME: ____

TDO: ____ . MONTH AND YEAR: ____

1. TWENTY-FOUR HOUR FORECASTS: DIRECTION SPEED
 MALONE: ____ ____
 CLIMATOLOGY (statistics): ____ ____
 CLIMATOLOGY (tracks): ____ ____
2. PAST MOVEMENT (SPEED): ____ Z* ____ Z* ____ Z* ____ Z* ____ Z*
 Latest Fix ____ Z
 To Past 5 Posits: ____ ____ ____ ____ ____
 Latest Posit ____ Z
 To Past 4 Posits: ____ ____ ____ ____ ____
3. BEST TRACK (FAST 24 HOURS): ____ Deg.
4. UPPER AIR DISCUSSION: ____
 (8 lines on actual form)

5. SURFACE DISCUSSION: ____
 (3 lines on actual form)

6. INDICATIONS OF INTENSIFICATION OR WEAKENING: ____

7. FINAL ASSESSMENT: ____
 (6 lines on actual form)

8. FORECAST MOVEMENT: **1ST 12HRS **12-24HRS **1ST 24HRS 24-48HRS
 Deg/Kts: ____ ____ ____ ____

*-- Time of past posits in chronological order.
 **-- Use as applicable.

TYPHOON FORECASTS ERRORS

TYPHOON	12 HR FORECASTS		24 HR FORECASTS		48 HR FORECASTS	
	NO. OF CASES	MEAN ERROR (NM)	NO. OF CASES	MEAN ERROR (NM)	NO. OF CASES	MEAN ERROR (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 FLOWN	TOTAL OBS.	TOTAL DROPS	FIXES REQUESTED	FIXES MADE	PENET FIXES	OTHER 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
TOTAL	215	3799	511	391	382	280	113

*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	--	--	CIRC DIA 30 MI
2	140732Z	06.3N	147.8E	54-P-10	--	60	9970	40	12	09	ELLIP MAJ AXIS 10 MI
3	142030Z	07.3N	146.6E	54-P-5	990	45	9920	55	10	07	
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
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	VM-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 LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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 LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

— GHR BEST TRACK POSITS

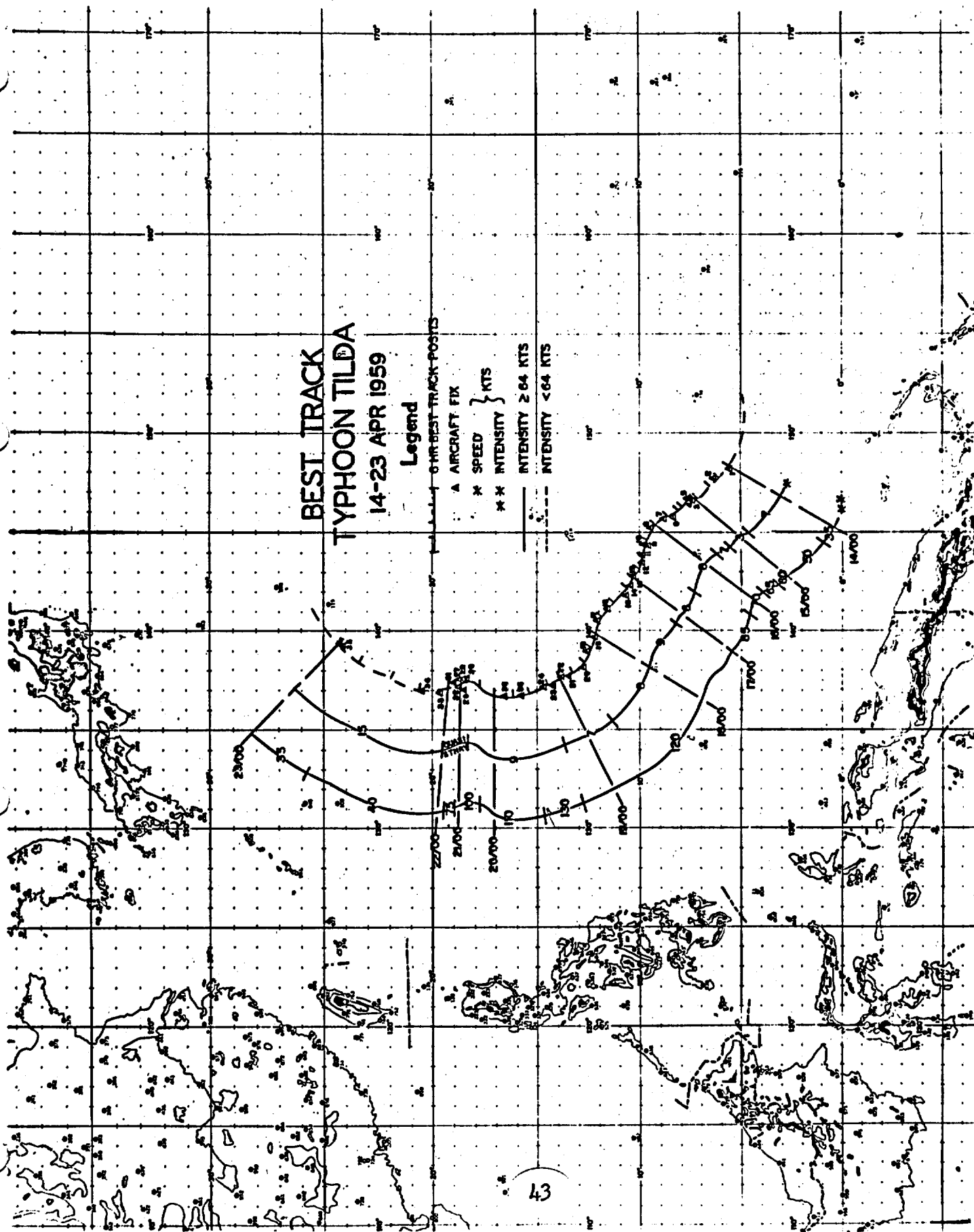
▲ AIRCRAFT FIX

* SPEED } KTS

** INTENSITY }

— INTENSITY ≥ 64 KTS

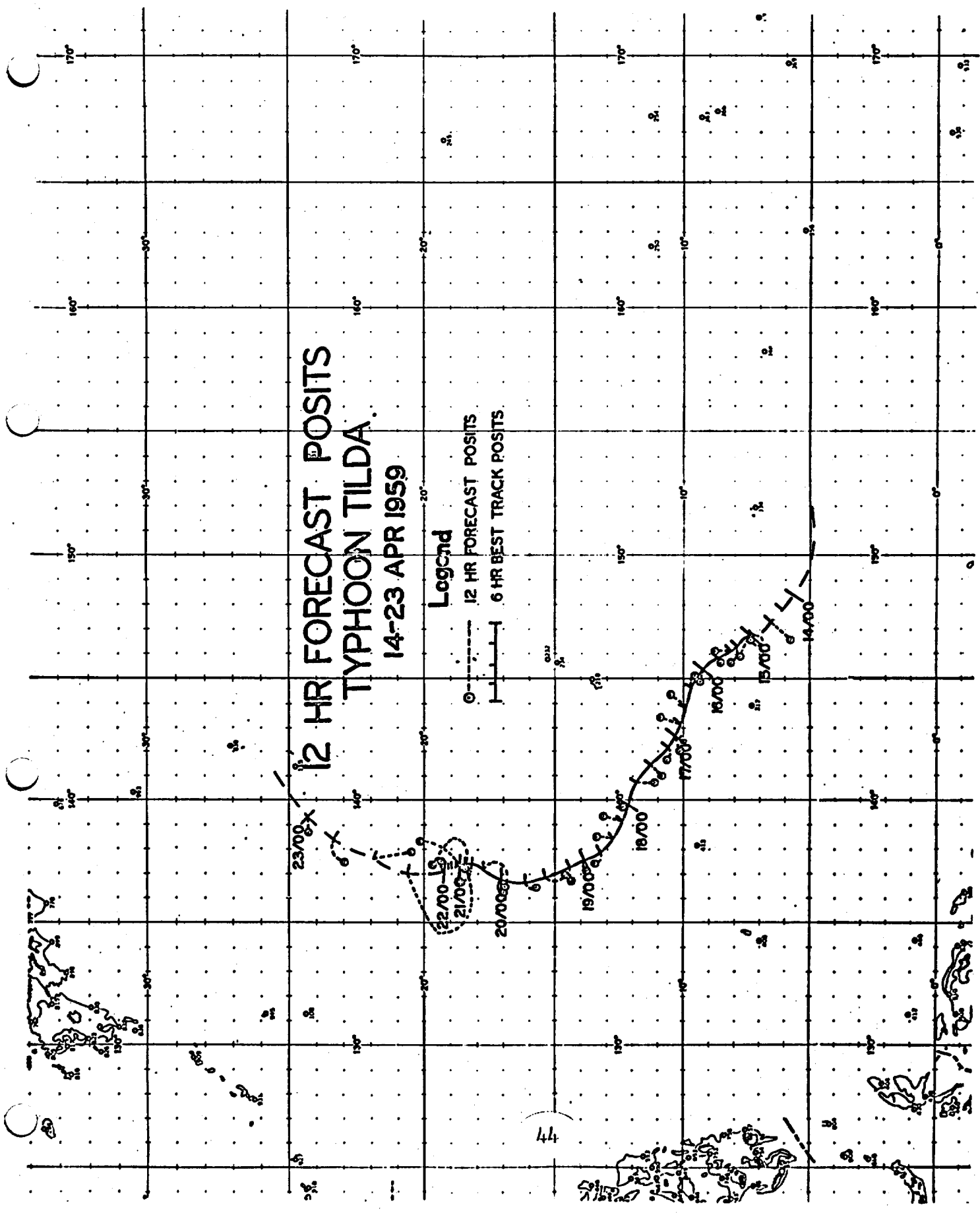
- - - INTENSITY < 64 KTS



12 HR FORECAST POSITS TYPHOON TILDA 14-23 APR 1959

Legend

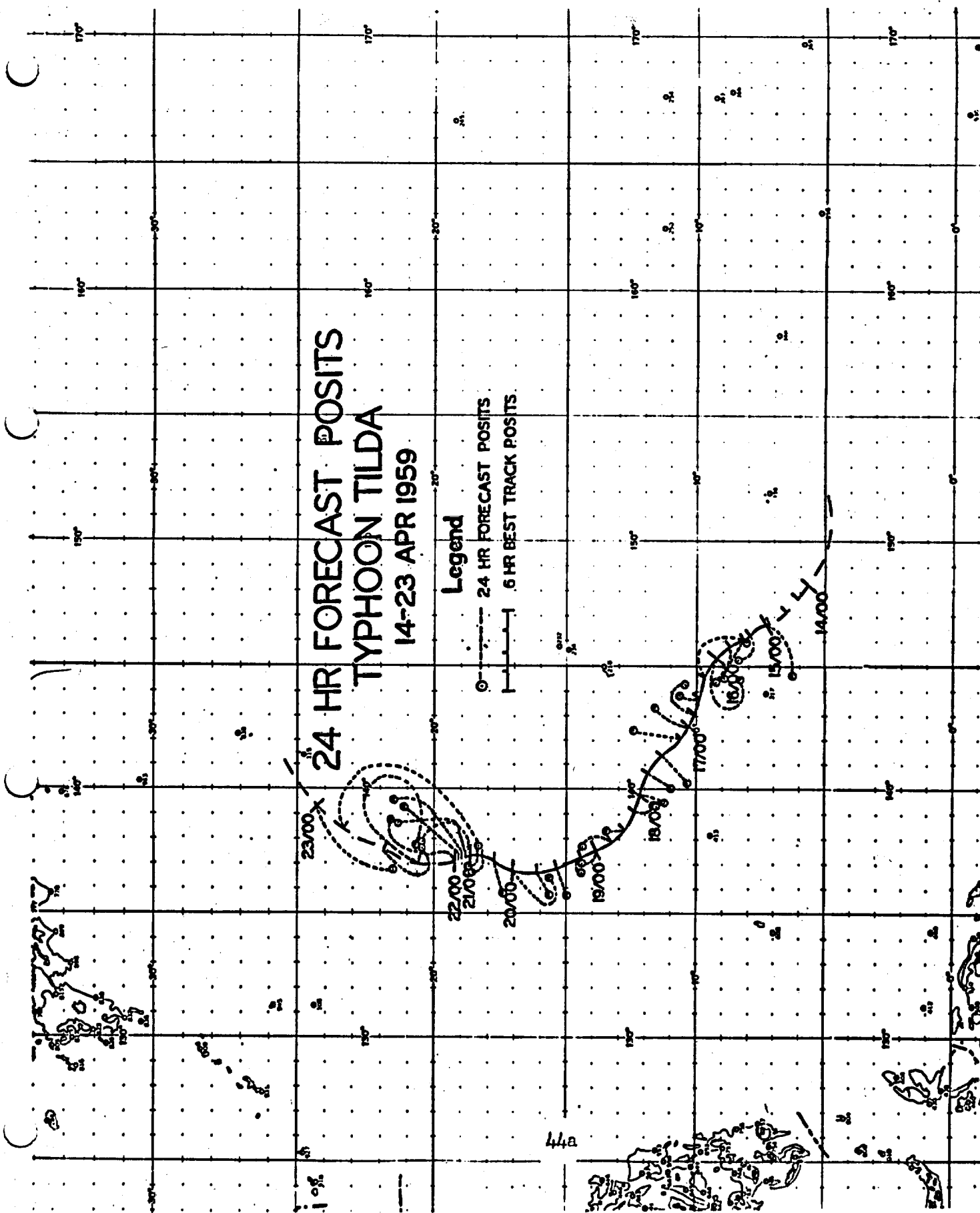
- --- 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS



24 HR FORECAST POSITS TYPHOON TILDA 14-23 APR 1959

Legend

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



44a

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."

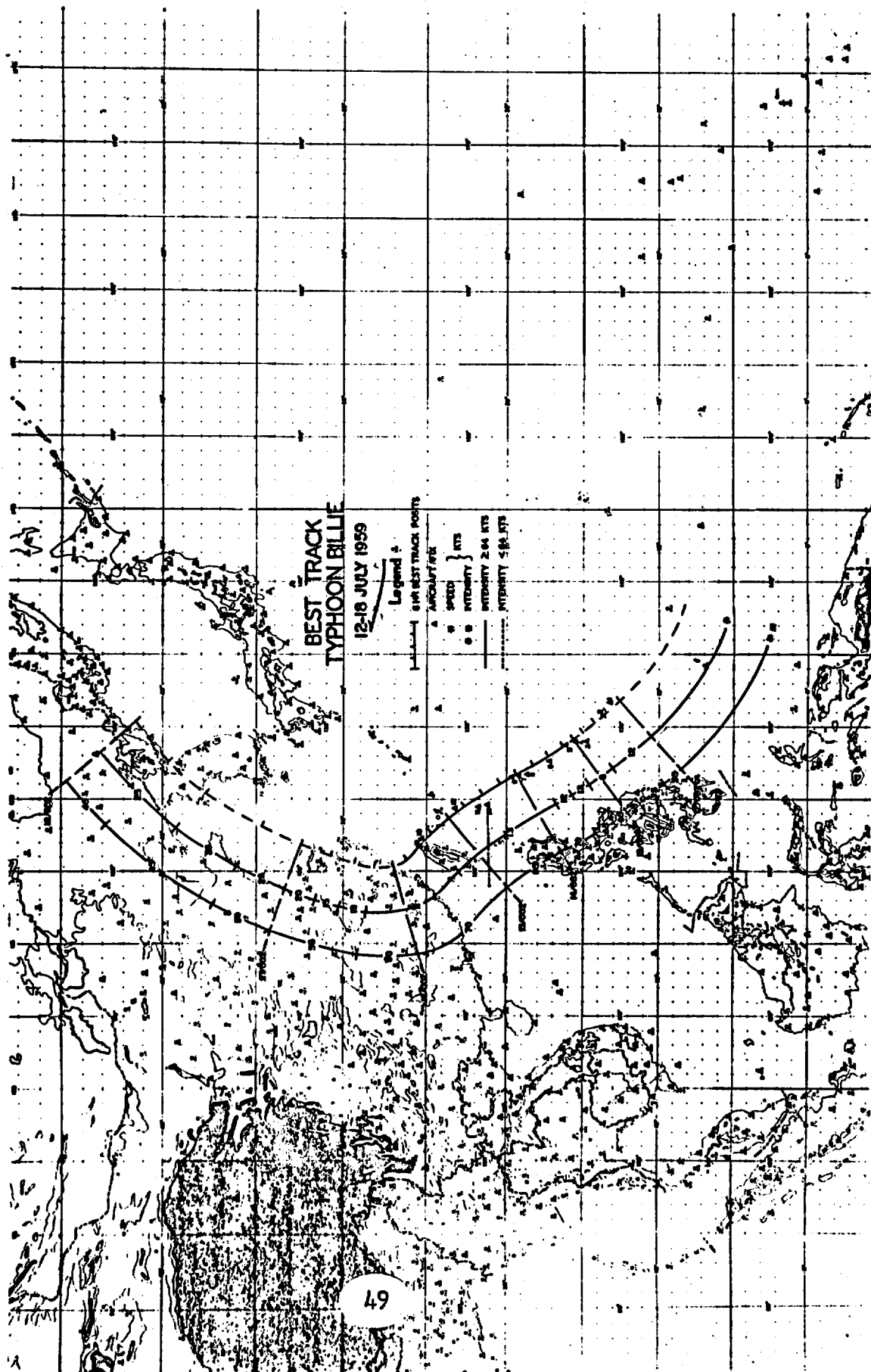
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON BILLIE

FTX NO.	TIME	LAT.	LONG.	#UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX			700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
								FLT	LVL	WND			
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	

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

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

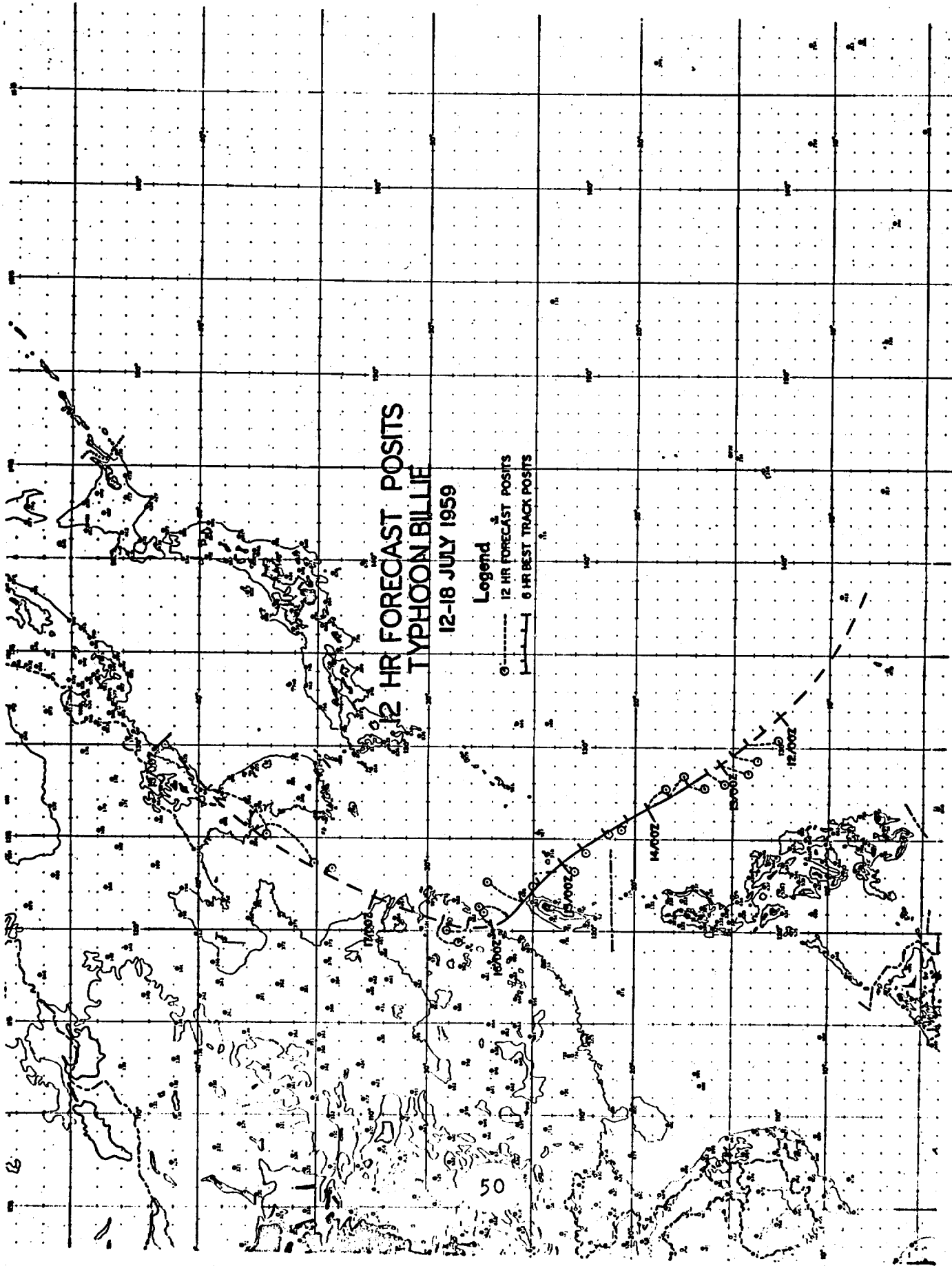


12 HR FORECAST POSITS
TYPHOON BILLIE

12-18 JULY 1959

Legend

- 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS

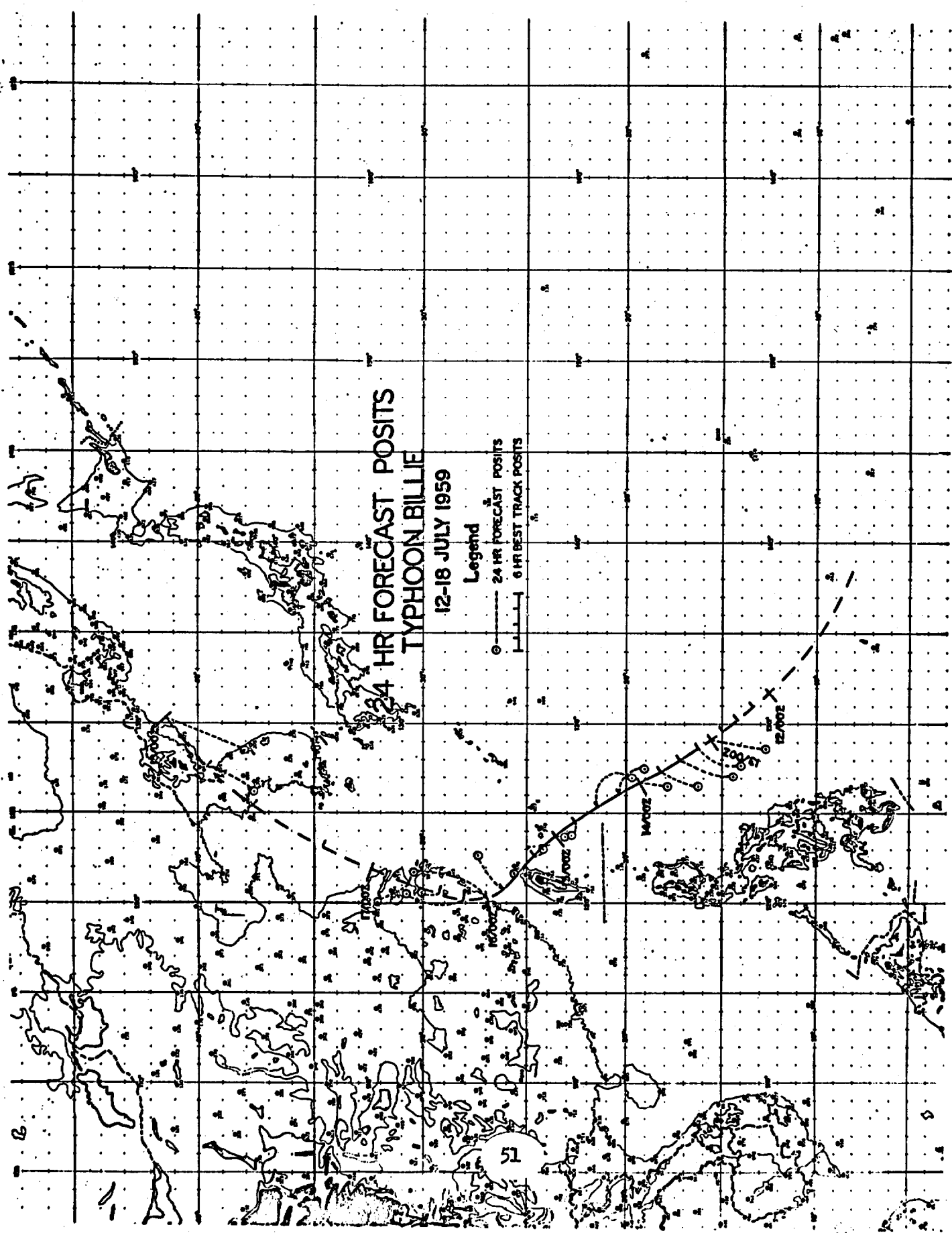


24 HR FORECAST POSITS
TYPHOON BILLIE

12-18 JULY 1959

Legend

- 24 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS



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 SRN 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.

