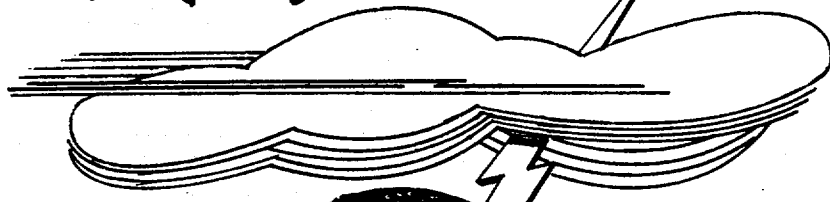


# ANNUAL TYPHOON *Report*



19

64



**FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER**  
**Guam, Mariana Islands**

**RADM. H. V. BIRD**

# REPORT DOCUMENTATION PAGE

Form Approved OMB No.  
0704-0188

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<b>1. REPORT DATE (DD-MM-YYYY)</b> 01-01-1995		<b>2. REPORT TYPE</b> Annual Typhoon Report		<b>3. DATES COVERED (FROM - TO)</b> xx-xx-1995 to xx-xx-1995	
<b>4. TITLE AND SUBTITLE</b> 1964 Annual Typhoon Report Unclassified			<b>5a. CONTRACT NUMBER</b>		
			<b>5b. GRANT NUMBER</b>		
			<b>5c. PROGRAM ELEMENT NUMBER</b>		
<b>6. AUTHOR(S)</b> Bird, H. V. ; Cassidy, Richard M. ; Lame, Roland C. ;			<b>5d. PROJECT NUMBER</b>		
			<b>5e. TASK NUMBER</b>		
			<b>5f. WORK UNIT NUMBER</b>		
<b>7. PERFORMING ORGANIZATION NAME AND ADDRESS</b> Joint Typhoon Warning Center 425 Luapele Road Pearl Harbor, HI96860-3103			<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>		
<b>9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS</b> Naval Pacific Meteorology and Oceanography Center Joing Typhoon Warning Center 425 Luapele Road Pearl Harbor, HI96860-3103			<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>		
			<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>		
<b>12. DISTRIBUTION/AVAILABILITY STATEMENT</b> APUBLIC RELEASE					
<b>13. SUPPLEMENTARY NOTES</b> See Also ADM001257, 2000 Annual Tropical Cyclone Report Joing Typhoon Warning Center (CD includes 1959-1999 ATRCs). Block 1 and Block 3 should be 1964.					
<b>14. ABSTRACT</b> This report is published annually and summarizes Western and Central North Pacific typhoons. During 1964, no typhoons or tropical storms were reported in the Central North Pacific.					
<b>15. SUBJECT TERMS</b>					
<b>16. SECURITY CLASSIFICATION OF:</b>		<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19. NAME OF RESPONSIBLE PERSON</b>	
a. REPORT Unclassified		Public Release	253	Fenster, Lynn lfenster@dtic.mil	
b. ABSTRACT Unclassified				<b>19b. TELEPHONE NUMBER</b>	
c. THIS PAGE Unclassified				International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007	
				<small>Standard Form 298 (Rev. 8-98) Prescribed by ANSI Std Z39.18</small>	

U. S. FLEET WEATHER CENTRAL/  
JOINT TYPHOON WARNING CENTER  
COMNAVMARIANAS BOX 12  
SAN FRANCISCO, CALIFORNIA

RICHARD M. CASSIDY  
Captain, U.S. Navy

COMMANDING

ROLAND C. LAME  
Lieutenant Colonel, USAF

DIRECTOR, JOINT TYPHOON WARNING CENTER

STAFF

LT John R. Lincoln, USN  
CAPT Stephen J. Balint, USAF  
LT Thomas D. Deagan, USN  
CWO-4 Leslie L. Britten, USAF  
Raymond F. Martinson, AGC, USN  
TSGT Robert H. Lajoie, USAF  
A1C Albert G. Larson, USAF  
Anthony Moreno, AG3, USN  
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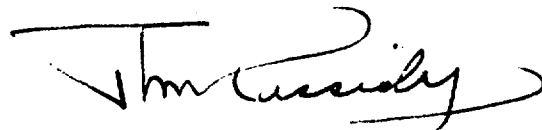
ANNUAL TYPHOON REPORT