$$\text{Wind max} = \left(20 - \frac{1}{5} \right) \sqrt{1010 - P_c}$$

(Where ϕ 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):

$$P_c = \frac{H_{700\text{mb}}}{28} + 638$$

(Where P_c is central pressure in mb, and $H_{700\text{mb}}$ 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 DOT 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</u> <u>NO.</u>	<u>DTG OF</u> <u>WARNING</u>	<u>WARNING</u> <u>BASIS</u>	<u>LAT</u> <u>(N)</u>	<u>LONG</u> <u>(W)</u>	<u>MOVEMENT</u> <u>DIR</u>	<u>SPD</u> <u>(KTS)</u>	<u>MAX</u> <u>WIND</u> <u>(KTS)</u>	<u>POSIT</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

[illegible]

甲子年 乙丑月 丙寅日
 丁卯月 戊辰日 己巳日

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 02-0600Z 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
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)

FIX NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN		MAX		MIN		MAX		700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
					SLP	MBS	SFC	WND	700MB HGT	LVL	WIND	WIND			
21	051300Z	29.0N	127.8E	54-T-20	--	--	--	--	--	--	--	--	--	--	CIRC DIA 75 MI
22	052130Z	29.1N	126.9E	54-P-10	974	--	75	--	9270	90	--	--	20	13	ELLIP 100X60 MI
23	052220Z	29.6N	128.2E	12-R-0	--	--	--	--	--	--	--	--	--	--	
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

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	32.3N	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
AVERAGE 24 HOUR FORECAST ERROR

74.7 NM
158.8 NM

BEST TRACK TYPHOON ELLEN 2-9 AUG 1959

Legend

6 HR BEST TRACK POSITS

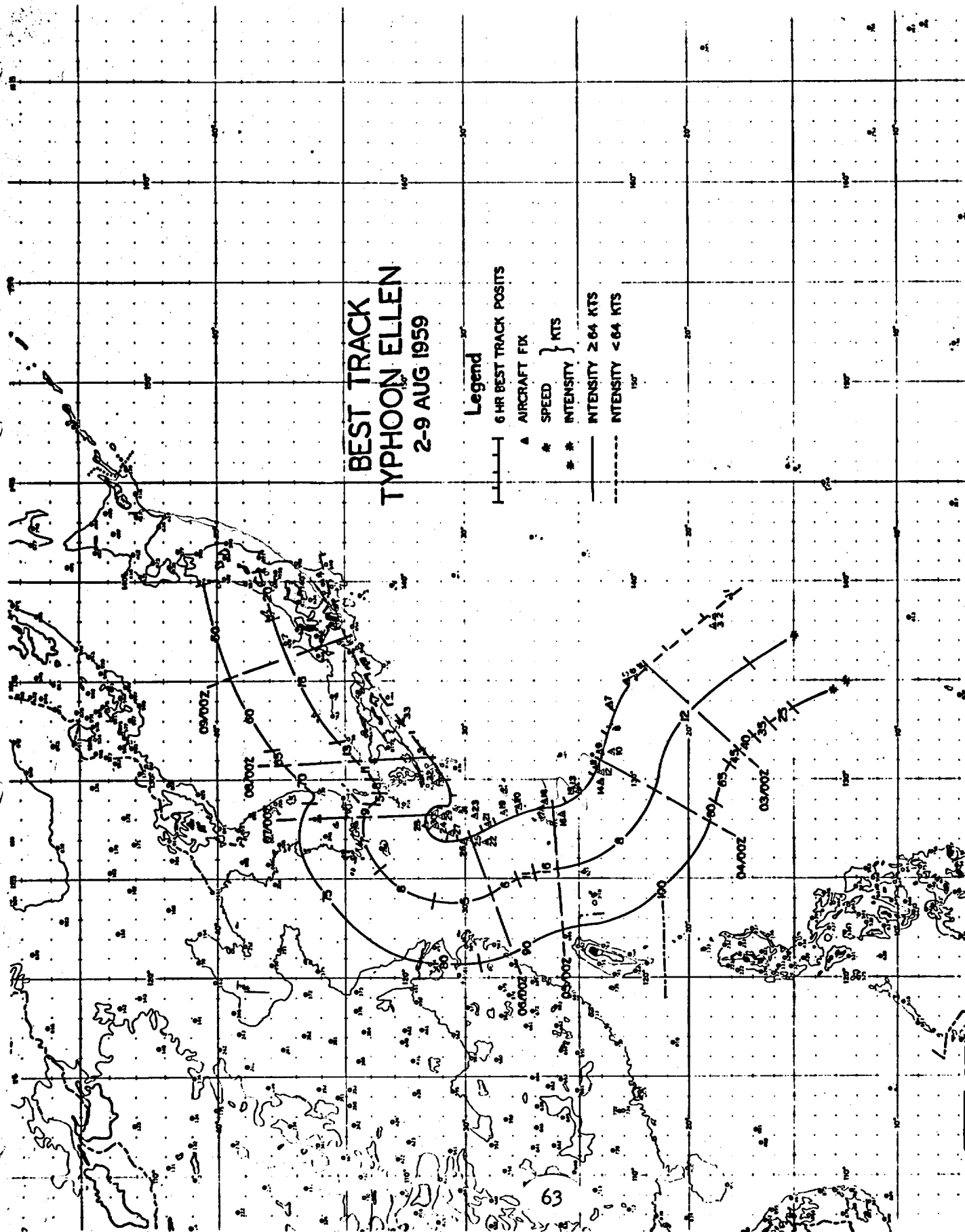
AIRCRAFT FIX

SPEED

INTENSITY KTS

INTENSITY ≥ 64 KTS

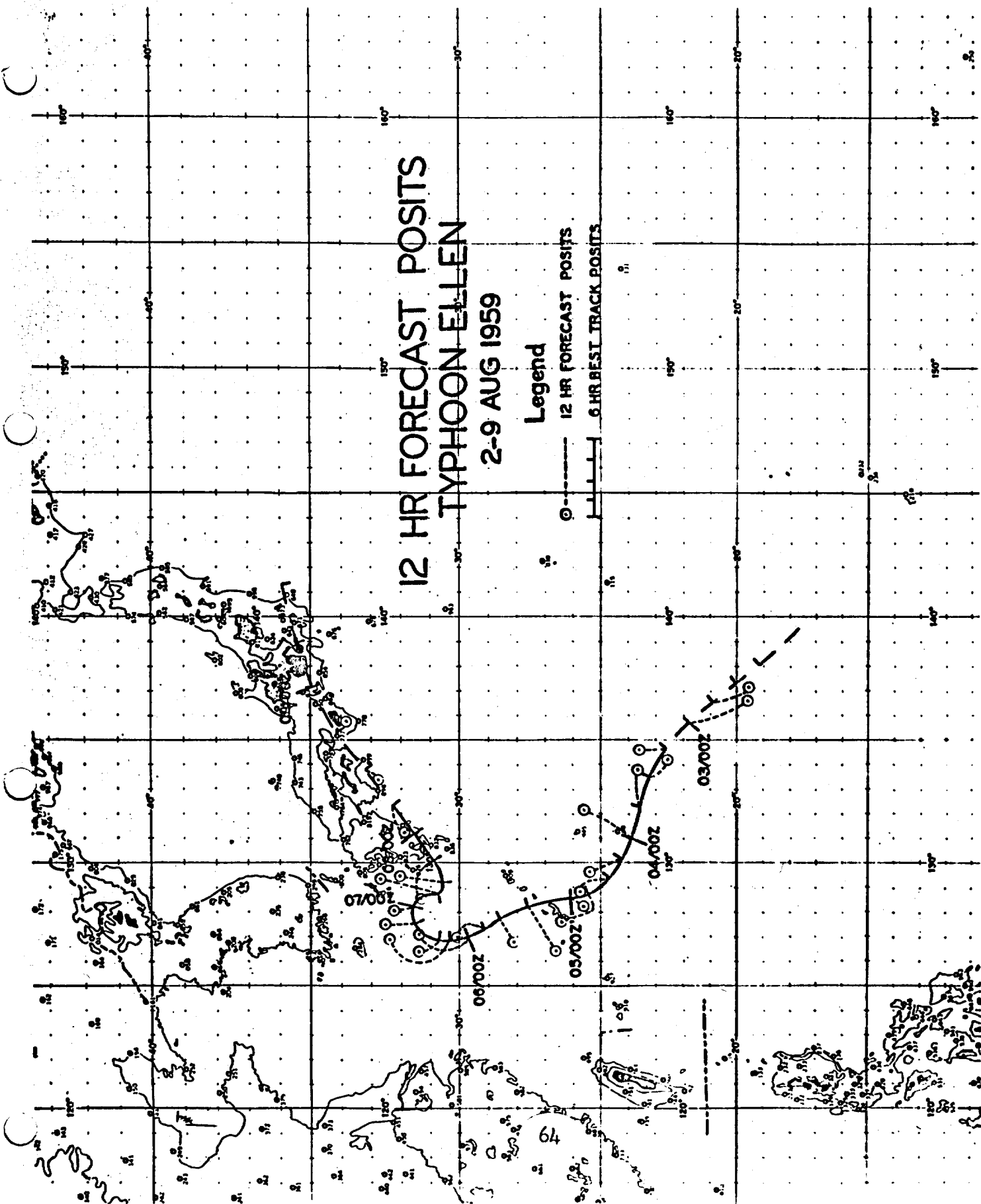
INTENSITY < 64 KTS



12 HR FORECAST POSITS TYPHOON ELLEN 2-9 AUG 1959

Legend

- 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS

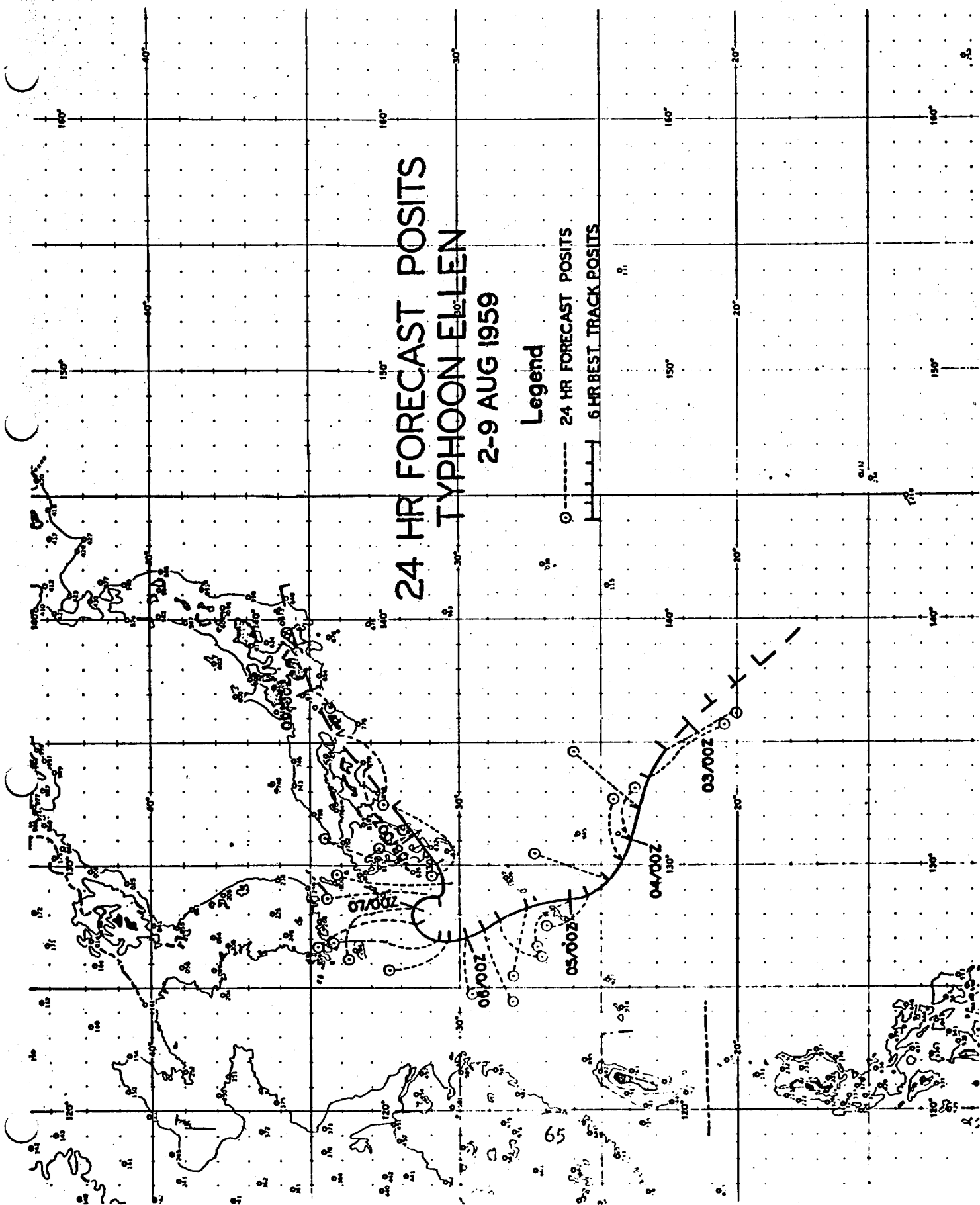


24 HR FORECAST POSITS TYPHOON ELLEN 2-9 AUG 1959

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			MAX			MAX			EYE CHARACTERISTICS
					SLP	MBS	WND	SFC	WND	HGT	700MB	TEMP	700MB	
												(°C)	DEPT	(°C)
1	120100Z	22.4N	145.2E	54-P-5	991		45	9860	40		11	11	11	CIRC DIA 25 MI
2	120905Z	23.4N	143.4E	54-P-15	968		65	9620	55		15	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	19	16	CIRC DIA 08 MI
5	130200Z	27.3N	140.8E	54-P-0	956		110	8960	60		20	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	16	15	CIRC DIA 25 MI

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

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

A AIRCRAFT FIX

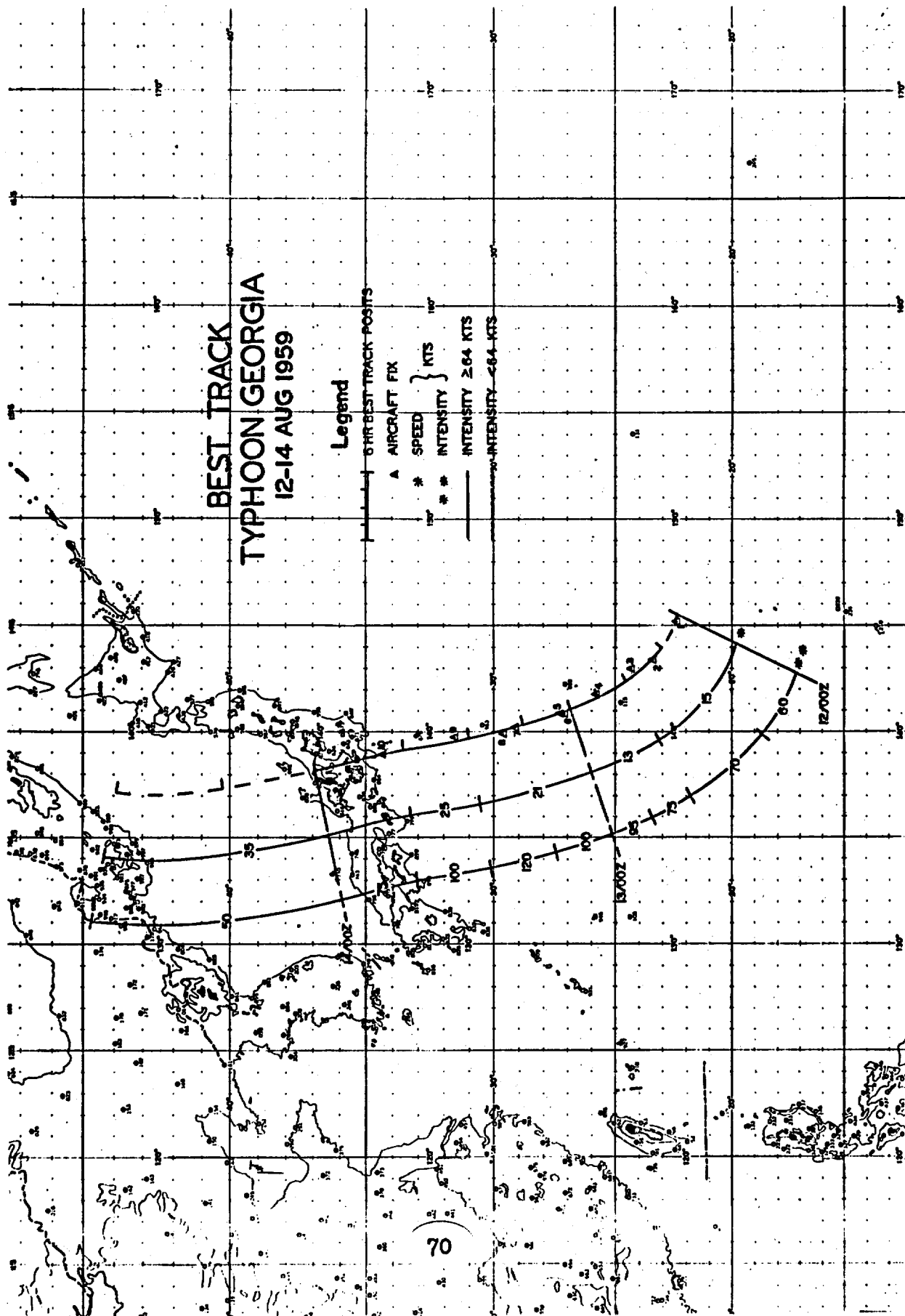
* SPEED

* INTENSITY

* KTS

INTENSITY ≥ 64 KTS

INTENSITY < 64 KTS



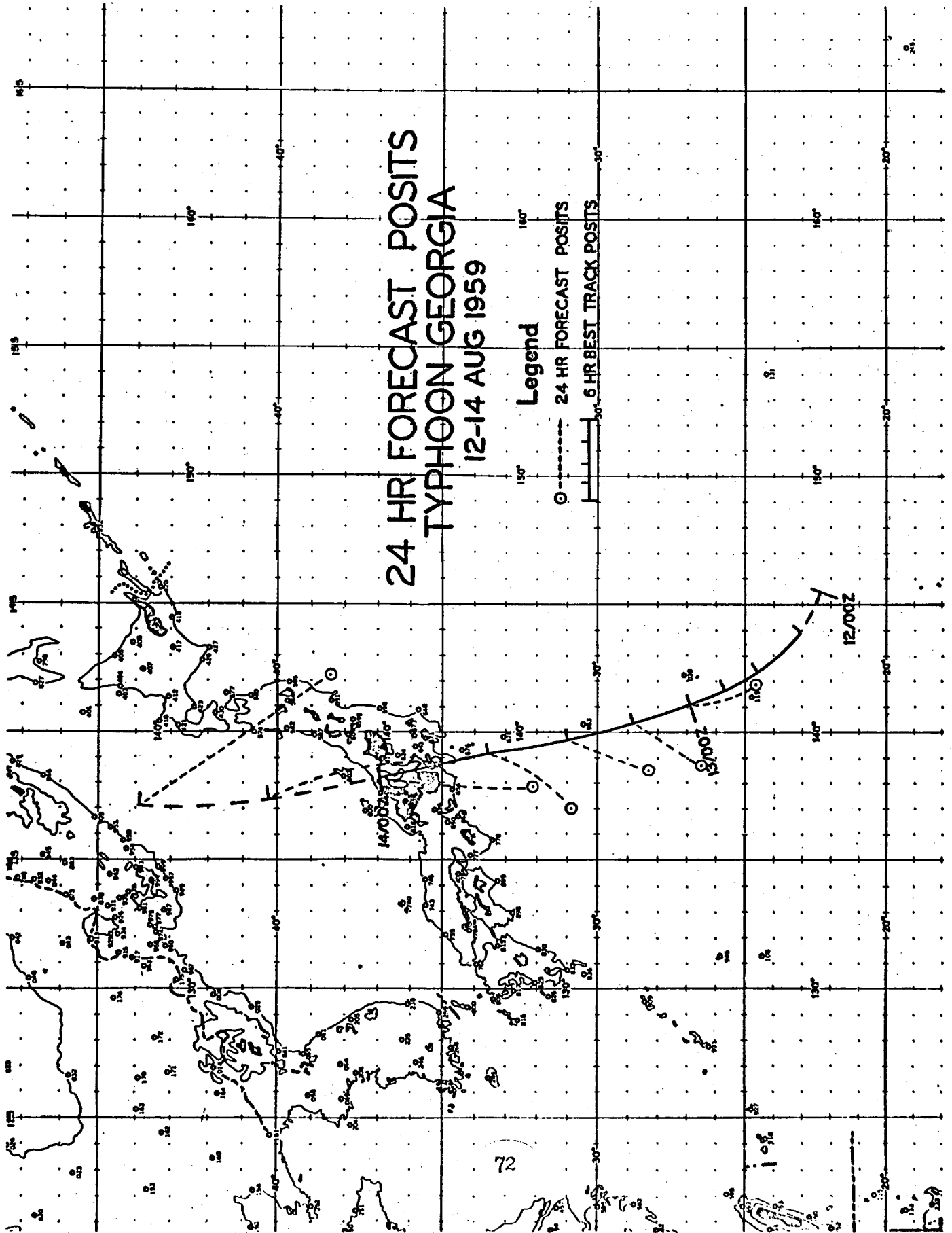
200/21
H-100

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			700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
								FLT LVL	WIND				
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	

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

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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		47.5 NM	
AVERAGE 24 HOUR FORECAST ERROR		123.8 NM	

BEST TRACK TYPHOON IRIS 19-23 AUG 1959

Legend

— 6 HR BEST TRACK POSITS

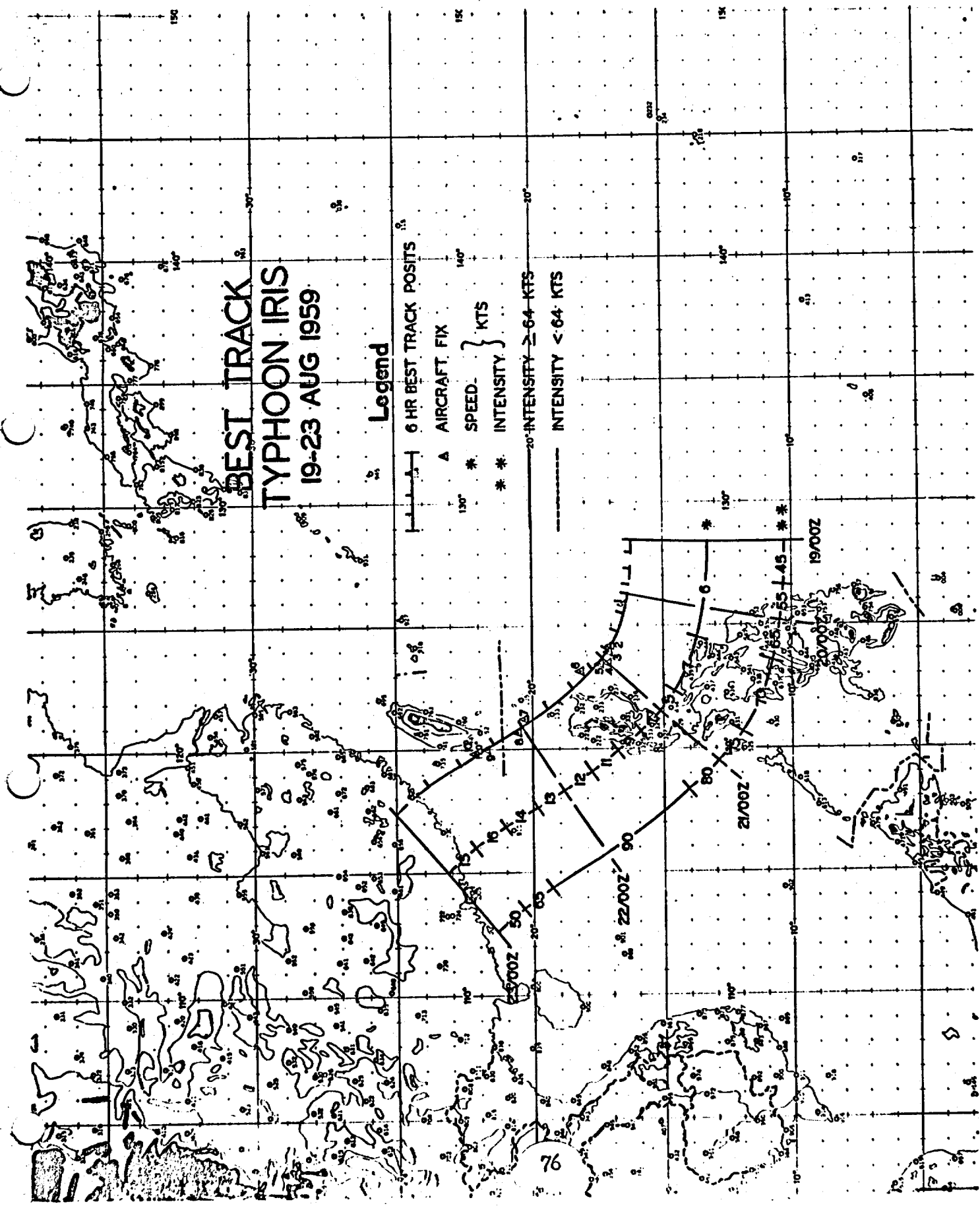
▲ AIRCRAFT FIX

* SPEED } KTS

* INTENSITY

— INTENSITY ≥ 64 KTS

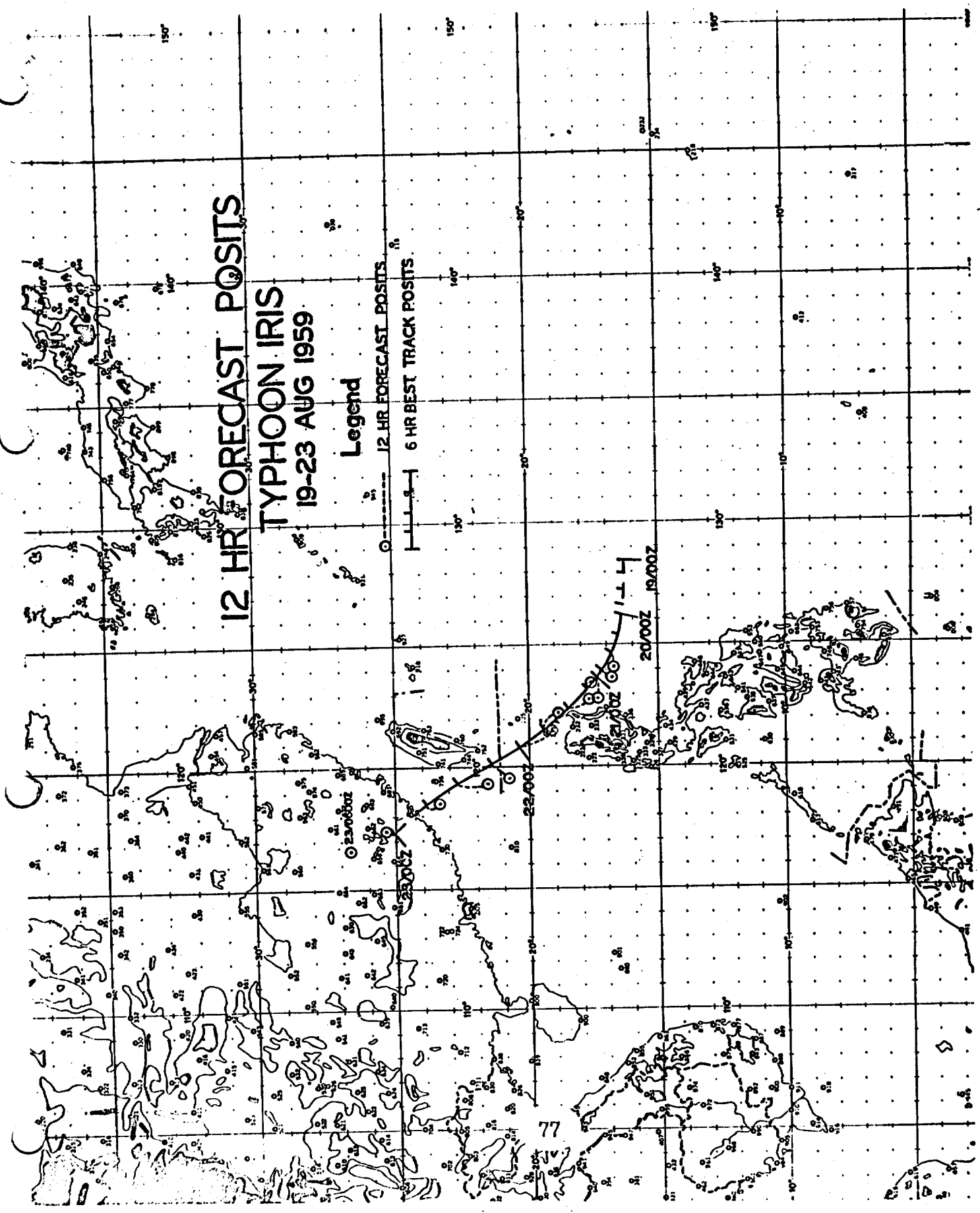
--- INTENSITY < 64 KTS



12 HR FORECAST POSITS
TYPHOON IRIS
19-23 AUG 1959

Legend

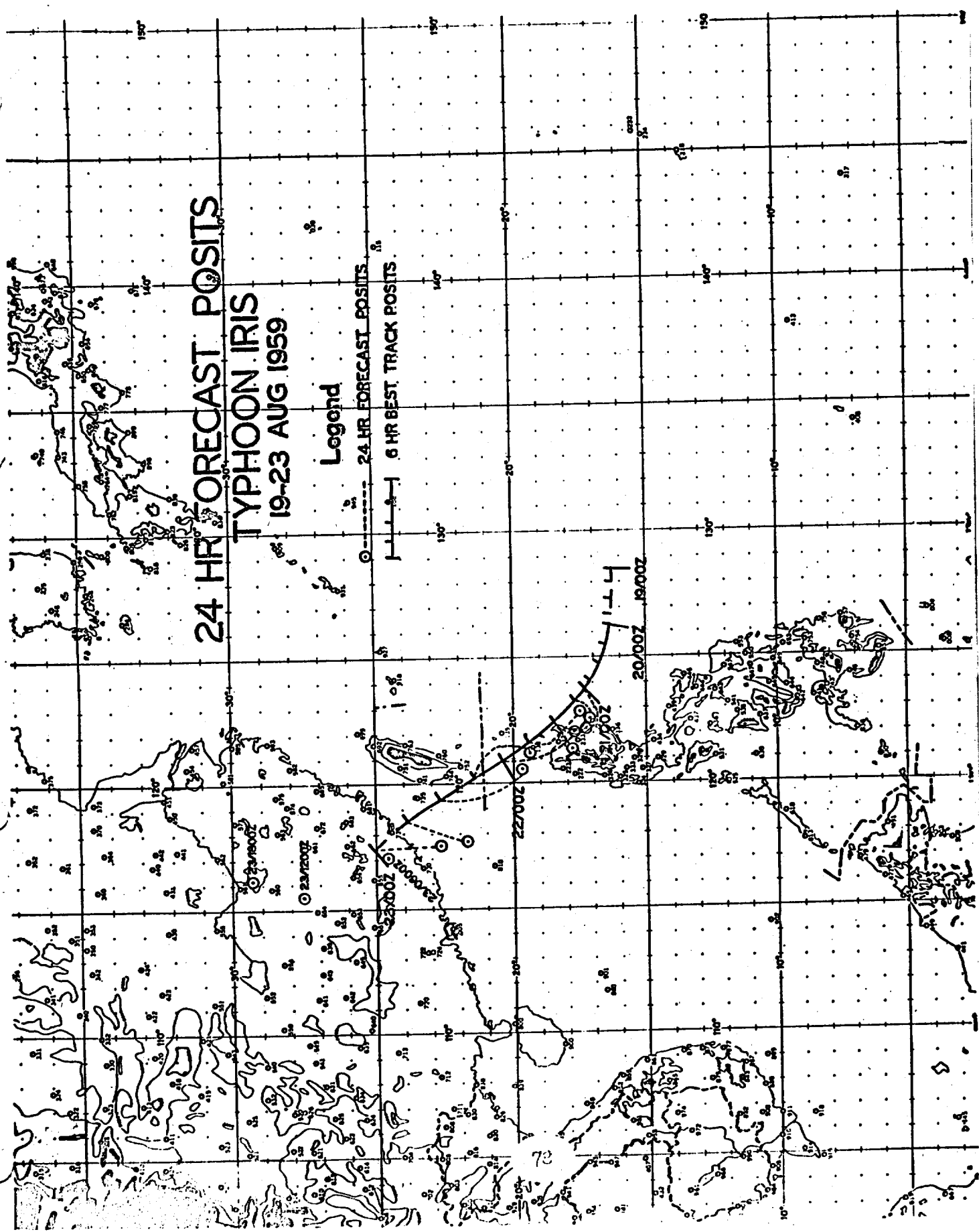
○-----○ 12 HR FORECAST POSITS
|---| 6 HR BEST TRACK POSITS



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

FLX NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCT	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX			700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
								FLT LVL	WIND				
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 NO.	TIME	LAT.	LONG.	#UNIT METHOD & ACCY	MIN		MAX		MIN		MAX		MAX		EYE CHARACTERISTICS	
					SLP	MBS	SFC	WND	HGT	700MB	FLT	TEMP	700MB	DEPPT		
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	--	--	--		

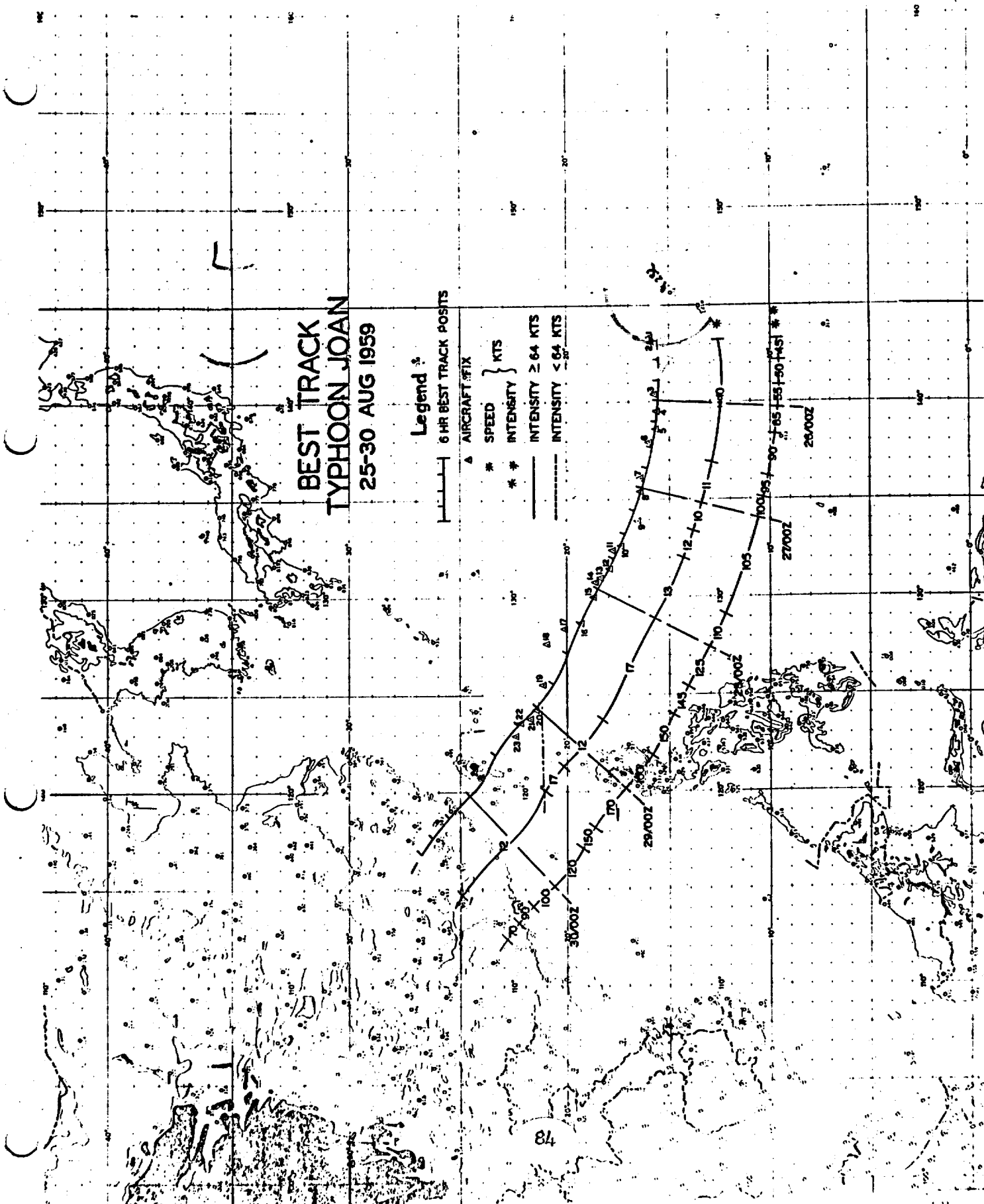
TYPHOON JOAN 25 - 30 AUGUST 1959
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

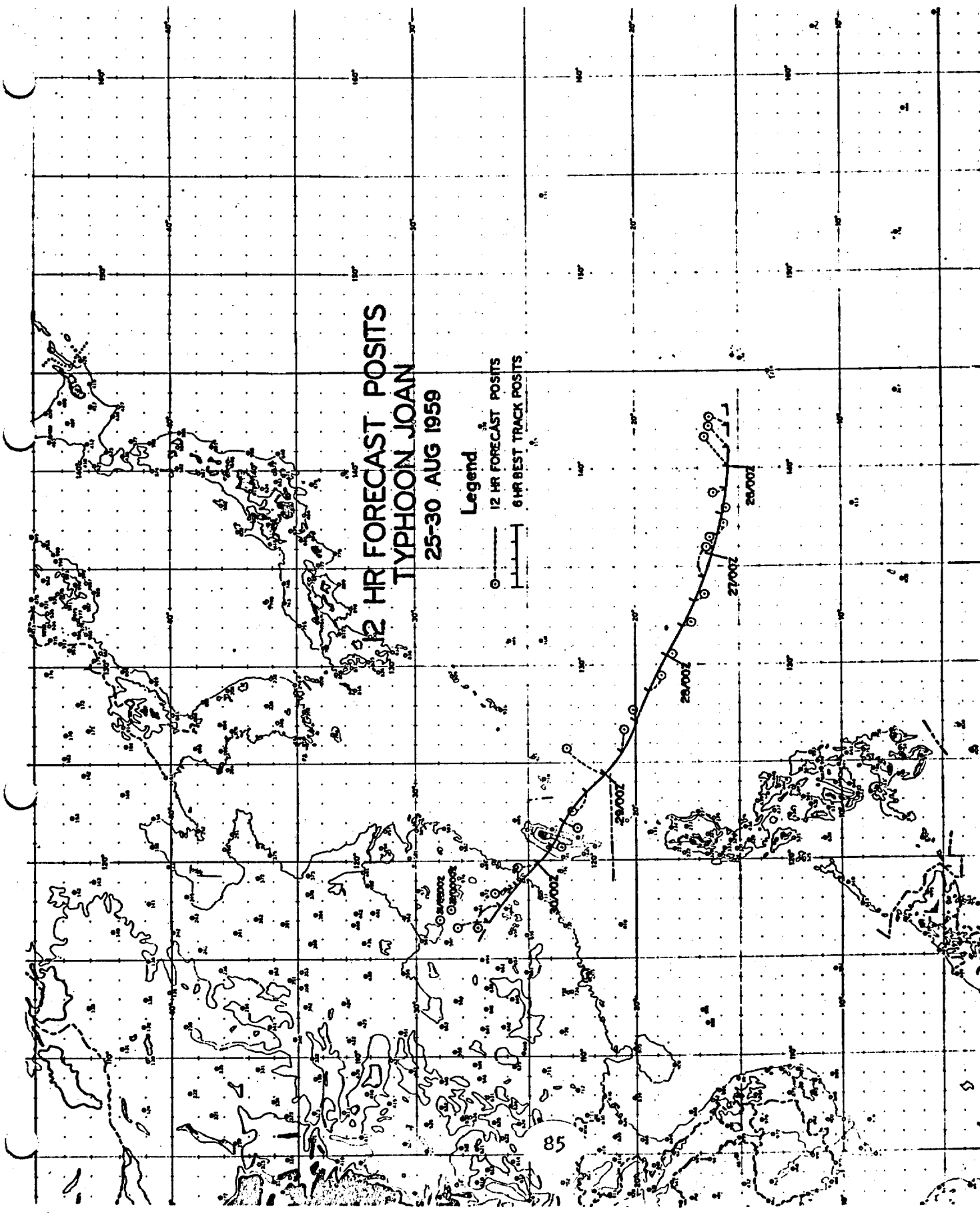
Legend

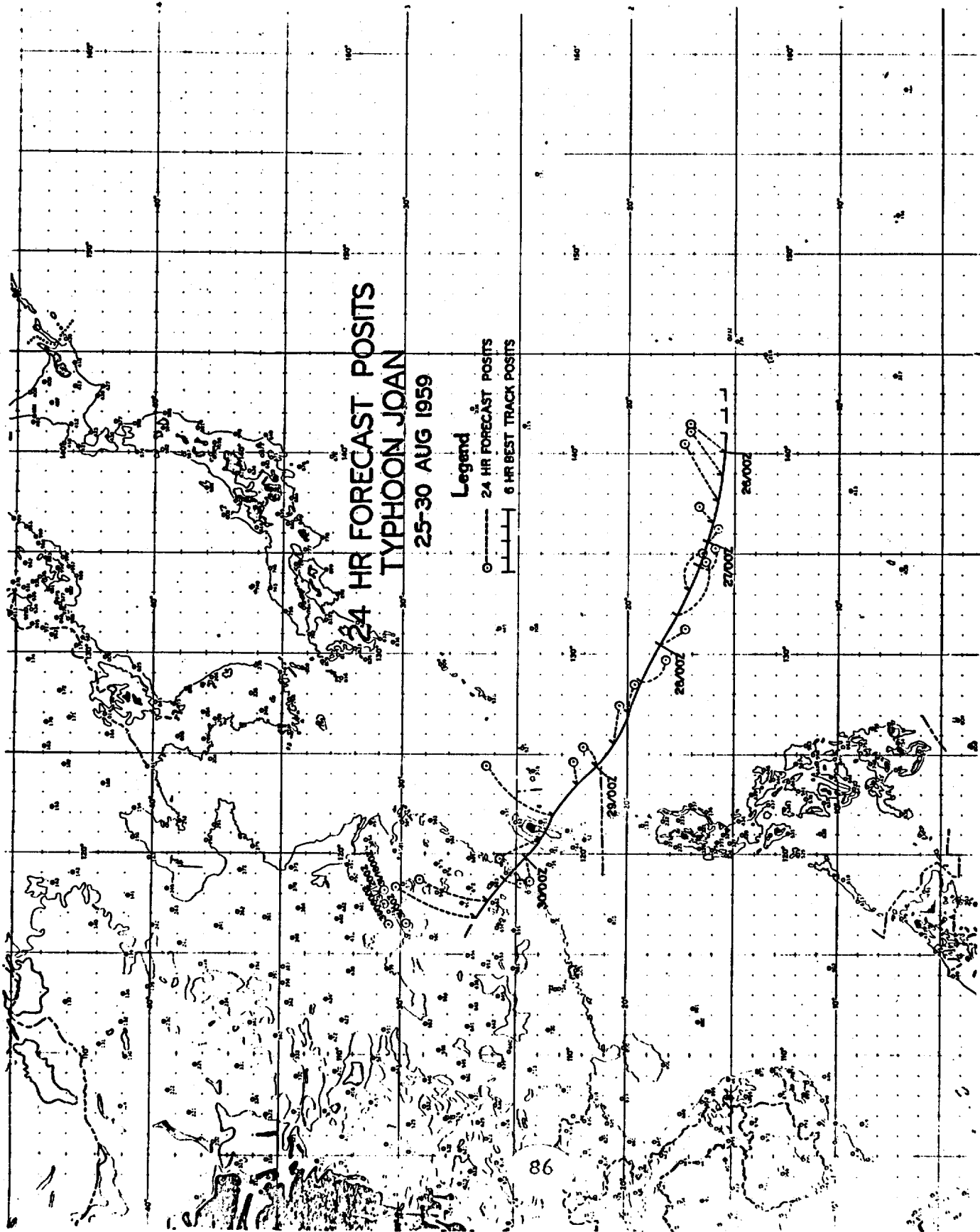
- 6 HR BEST TRACK POSITS
- AIRCRAFT FIX
- SPEED KTS
- INTENSITY
- INTENSITY ≥ 64 KTS
- INTENSITY < 64 KTS



12 HR FORECAST POSITS
TYPHOON JOAN
25-30 AUG 1959

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





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

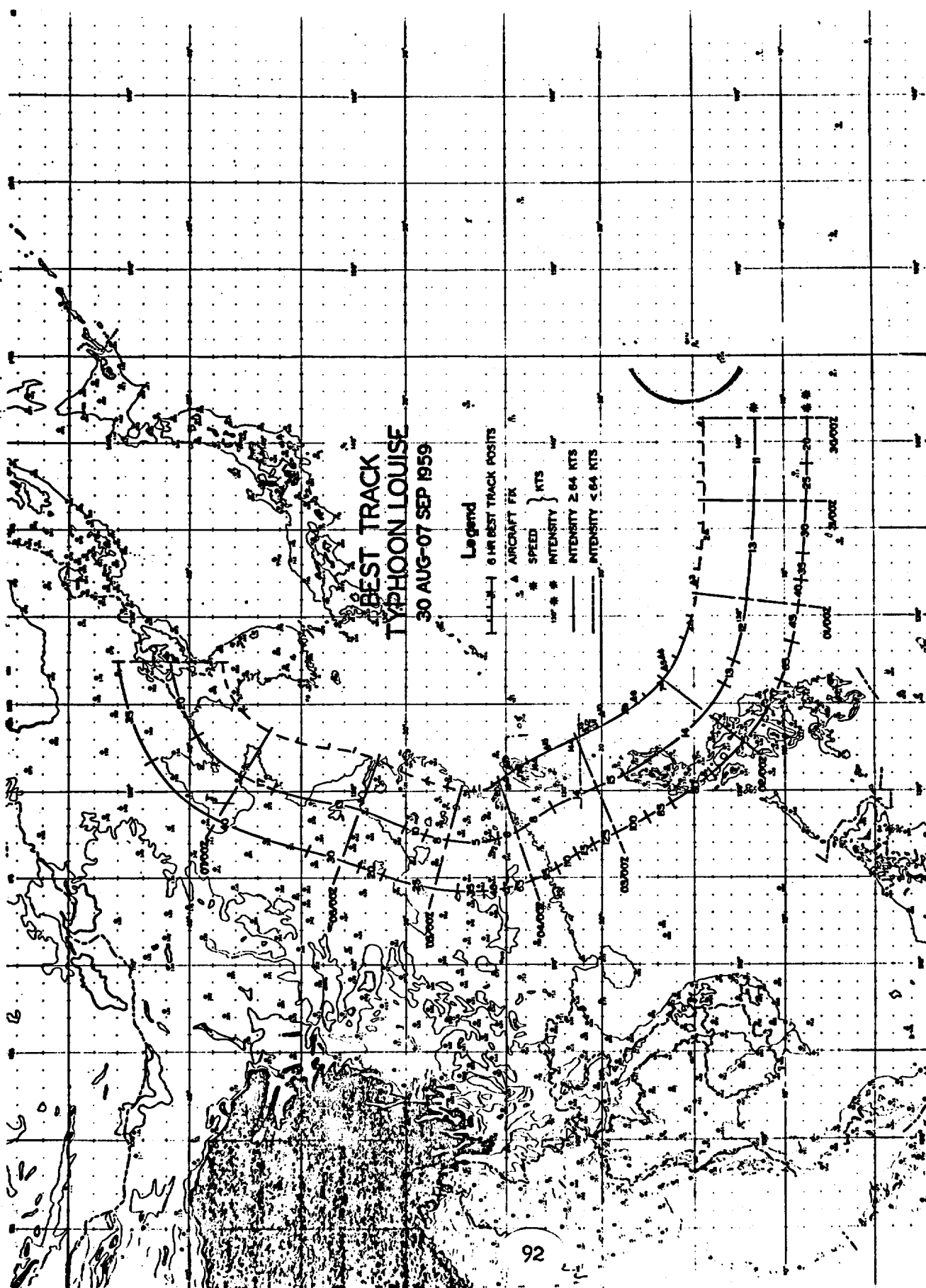
FIX NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN SLP	MAX SFC WND	MIN 700MB HGT	MAX			700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
								FLT	IVL	WND			
1	300030Z	14.5N	141.0E	54-P-5	1008	15	--	--	--	--	24	20	CNTR CALM
2	310645Z	14.3N	134.9E	54-P-5	1001	20	--	--	25	--	24	24	EYE DIFFUSE
3	312105Z	15.0N	131.9E	54-P-5	996	35	9950	45	--	--	11	08	WALL CIDS, 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	--	--	--	--	--	--	--	--	EYE INDEFINITE
18	032000Z	25.0N	121.4E	54-T-25	--	--	--	--	--	--	--	--	CIRC DIA 50 MI
19	032315Z	25.0N	120.7E	54-P-2	993	125	9940	--	--	--	11	11	CIRC DIA 100 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	- - - -	-	- - - -	-