U. S. FLEET WEATHER CENTRAL/  
JOINT TYPHOON WARNING CENTER  
COMNAVMARIANAS BOX 12  
SAN FRANCISCO, CALIFORNIA

FWC/JTWC:RMC:np  
3140  
Ser: 54  
15 February 1965

From: Commanding Officer, U. S. Fleet Weather Central/  
Joint Typhoon Warning Center, Guam, M. I.  
To: Chief of Naval Operations  
Via: Commander in Chief, U. S. Pacific Fleet  
Subj: Annual Typhoon Report, 1964; submission of  
Ref: (a) OPNAV Instruction 3140.17D  
(b) SECNAV Instruction 5600.16

1. The Annual Typhoon Report, 1964, is submitted herewith in accordance with paragraph 4.a. of reference (a).
2. During calendar year 1964, a total of 26 destructive typhoons, 14 tropical storms and five tropical depressions threatened the Western Pacific area, necessitating the issuance of 730 individual warnings and the placement of the FWC/JTWC Guam in "warning status" for 153 calendar days.
3. In comparison with past years, the 26 typhoons of 1964 set a new record; 24 in 1962 was the previous record. The South China Sea area was particularly active with ten typhoons in 1964 compared with an average of 3.2 per year in recent years.
4. This report has been reviewed and approved in accordance with reference (b).



R. M. CASSIDY



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## FOREWORD

This report is published annually and summarizes Western and Central North Pacific typhoons. During 1964, no typhoons or tropical storms were reported in the Central North Pacific.

When directed by CINCPAC in May 1959, CINCPACFLT redesignated Fleet Weather Central, Guam as Fleet Weather Central/Joint Typhoon Warning Center (FWC/JTWC), Guam, with the following additional responsibilities:

1. To provide warnings to U. S. Government agencies for all tropical cyclones west of 180 degrees longitude north of the equator to the Asiatic coast and Malayan Peninsula.
2. To determine tropical cyclone reconnaissance requirements and assign priorities.
3. To conduct investigative and post analysis programs including preparation of the Annual Typhoon Report.
4. To conduct tropical cyclone forecasting and detection research as practicable.

Fuchu Air Force Weather Central, coordinating with Fleet Weather Facility Yokosuka was designated as alternate JTWC in case of failure of FWC/JTWC Guam.

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

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, is responsible for surveillance and issuance of warnings in the Central North Pacific area north of the equator between 180 degrees and west of 140 degrees west. There were no tropical cyclones within this area in 1964.

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**CHAPTER I**

**OPERATIONAL PROCEDURES**

## A. GENERAL

Within the Fleet Weather Central/Joint Typhoon Warning Center (FWC/JTWC), the basic analysis is the responsibility of the Fleet Weather Central (FWC). Micro-analysis, forecast aid evaluation and the warnings, as described below are the functions of the Joint Typhoon Warning Center (JTWC). Basic chart prognoses that are received from Fleet Numerical Weather Facility (FNWF), Monterey, Calif. are utilized, in addition to locally prepared prog's.

## B. ANALYSES

### 1. FWC

a. Types of contour (c) and/or streamline (s) charts with standard times:

- (1) Surface; 0000Z, 0600Z, 1200Z and 1800Z (c).
- (2) Gradient level (2000 to 3000 ft. above ground); 0000Z and 1200Z (s).
- (3) 850mb; 0000Z and 1200Z (s).
- (4) 700mb; 0000Z and 1200Z (s) & (c).
- (5) 500mb; 0000Z and 1200Z (s) & (c).
- (6) 300mb; 0000Z and 1200Z (c).
- (7) 200mb; 0000Z and 1200Z (s).
- (8) Sea Surface Temperature Chart; 24-hour composite analyzed once daily.

b. Cross sections for selected tropical Pacific stations.

- (1) Checkerboards or Stidd Diagram.
- (2) Time Cross Sections.

### 2. JTWC

a. Micro-analysis:

- (1) Sectional charts; hourly and 3-hourly as required.

- (2) Reconnaissance reports.
- (3) 700mb; 0000Z and 1200Z, 10-meter interval analysis (c).
- (4) 500mb; 0000Z and 1200Z, 20-meter interval analysis (c).
- (5) 300mb; 0000