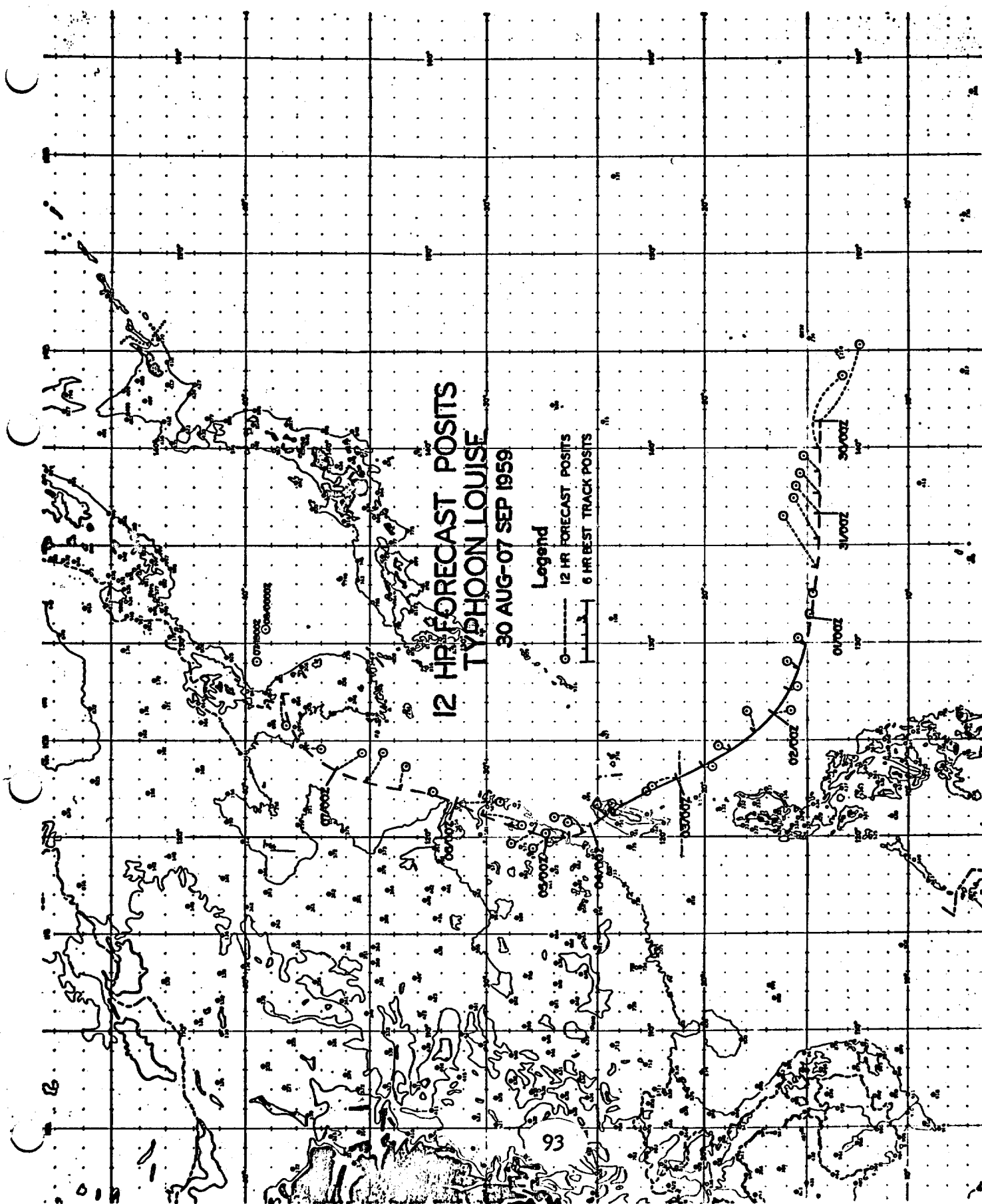
TYPHOON LOUISE 30 AUG - 07 SEPT 1959
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

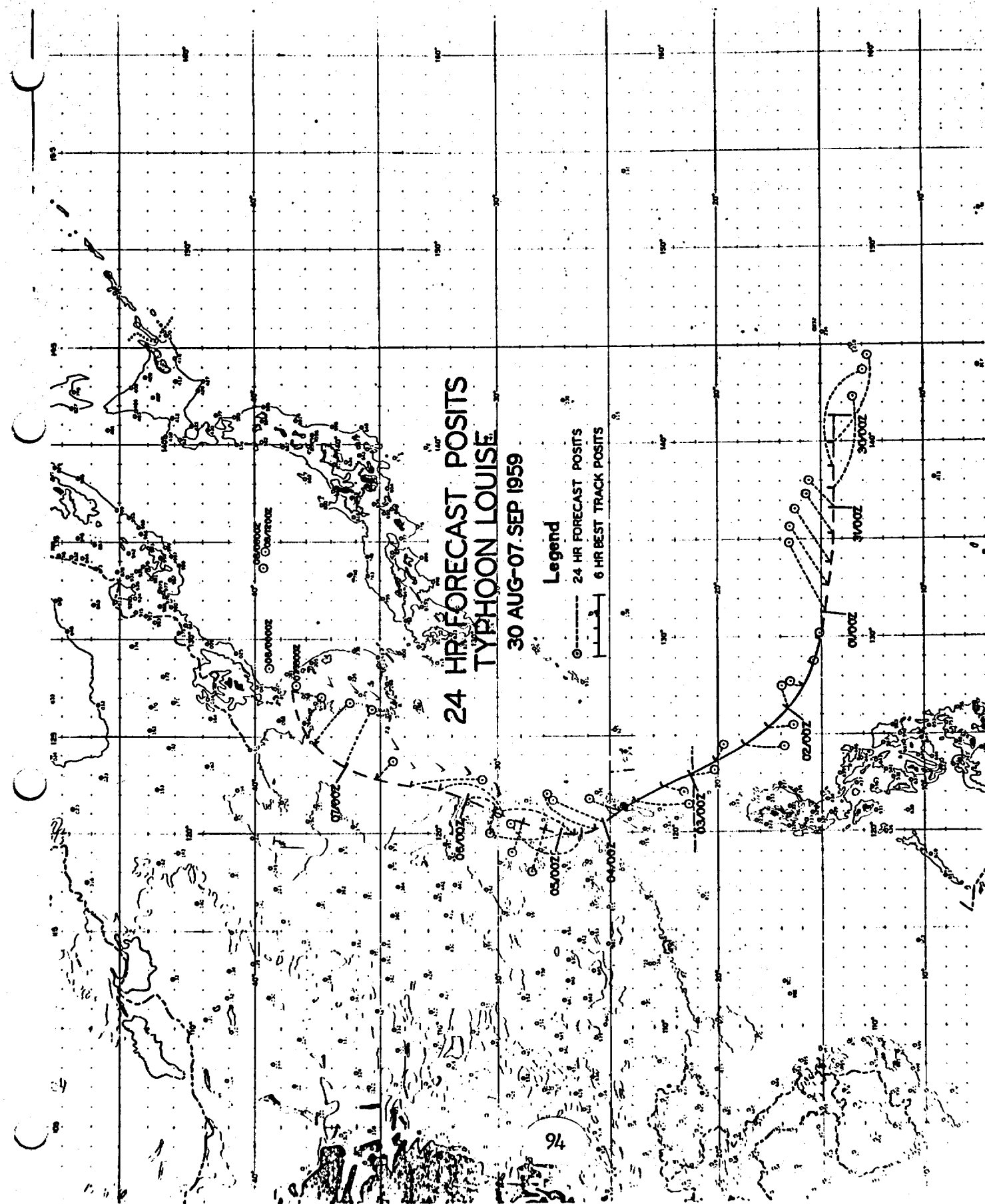
DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR DEG. DISTANCE
070000Z	36.3N 123.4E	----	----
070600Z	37.7N 124.7E	----	----
071200Z	38.5N 127.0E	----	----
AVERAGE 12 HOUR FORECAST ERROR		46.8 NM	
AVERAGE 24 HOUR FORECAST ERROR		114.6 NM	



**BEST TRACK
TYPHOON LOUISE
30 AUG-07 SEP 1959**

- Legend**
- 6 HR BEST TRACK POSITS
 - ▲ AIRCRAFT FIX
 - * SPEED KTS
 - INTENSITY KTS
 - 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, JTWIC 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	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--	--	--	--	--	--	--	

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

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

1 6 HR BEST TRACK POSITS

A AIRCRAFT FIX

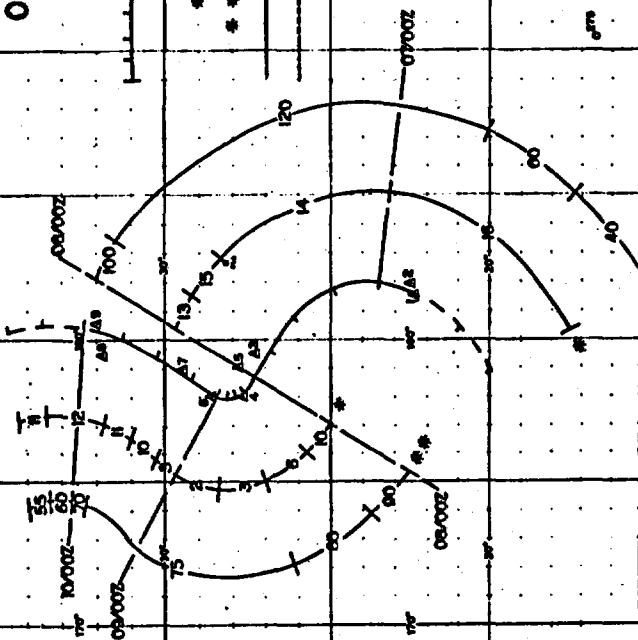
* SPEED

* INTENSITY

* KTS

— INTENSITY ≥ 64 KTS

- - - INTENSITY < 64 KTS

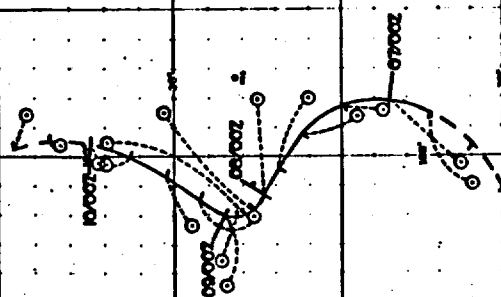


12 HR FORECAST POSITS TYPHOON PATSY

06-10 SEP 1959

Legend

- 12 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS



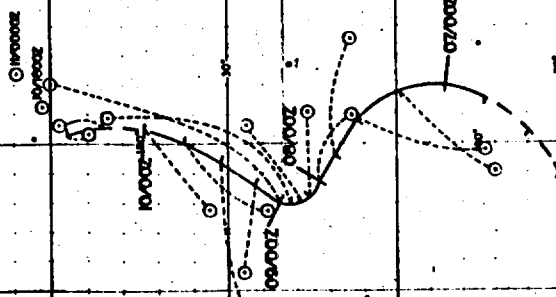
100

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 WIND	MIN 700MB HGT	MAX FLT LVL WIND	700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
1	110200Z	13.6N	146.2E	54-P-10	1008	35	--	--	--	--	CNTR OVC HVI 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 30 MI
14	132307Z	19.6N	130.0E	12-R-15	--	--	--	--	--	--	OBLONG 35 MI WIDE
15	140225Z	19.8N	129.3E	54-P-2	--	--	8230	100	20	14	CIRC DIA 20 MI
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

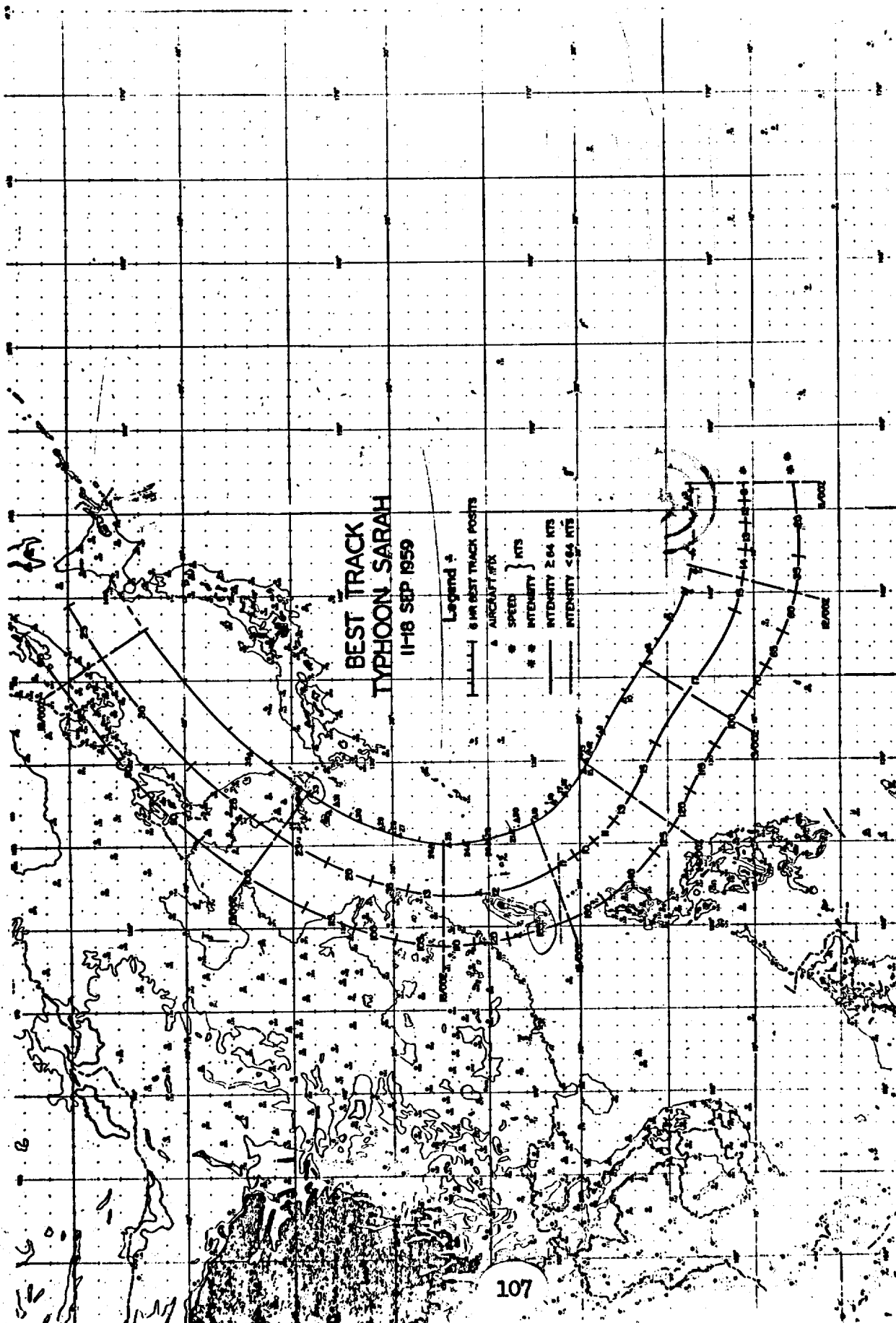
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON SARAH (CONT'D)

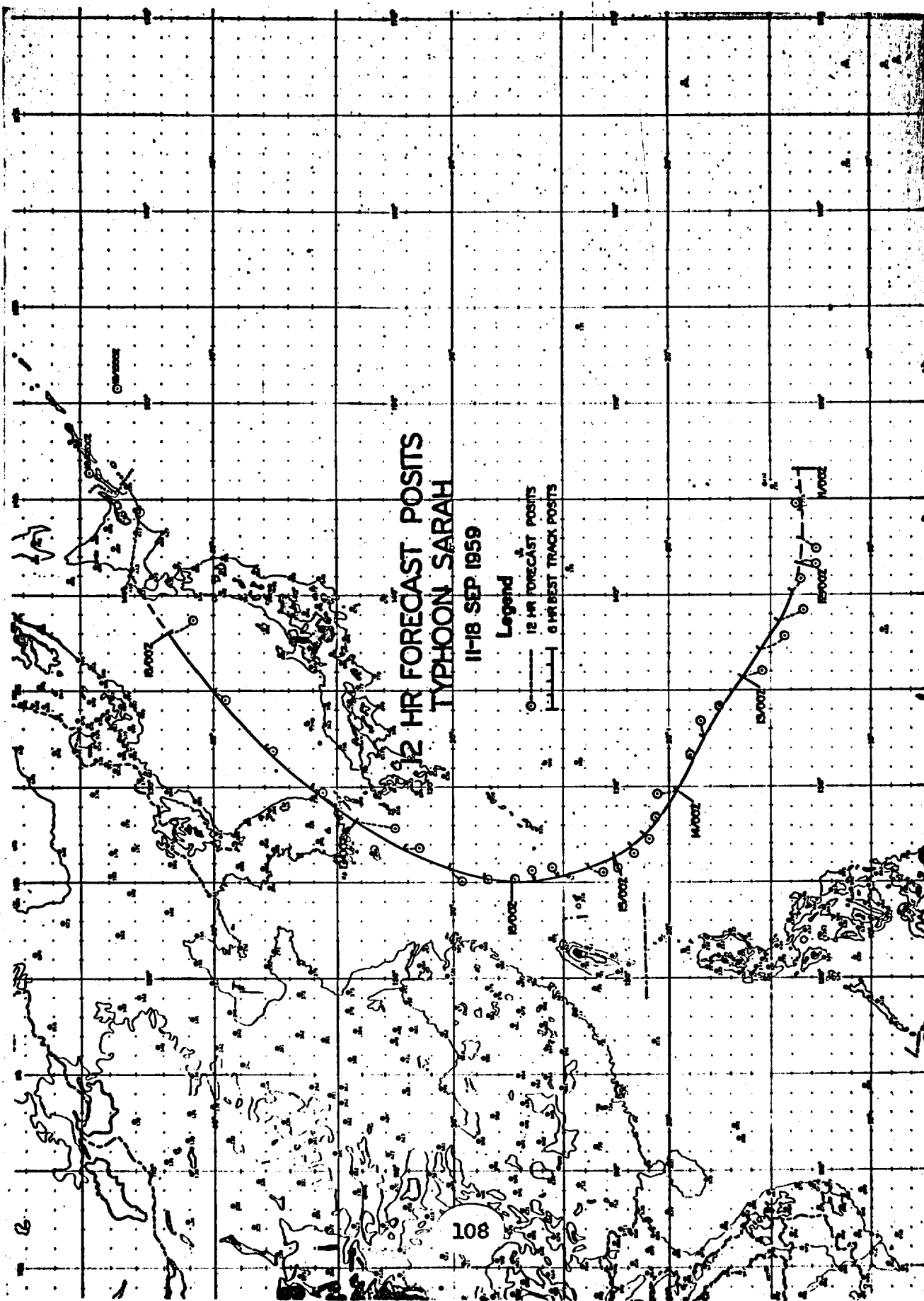
FIX NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX FLT LVL WND	700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
20	150156Z	23.4N	126.3E	56-P-5	905	130	--	--	--	--	CIRC DIA 15 MI
21	150540Z	23.8N	125.8E	56-R-5	--	--	--	--	--	--	CIRC DIA 25 MI
22	151110Z	25.0N	125.2E	12-R-10	--	--	--	--	--	--	ELLIP 20x15 MI
23	151230Z	25.0N	125.1E	54-R-3	--	--	--	--	--	--	CIRC DIA 20 MI
24	151853Z	26.1N	125.0E	56-R-10	--	--	--	--	--	--	CIRC DIA 23 MI
25	152309Z	27.1N	125.0E	12-R-2	--	--	--	--	--	--	CIRC DIA 25 MI
26	160342Z	28.0N	124.9E	56-P-5	930	--	8330	--	15	15	CIRC DIA 20 MI
27	161030Z	29.7N	125.6E	54-P-5	936	--	8340	90	19	15	DIA 20 MI
28	161100Z	30.0N	125.6E	12-R-15	--	--	--	--	--	--	CIRC 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	--	--	--	--	--	--	CIRC DIA 20 MI
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	912	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	- - - -	- - - -

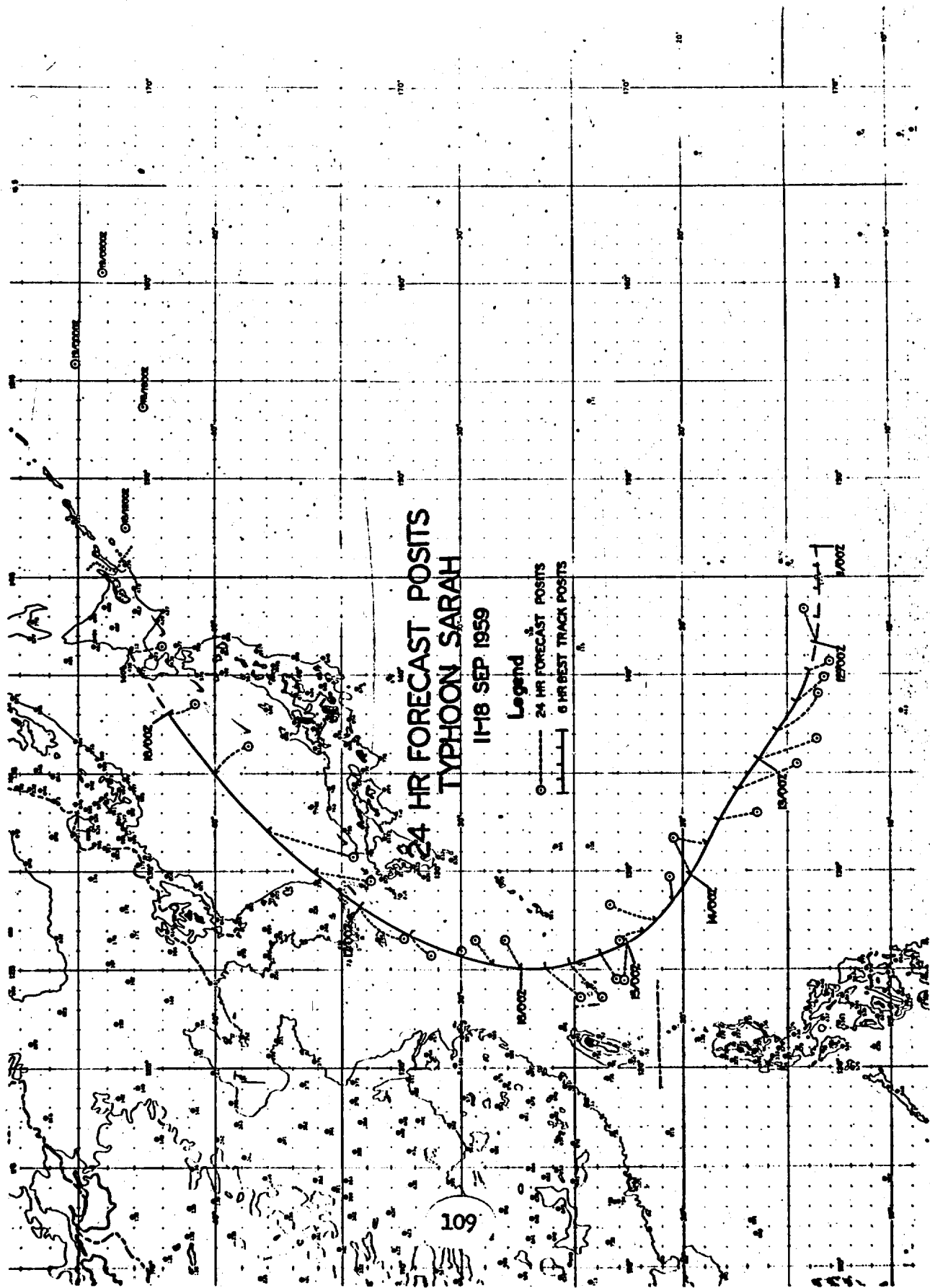
AVERAGE 12 HOUR ERROR 43.8 NM
AVERAGE 24 HOUR ERROR 105.9 NM





12 HR FORECAST POSITS
TYPHOON SARAH
11-18 SEP 1959

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



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.

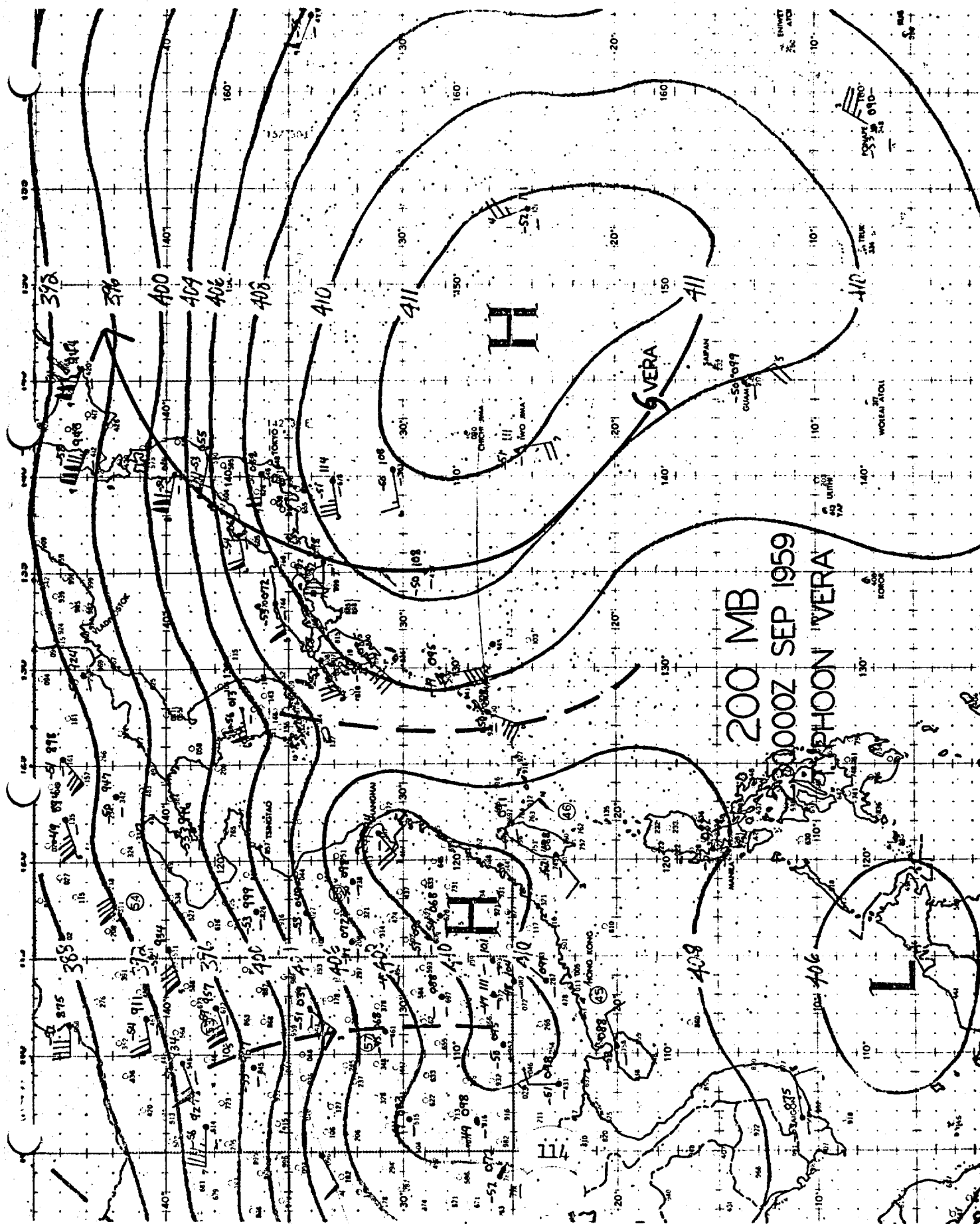
Typhoon VERA reached her peak intensity early in her history, and did not weaken appreciably until reaching well into northern latitudes. This may be attributed in part to strong divergence aloft which accompanied VERA until she moved into the Zonal Westerlies over Japan. As VERA moved northeastward 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."

DATE 26-27 SEPTEMBER 1959

113



RECONNAISSANCE AIRCRAFT FIXES - TYPHOON VERA

FIX NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WIND	MIN 700MB HGT	MAX FLT LVL	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

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON VERA (CONT'D)

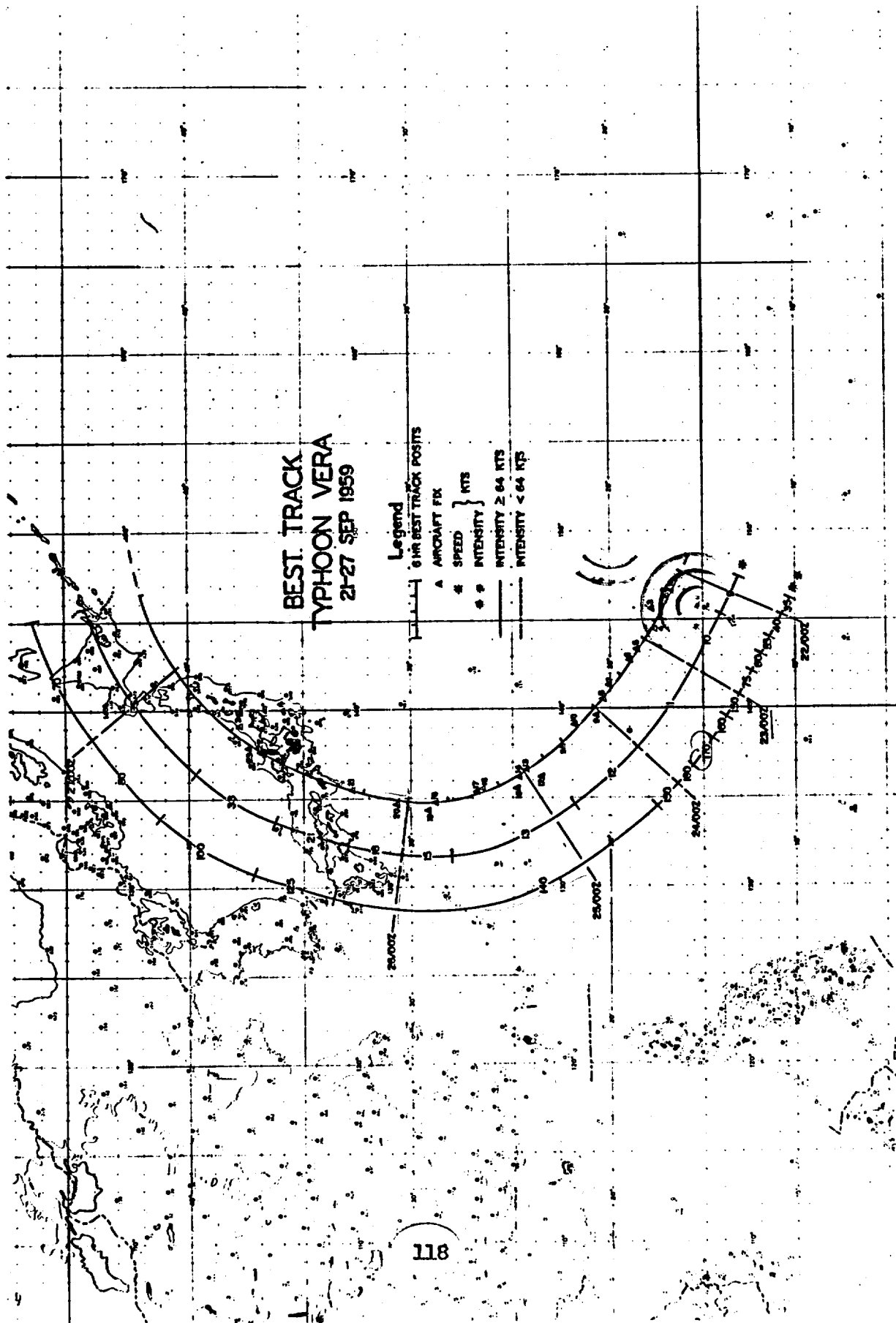
FIX NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WIND	MIN 700MB HGT	MAX		700MB TEMP (°C)	700MB DEPT (°C)	EYE CHARACTERISTICS
								FLT LVL	WIND			
20	260200Z	30.7N	134.7E	54-P-10	929	160	8010	100		20	17	EYE INDEFINITE
21	260800Z	32.8N	135.5E	54-P-2	926	100	8020	150		18	18	CIRC DIA 20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

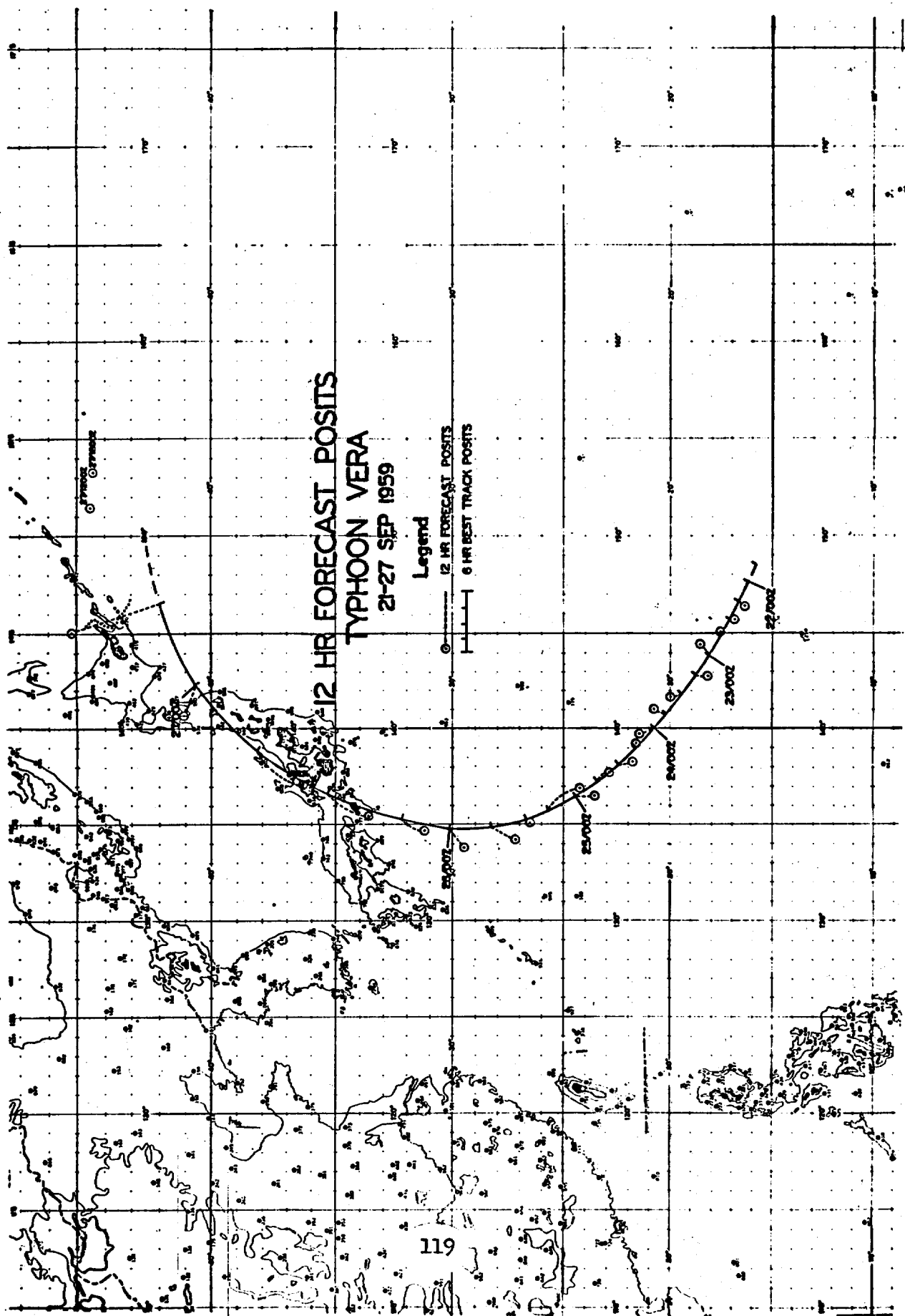
TYPHOON VERA 21 - 27 SEPT. 1959
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

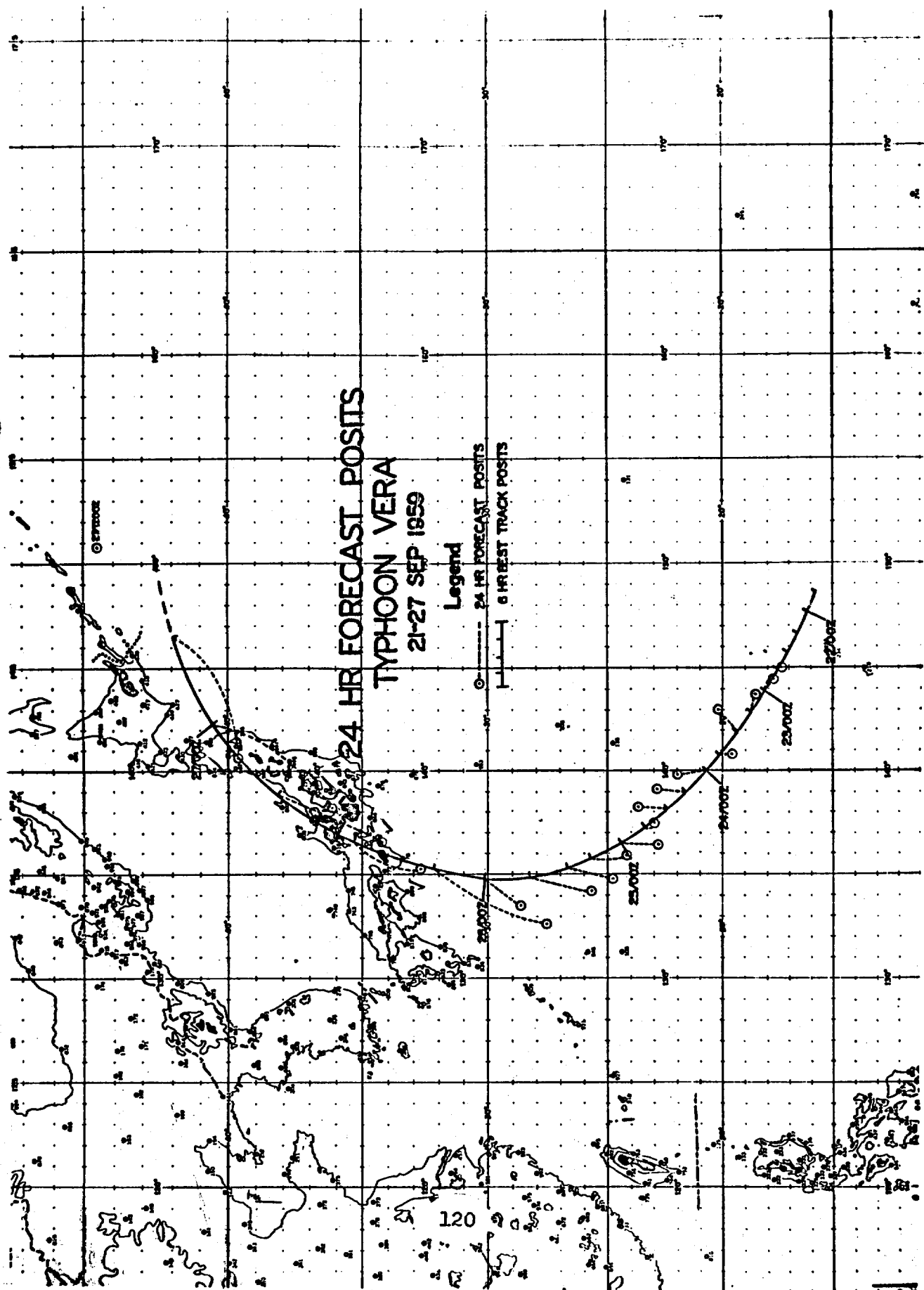
Legend
 6 HR BEST TRACK POSITS
 AIRCRAFT FIX
 SPEED } KTS
 INTENSITY }
 INTENSITY ≥ 64 KTS
 INTENSITY < 64 KTS





12 HR FORECAST POSITS
TYPHOON VERA
21-27 SEP 1959

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



L. TYPHOON AMY (3-7 OCTOBER 1959)

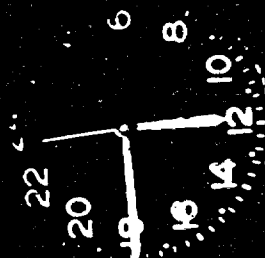
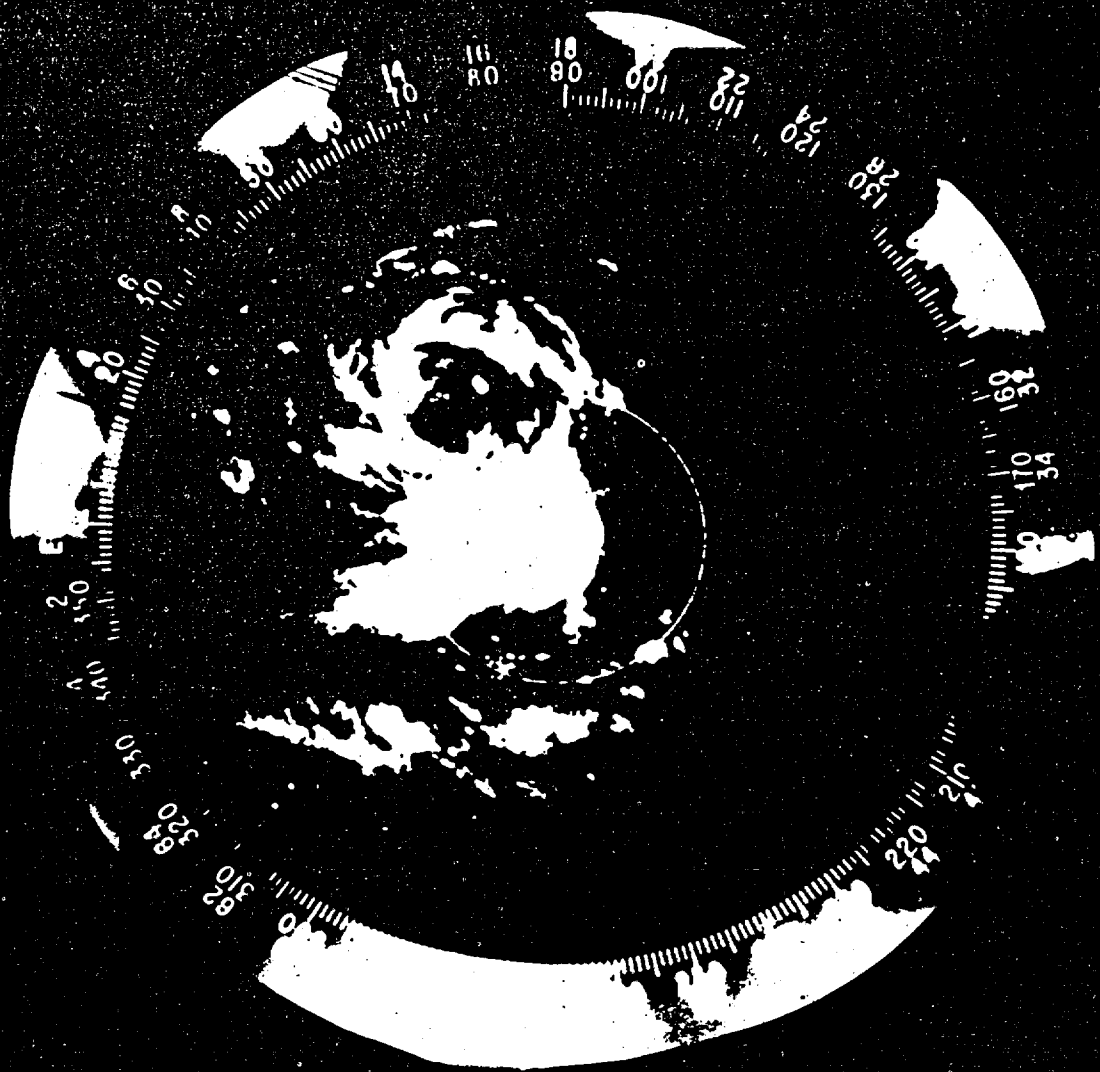
On 1 October, a weak cyclonic circulation on the Intertropical Convergence Zone was observed to the east of the Philippines. Subsequent analyses indicated that this circulation was almost stationary and that pressures in the area were gradually decreasing. Reconnaissance was therefore requested and at 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.



0-3-3

AMY

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON ARMY

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

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

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

6 HR BEST TRACK POSITS

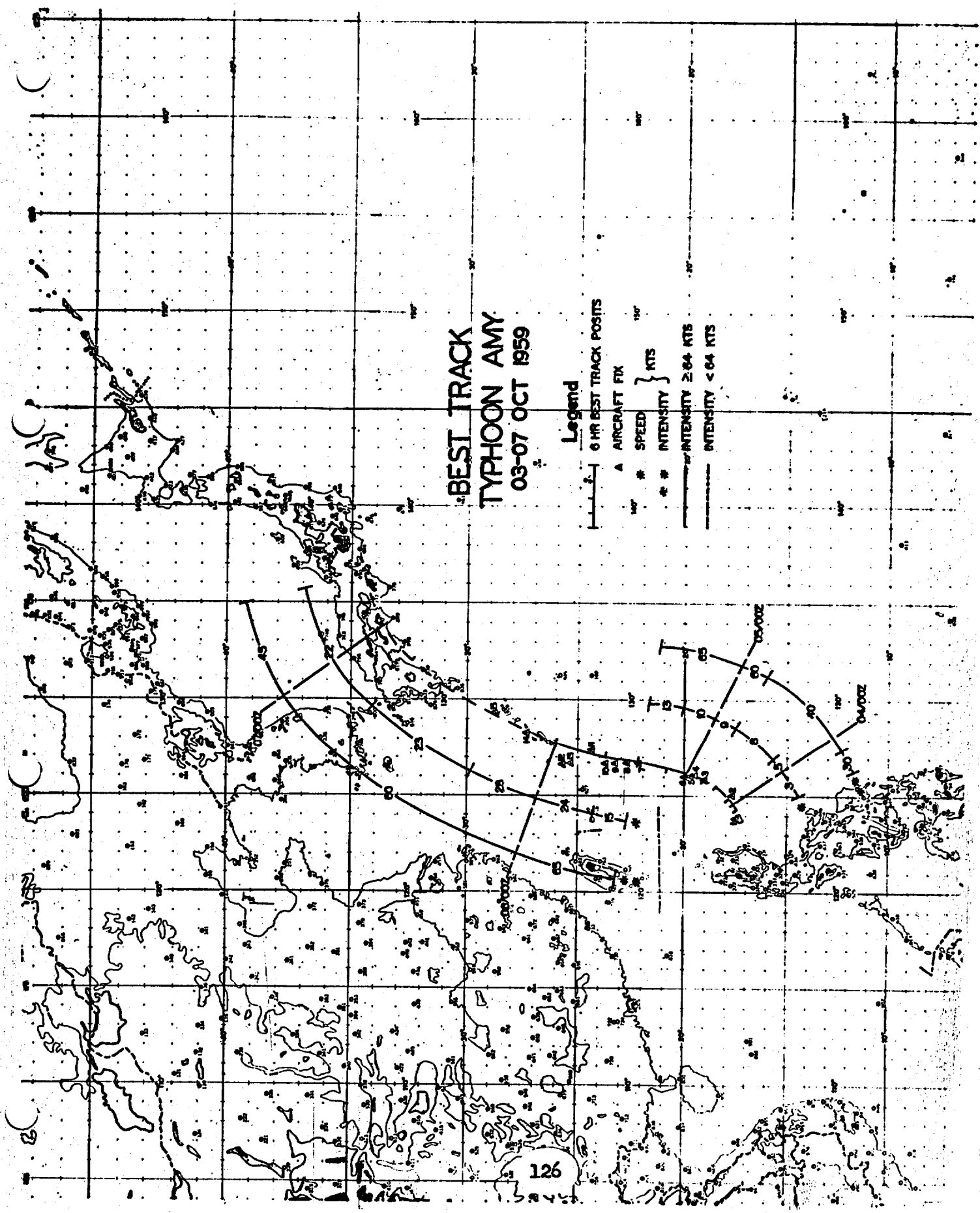
A AIRCRAFT FIX

* SPEED

* INTENSITY

--- INTENSITY ≥ 64 KTS

--- INTENSITY < 64 KTS



12 HR FORECAST POSITS

TYPHOON AMY

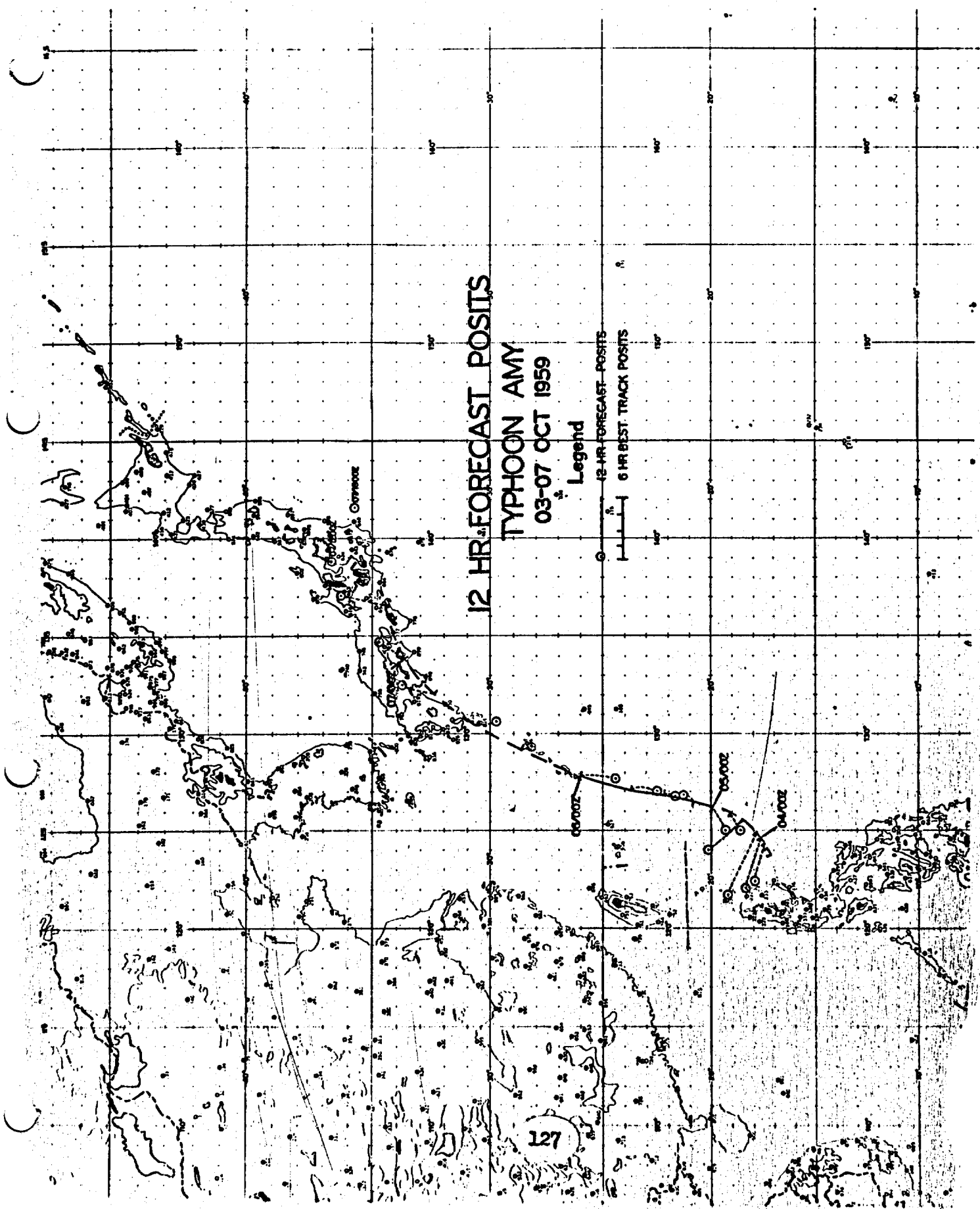
03-07 OCT 1959

Legend

12 HR FORECAST POSITS

6 HR BEST TRACK POSITS

127



24 HR FORECAST POSITS

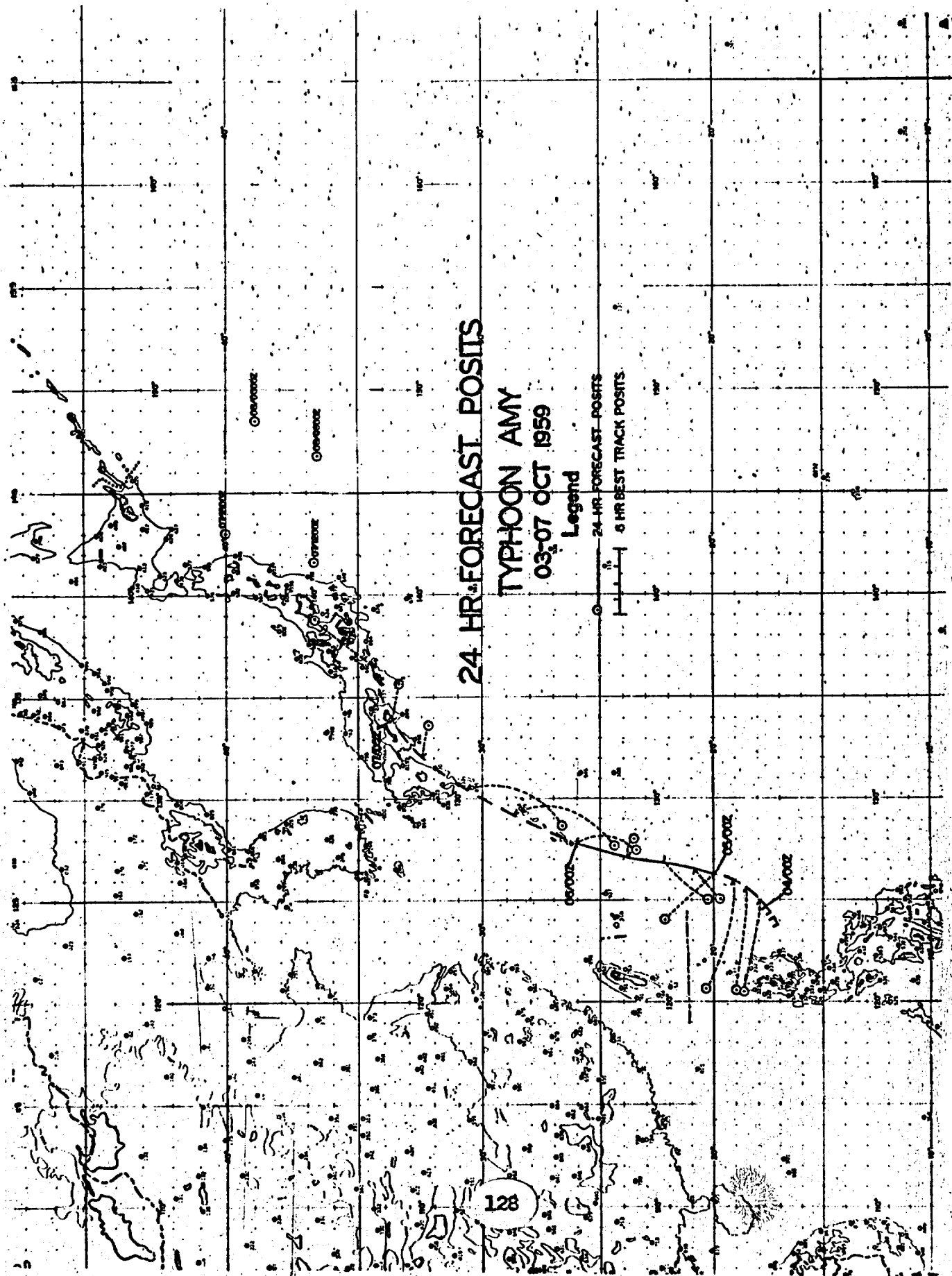
TYPHOON AMY

03-07 OCT 1959

Legend

24 HR FORECAST POSITS

6 HR BEST TRACK POSITS



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

FIX NO.	TIME	LAT.	LONG.	MURKITT METHOD & ACCT	MIN			MAX			700MB			EYE CHARACTERISTICS
					SHP	MPS	HGT	SFC	WIND	WIND	FLT LVL	TEMP (°C)	DEWPT (°C)	
1	090215Z	10.4N	137.3E	54-P-10	--	--	10120	35	35	10120	35	09	09	EYE ILL DEFINED
2	090700Z	10.9N	136.6E	54-P-5	1006	--	10080	40	40	10080	35	09	09	EYE FILLED WITH CLDS
3	092100Z	12.0N	135.0E	54-P-5	994	--	10130	30	30	10130	30	11	08	EYE ILL DEFINED
4	100800Z	13.4N	133.9E	54-P-2	993	--	10100	50	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	--	9910	90	90	9910	--	16	05	TURBC SVR W QUAD
7	110140Z	14.3N	131.7E	54-P-5	989	--	9890	100	100	9890	--	17	07	CIRC DIA 25 MI
8	110800Z	14.7N	131.0E	54-P-5	980	--	9630	70	70	9630	70	18	12	CIRC DIA 15 MI
9	111400Z	14.8N	130.3E	54-R-10	--	--	--	--	--	--	--	--	--	TURBC LGT N&W QUADS
10	112000Z	15.4N	128.6E	54-T-40	--	--	--	--	--	--	60	--	--	CIRC DIA 40 MI
11	112200Z	15.5N	129.2E	54-P-15	972	--	9420	80	80	9420	--	17	12	WALL CLDS ALL QUADS
12	120030Z	15.8N	129.0E	54-P-15	975	--	9480	175	175	9480	--	16	13	WELL DEFINED EYE
13	121422Z	16.9N	126.9E	12-R-10	--	--	--	--	--	--	--	--	--	CIRC DIA 10 MI
14	122000Z	17.3N	126.2E	54-R-15	--	--	--	--	--	--	--	--	--	WALL CLDS ALL QUADS
15	122200Z	17.5N	126.0E	54-P-5	932	--	8180	150	150	8180	--	17	15	CIRC DIA 08 MI
16	130200Z	17.9N	125.9E	54-P-5	916	--	7730	125	125	7730	--	17	16	CLOSED EYE 08 MI DIA
17	130433Z	18.0N	125.7E	54-P-5	--	--	--	--	--	--	--	--	--	PERFECT EYE FORMATION
18	130800Z	18.3N	125.4E	54-P-5	905	--	7320	145	145	7320	180	20	15	DOUBLE WALL CLDS
19	131605Z	18.7N	125.2E	54-R-5	--	--	--	--	--	--	--	--	--	WALL CLDS ALL QUADS
20	132200Z	19.3N	124.9E	54-P-3	914	--	7630	100	100	7630	110	17	15	WELL DEFINED CIRC EYE
21	132316Z	19.5N	125.1E	12-R-5	--	--	--	--	--	--	--	--	--	

[illegible]

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON CHARLOTTE (CONT'D)

FIX NC.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN SLP MRS	MAX SFC WIND	MIN 700MB HGT	MAX FLT LVL	700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
43	172000Z	28.1N	131.5E	54-P-5	974	--	9500	70	22	16	CIRC DIA 45 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	TURB 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 LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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	

BEST TRACK TYPHOON CHARLOTTE 09-19 OCT 1959

Legend

— 6 HR BEST TRACK POSITS

A AIRCRAFT FIX

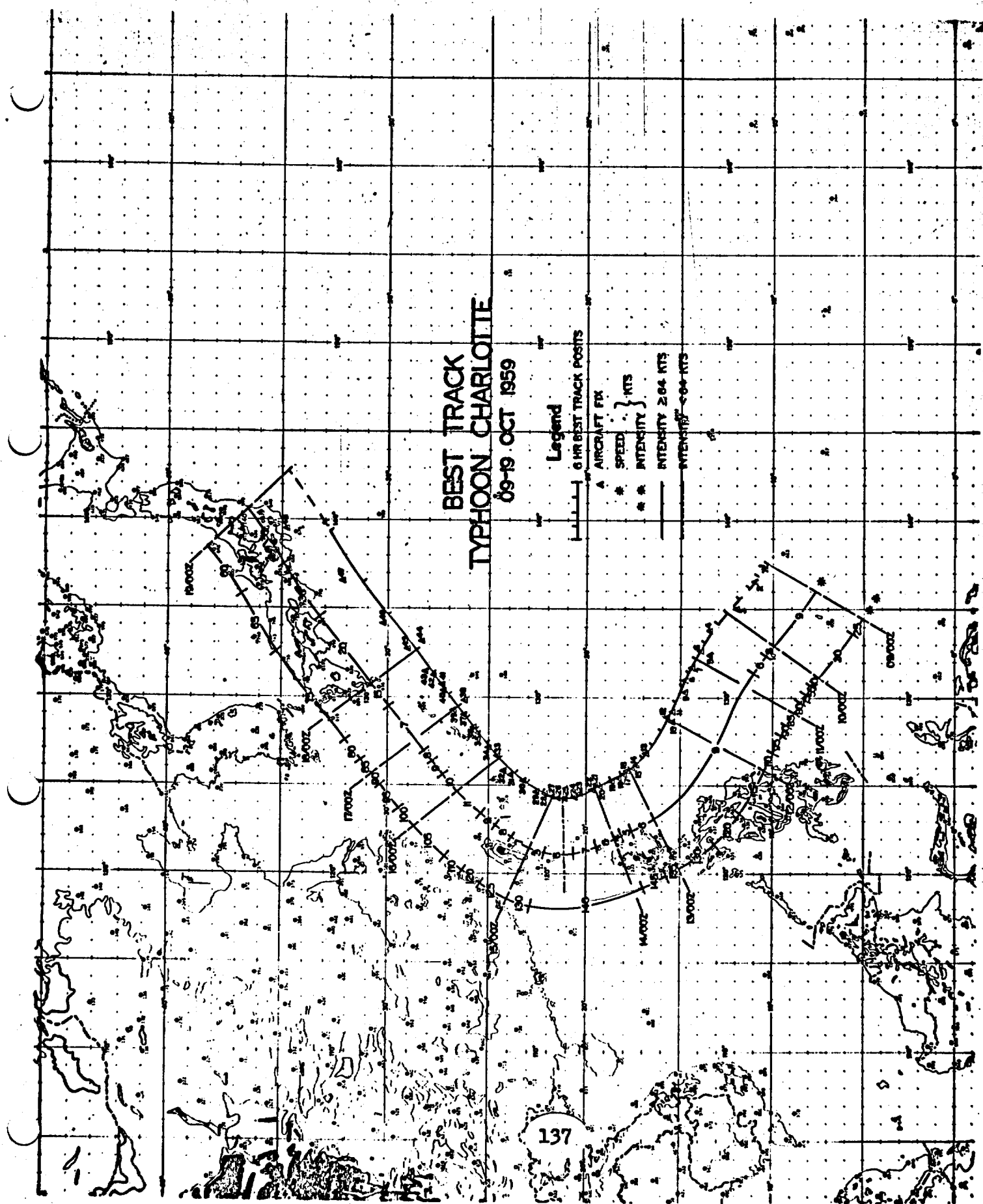
* SPEED

* * INTENSITY

— INTENSITY 264 KTS

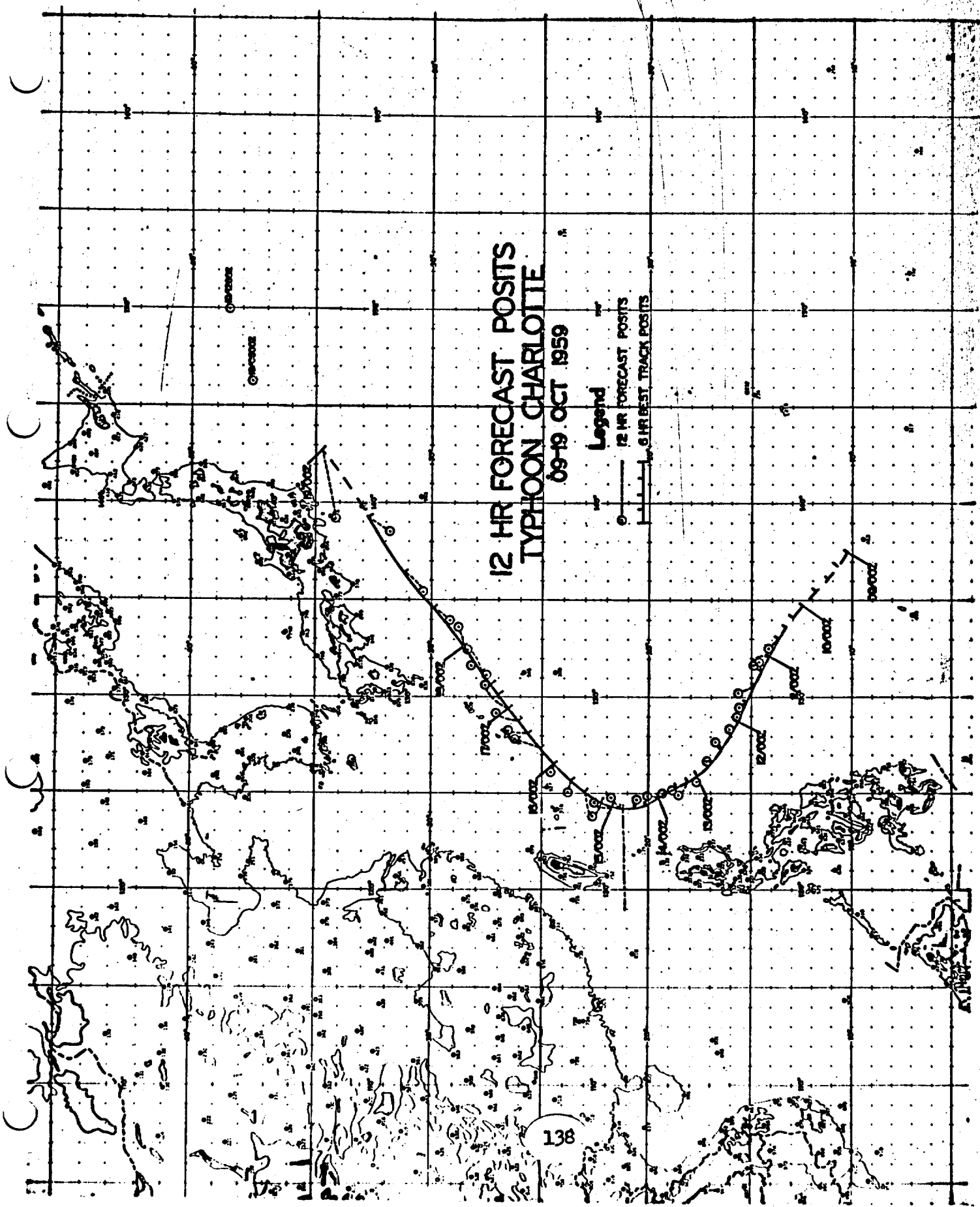
— INTENSITY 200 KTS

137



12 HR FORECAST POSITS
TYPHOON CHARLOTTE
09-19 OCT 1959

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

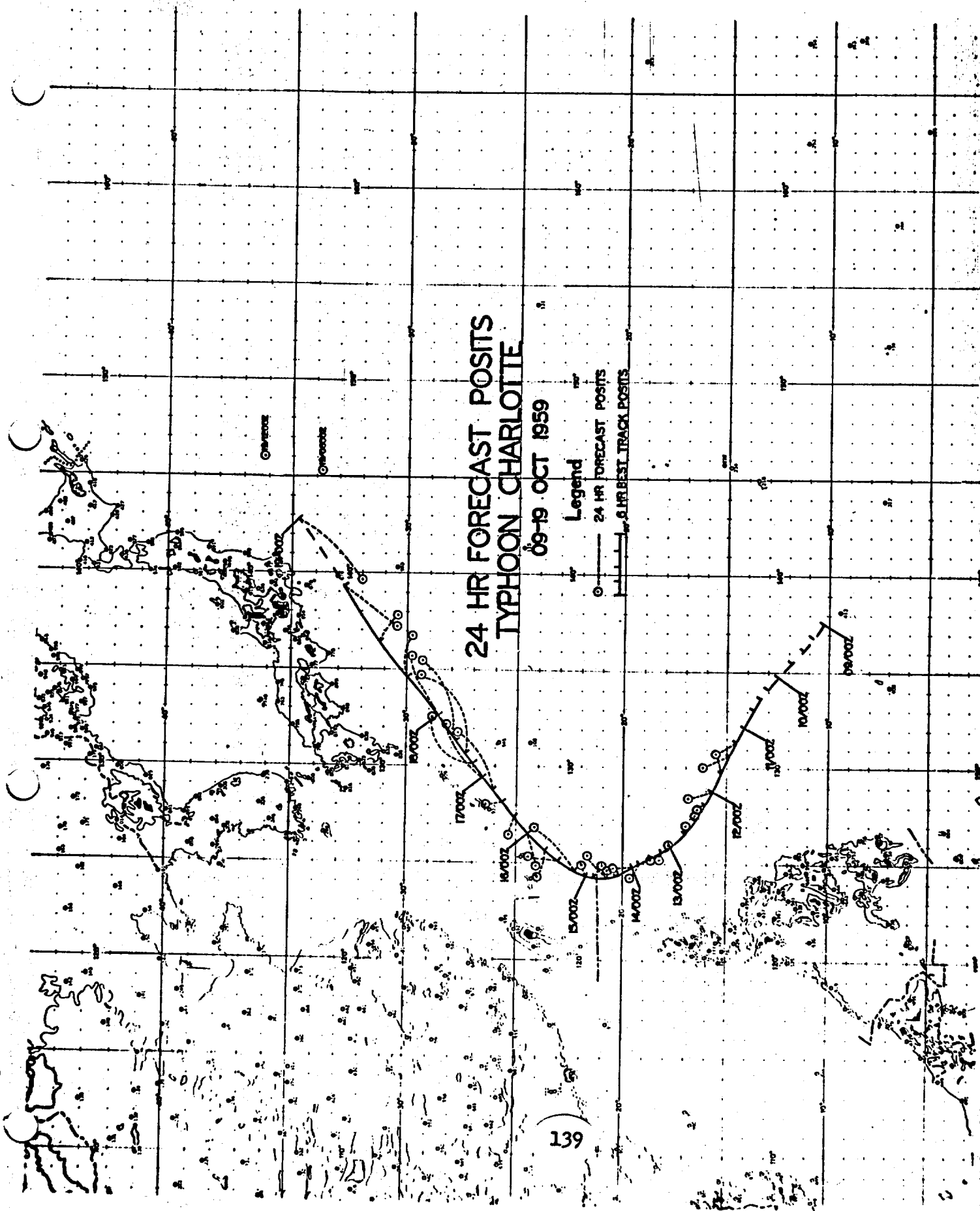


24 HR FORECAST POSITS TYPHOON CHARLOTTE

09-19 OCT 1959

Legend

○ 24 HR FORECAST POSITS
— 6 HR BEST TRACK POSITS



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 northeasterly 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 WIND	MIN 700MB HGT	MAX FLT LVL	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-R-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 WIND	MIN 700MB HGT	MAX			700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
								FLT	LVL	WIND			
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 64K

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

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

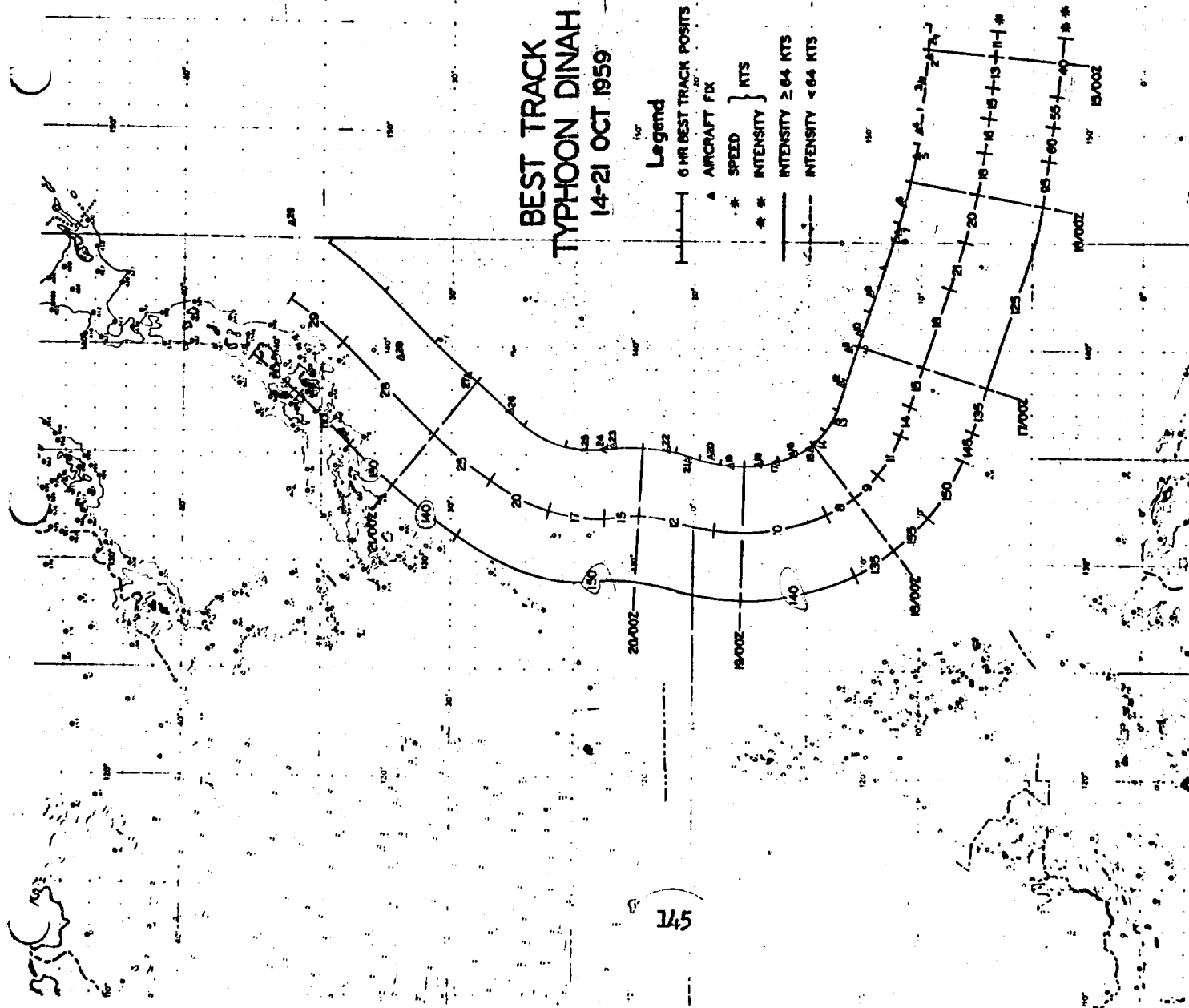
▲ AIRCRAFT FIX

* SPEED

* INTENSITY

— INTENSITY ≥ 64 KTS

- - - INTENSITY < 64 KTS



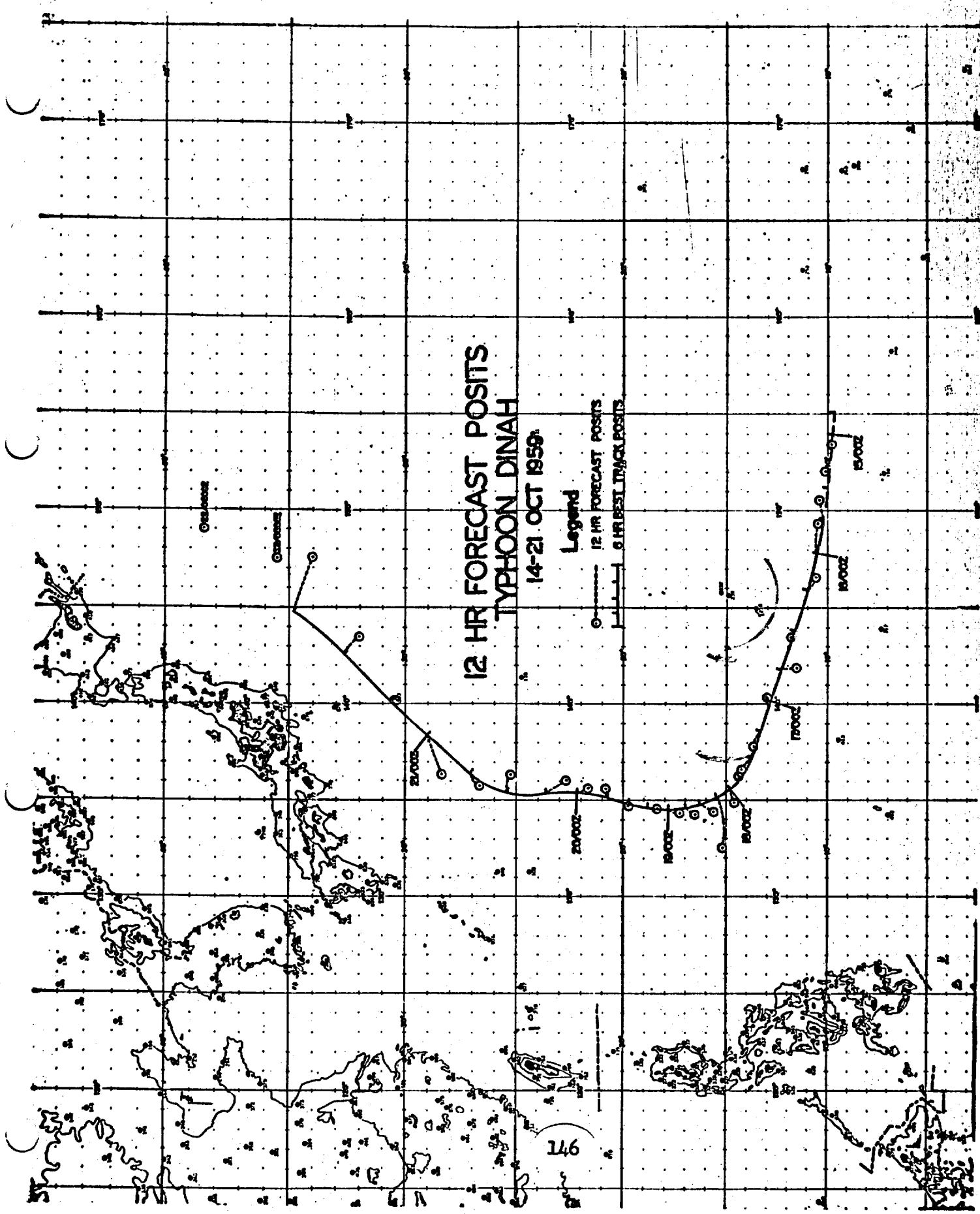
12 HR FORECAST POSITS
TYPHOON DINAH

14-21 OCT 1959

Legend

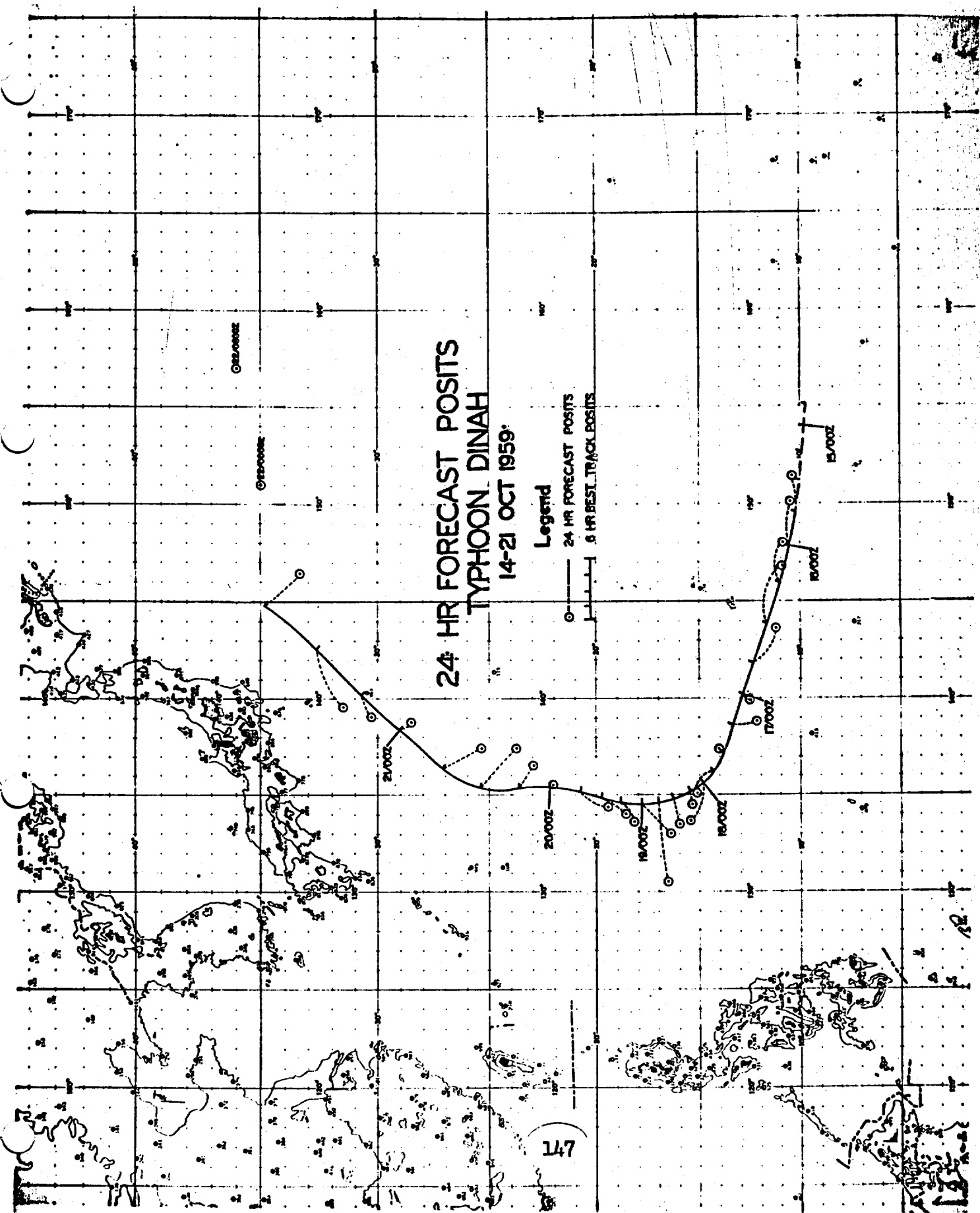
12 HR FORECAST POSITS

6 HR BEST TRACK POSITS



24 HR FORECAST POSITS TYPHOON DINAH 14-21 OCT 1959

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



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

FIX NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN SLP	MAX SFC WND	MIN 700MB HGT	MAX FLT LVL	700MB TEMP (°C)	700MB DEWPT (°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	MAX			700MB		EYE CHARACTERISTICS
					MIN	SFC	MIN	TEMP	DEWPT	
				MBS	WIND	HGT	WIND	(°C)	(°C)	
21	110200Z	18.2N	125.1E	54-P-2	970	75	9260	60	11	CIRC DIA 75 MI
22	110730Z	19.5N	125.2E	54-P-5	966	130	9180	105	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	13	CIRC DIA 60 MI
26	120100Z	22.3N	123.8E	54-P-2	959	75	8980	115	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		

BEST TRACK TYPHOON EMMA

05-13 NOV 1959

Legend

6 HR BEST TRACK POSITS

AIRCRAFT FIX

SPEED
INTENSITY

KTS

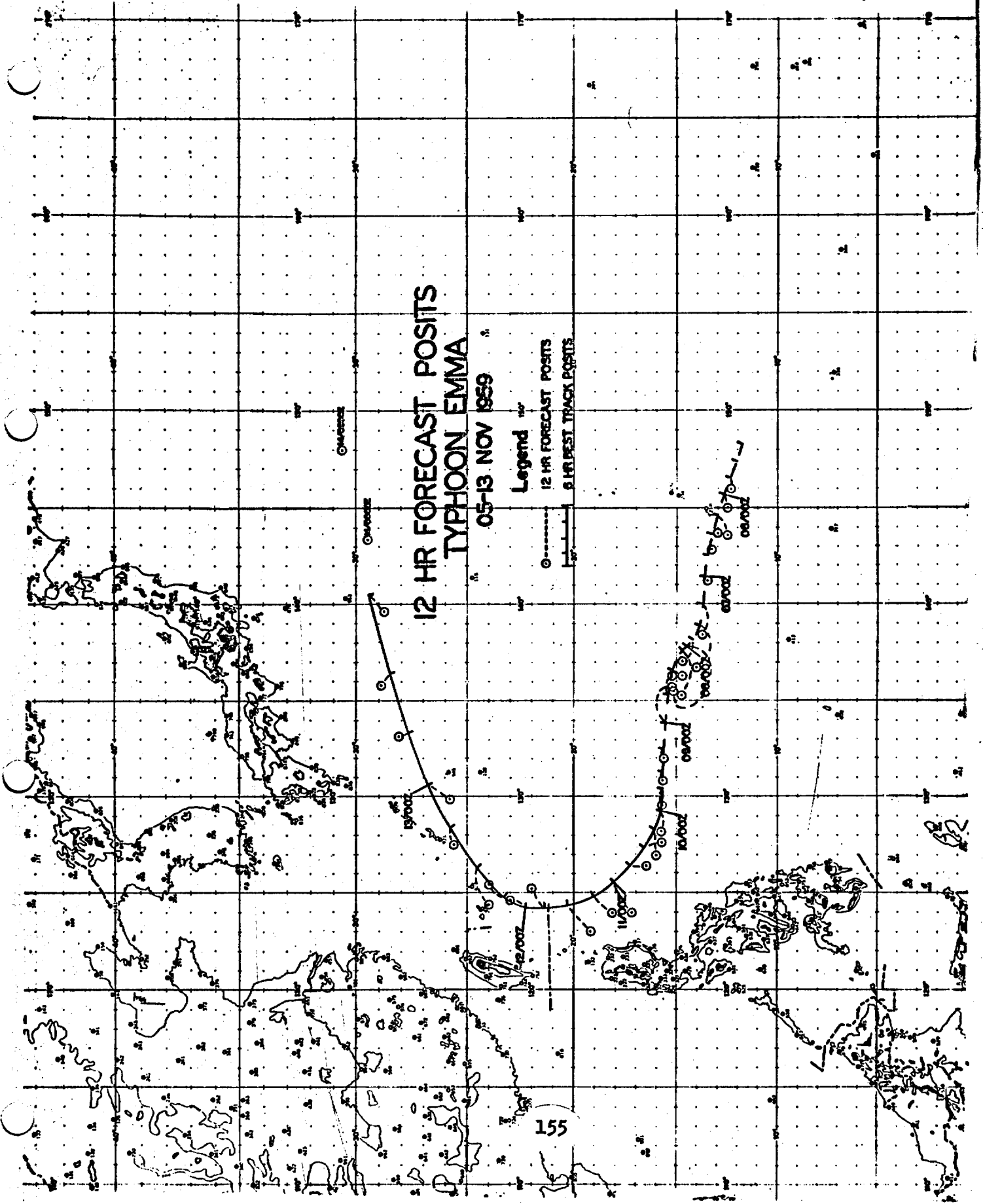
INTENSITY 204 KTS

INTENSITY 104 KTS

12 HR FORECAST POSITS
TYPHOON EMMA

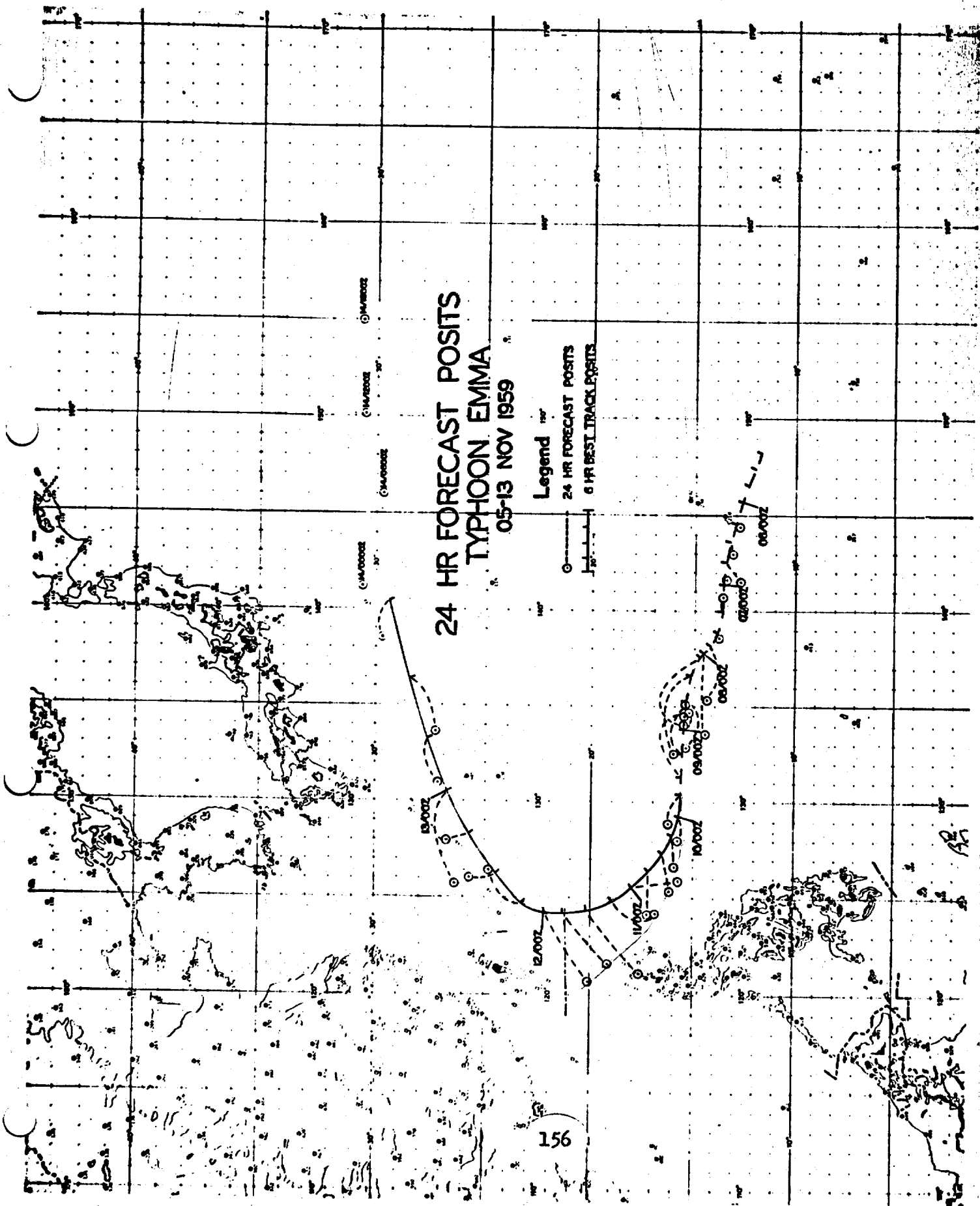
05-13 NOV 1959

Legend
12 HR FORECAST POSITS
9 HURST TRACK POSITS



24 HR FORECAST POSITS
TYPHOON EMMA
05-13 NOV 1959

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



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
7	141221Z	10.1N	130.5E	54-R-20	-	-	-	-	-	-	CIRC DIA 40 MI
8	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 NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCT	MIN SLP HES	MAX SFC WIND	MIN 700MB HGT	MAX			700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
								FLT	LVL	WIND			
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

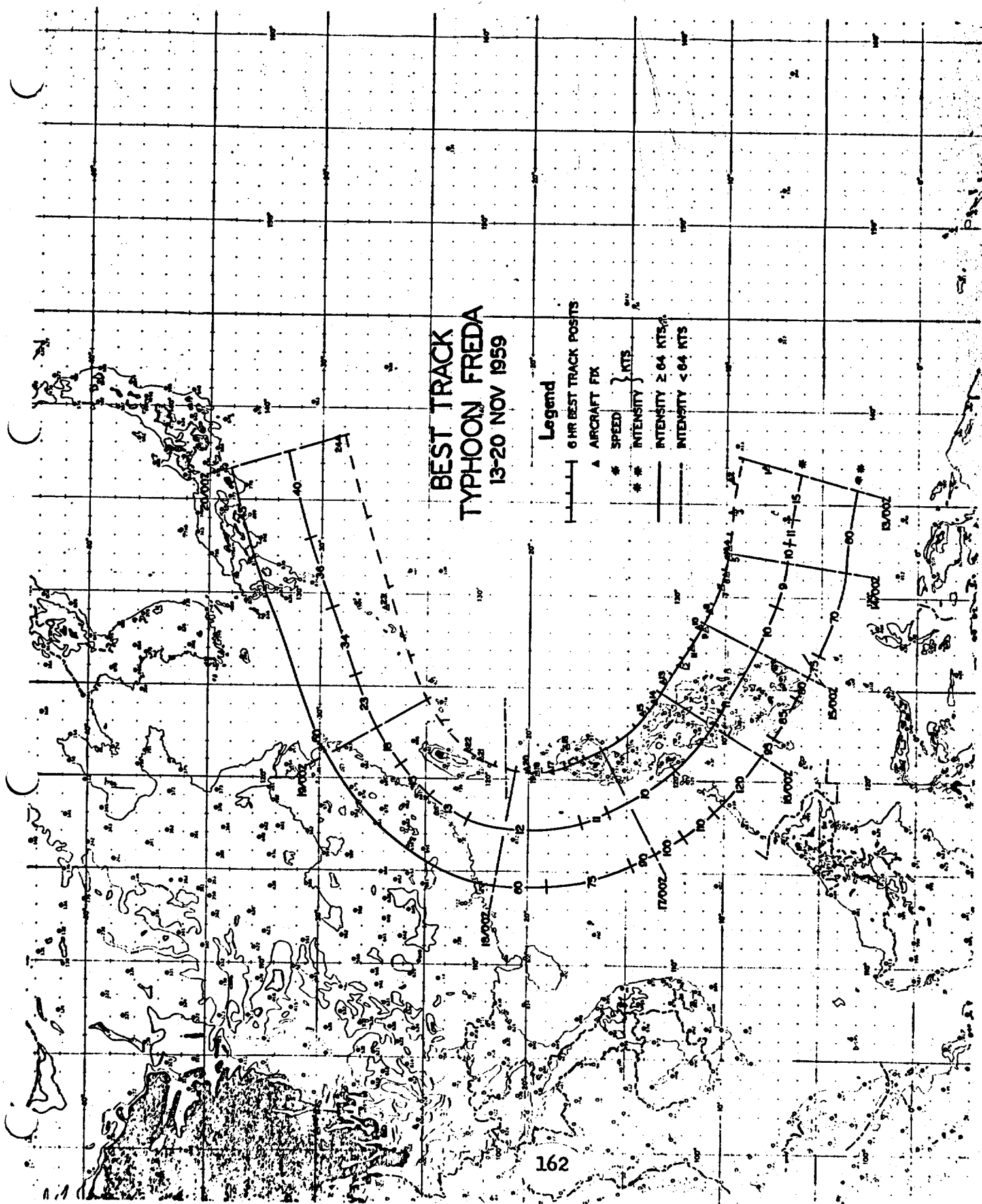
TYPHOON FRED A 13 - 20 NOV. 1959
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

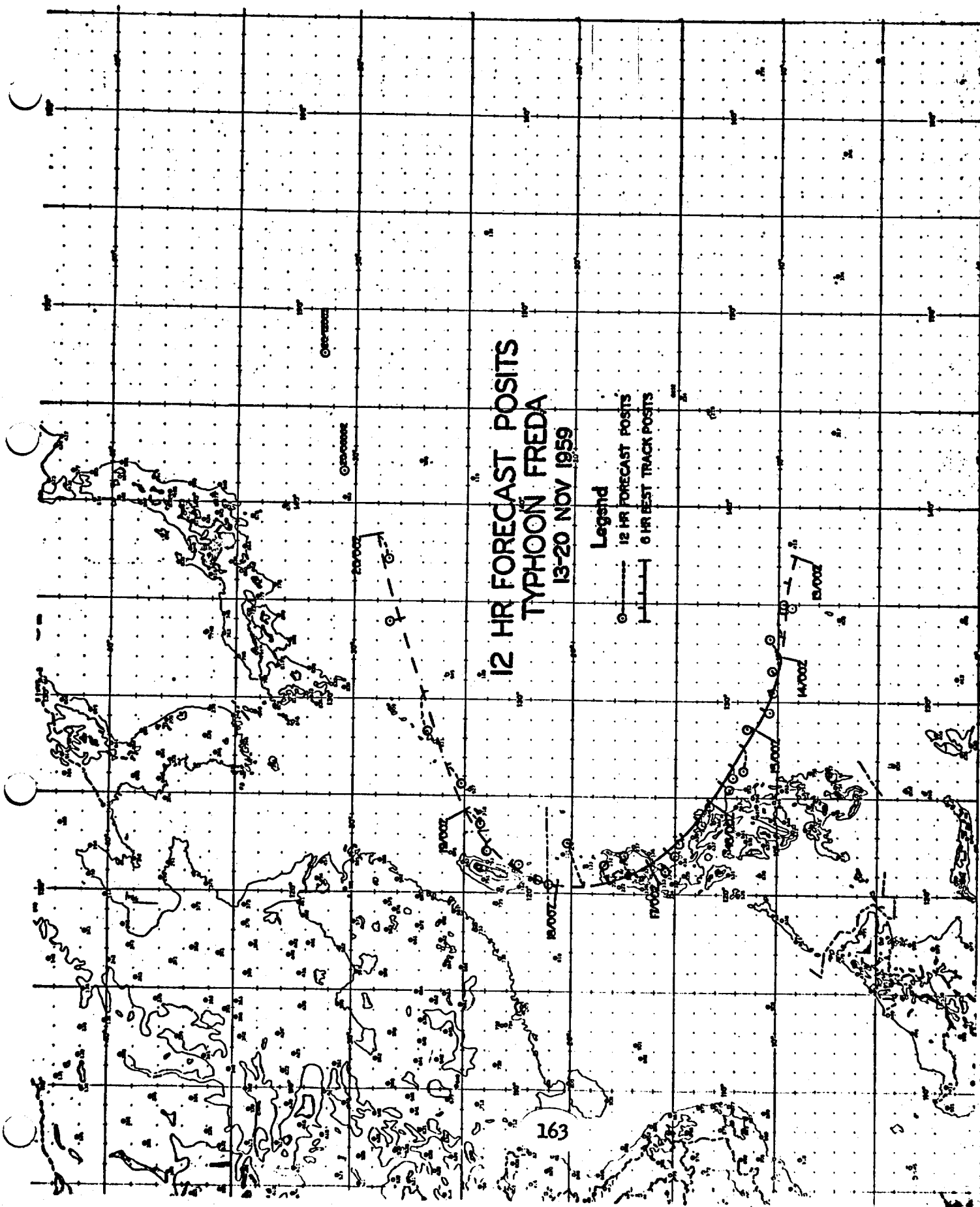
- 6 HR BEST TRACK POSITS
- ▲ AIRCRAFT FIX
- # SPEED
- # INTENSITY
- INTENSITY ≥ 64 KTS
- INTENSITY < 64 KTS



12 HR FORECAST POSITS
TYPHOON FRED
13-20 NOV 1959

Legend
12 HR FORECAST POSITS
6 HR BEST TRACK POSITS

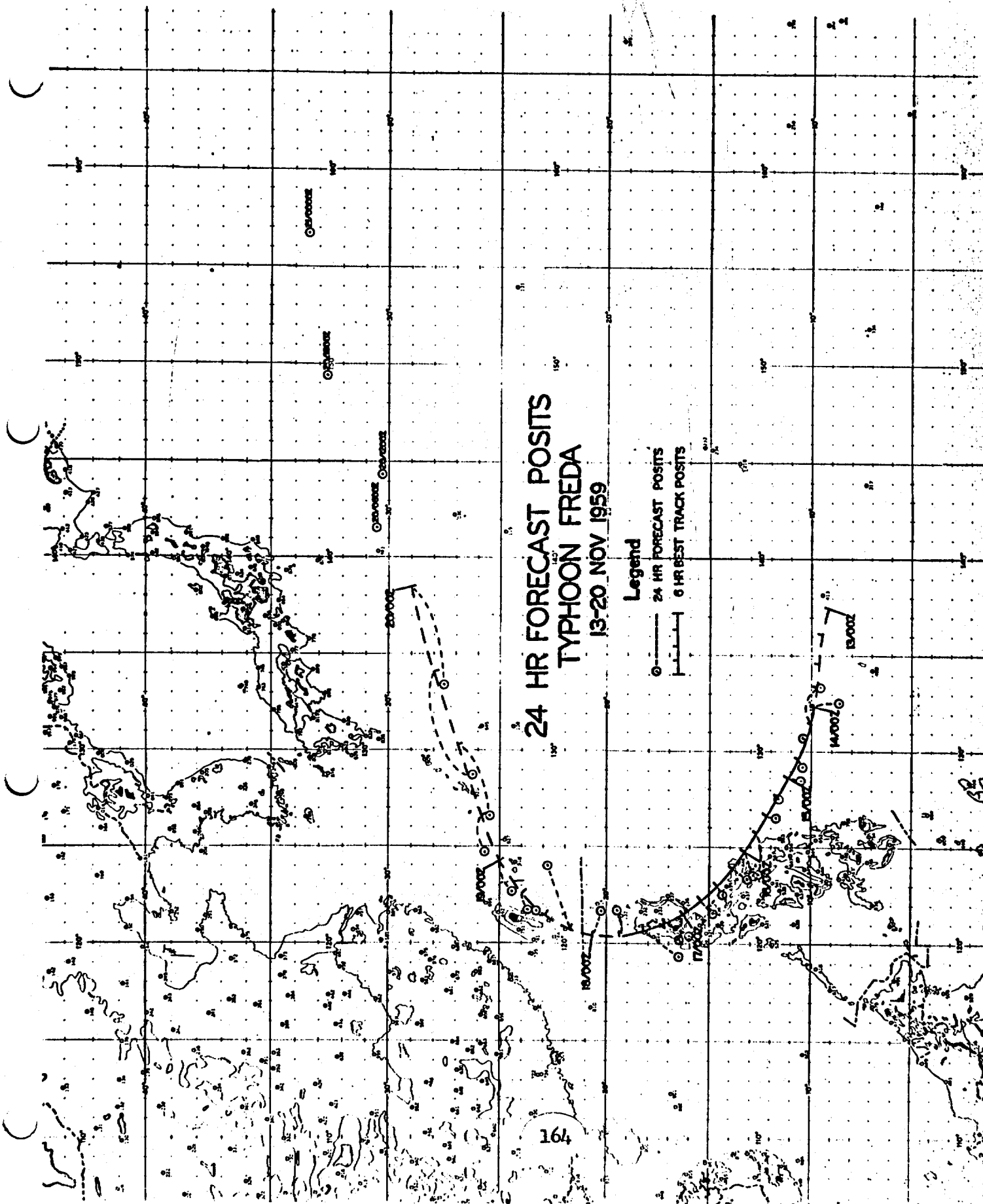
163



24 HR FORECAST POSITS
TYPHOON FREDA
13-20 NOV 1959

Legend

- 24 HR FORECAST POSITS
- 6 HR BEST TRACK POSITS



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 KFS	MAX SPC KND	MIN 700MB HGT	MAX FLT LVL	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	10.3N	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 NO	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN			MAX			700MB TEMP (°C)	700MB DEWPT (°C)	EYE CHARACTERISTICS
					MIN SLP	MAX SFC	MIN HGT	MAX FLT	LVL	WIND			
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	-	-	-	-			-	-	
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 LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

A AIRCRAFT FIX

* SPEED } KTS

* * INTENSITY

— INTENSITY 2-64 KTS

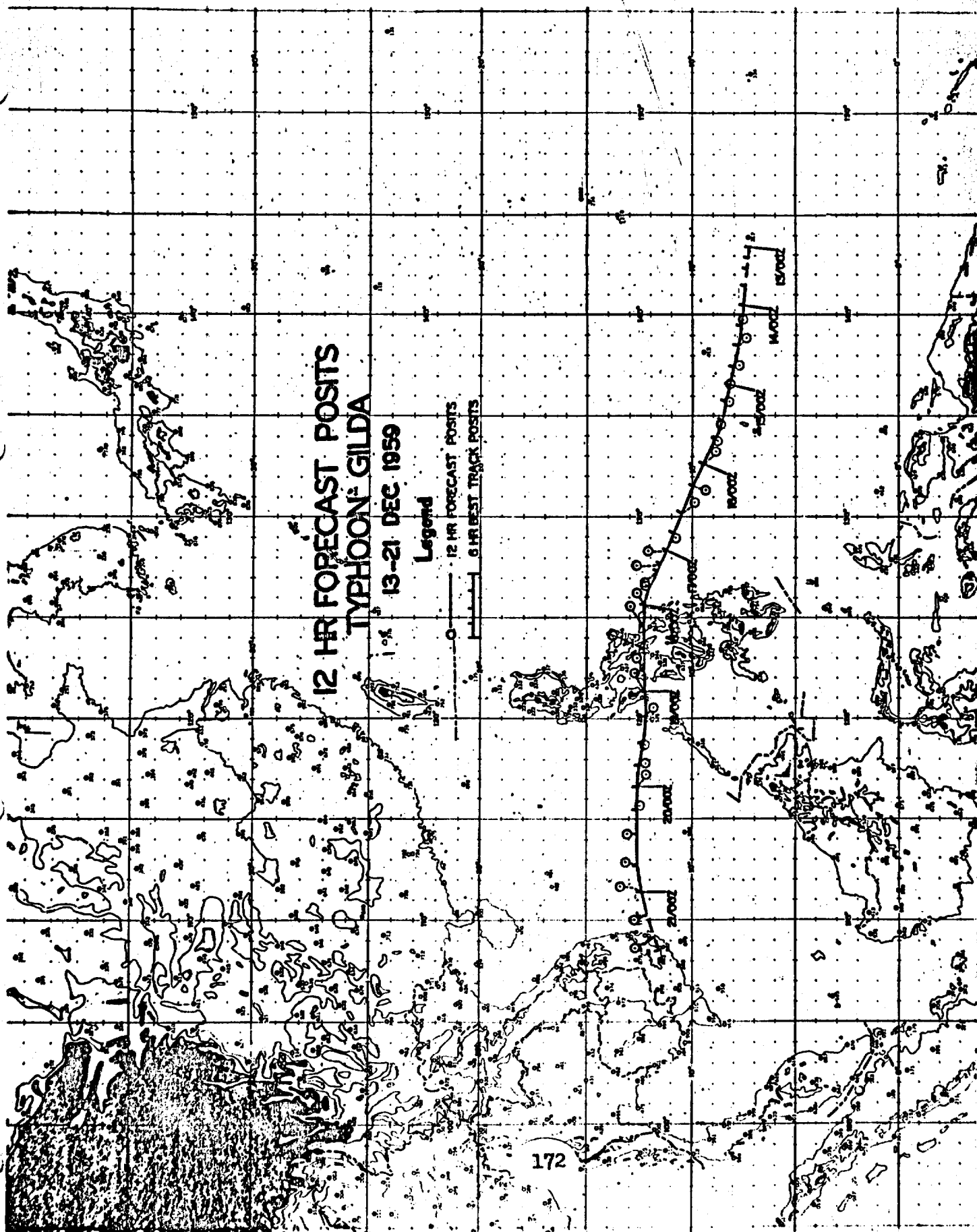
— INTENSITY > 64 KTS

12 HR FORECAST POSITS
TYPHOON GILDA

13-21 DEC 1959

Legend

12 HR FORECAST POSITS
6 HR BEST TRACK POSITS

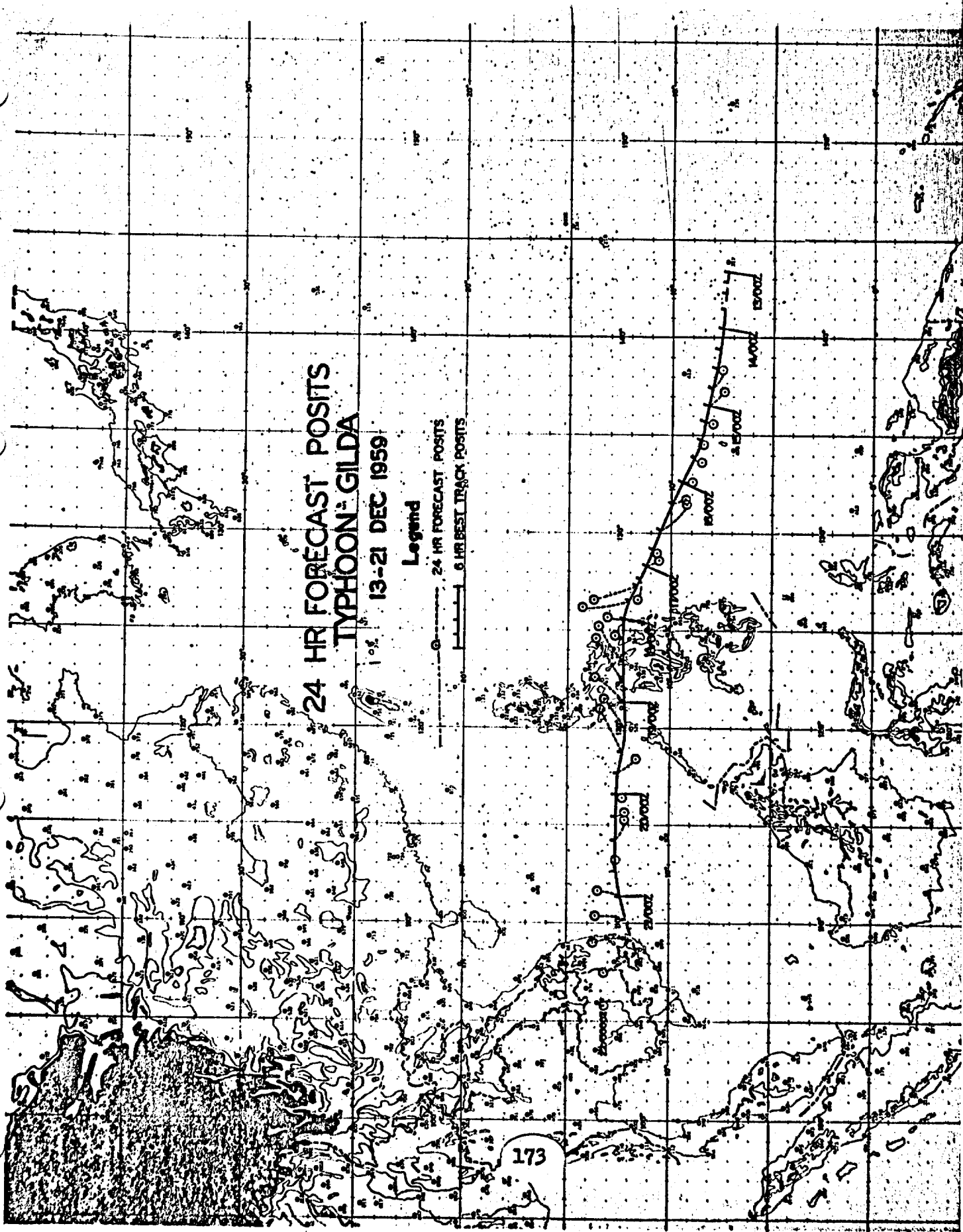


24 HR FORECAST POSITS
TYPHOON GILDA

13-21 DEC 1959

Legend

24 HR FORECAST POSITS
6 HR BEST TRACK POSITS



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 & ACCY	MIN SLP MBS	MAX SFC WIND	MIN 700MB HGT	MAX FLT LVL WIND	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 25MI
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	934	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 FLIES - TYPHOON HARRIET (CONT'D)

FLY NO.	TIME	LAT.	LONG.	*UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WIND	MIN 700MB HGT	MAX			700MB TEMP (°C)	700MB DEPT (°C)	EYE CHARACTERISTICS
								FLT LVL	WIND				
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	-	-	-	-			-	-	CIRC DIA 25 MIL
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	14.6N	126.3E	54-R-10	-	-	-	-			-	-	CONTIN RAIN TURRELC 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	VM-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 LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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

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

DTG	STORM POSITION LAT. LONG.	12 HR ERROR DEG. DISTANCE	24 HR ERROR 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 HARRET 24 DEC 1959 - 02 JAN 1960

Legend

6 HR BEST TRACK POSITS

AIRCRAFT FIX

SPEED KTS

** INTENSITY

INTENSITY ≥ 64 KTS

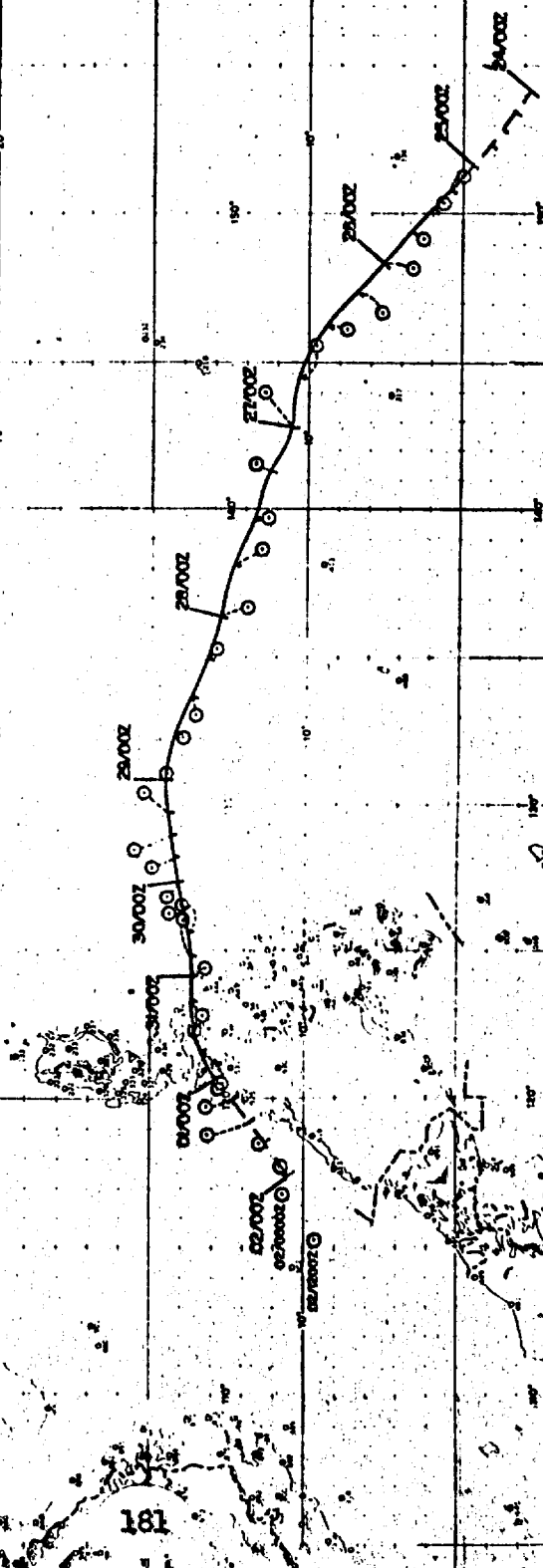
INTENSITY < 64 KTS

24 DEC 1959 - 02 JAN 1960

Legend

①----- 12 HR FORECAST POSITS

6 HIREST TRACK POSITS

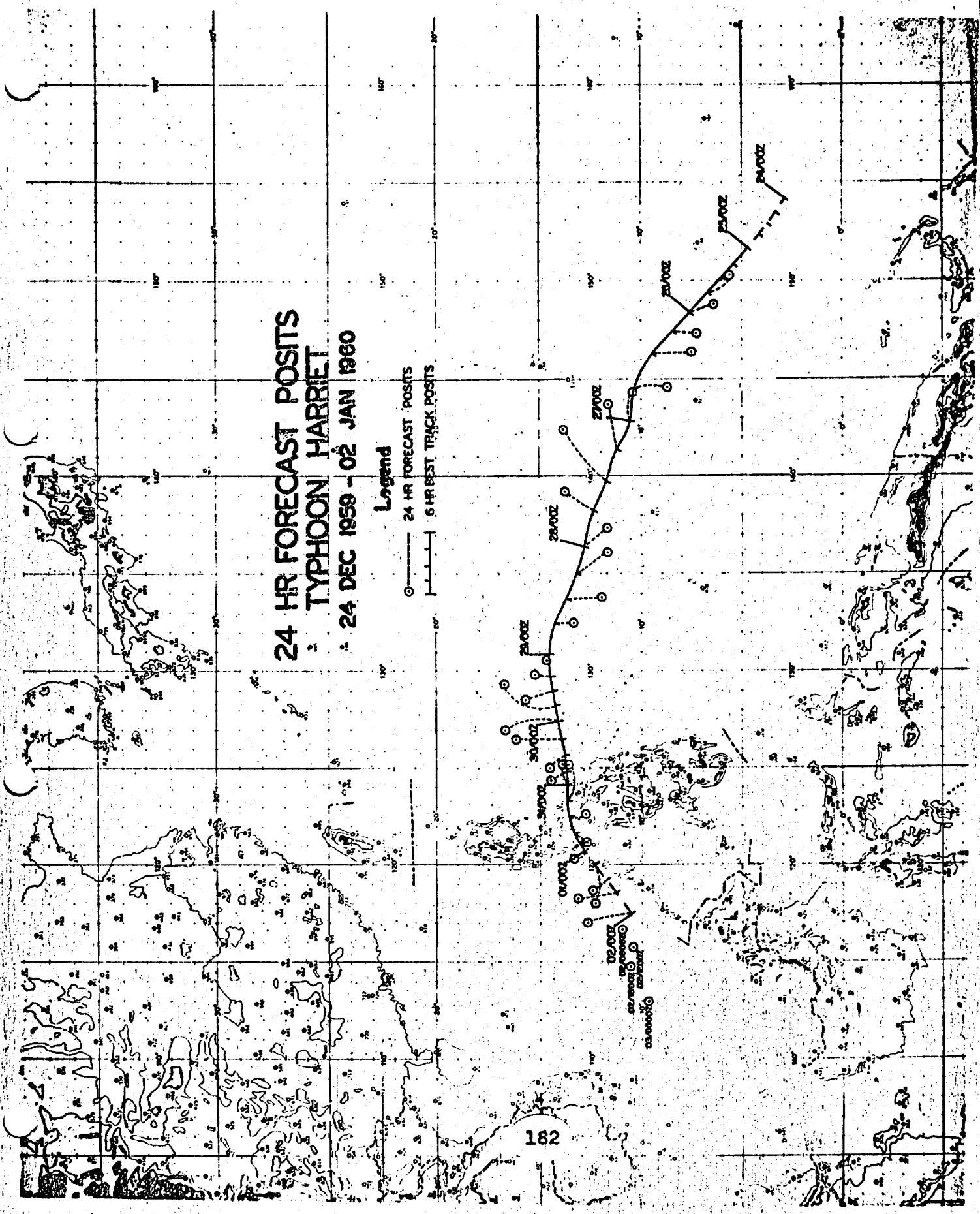


24 HR FORECAST POSITS
TYPHOON HARRIET

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."

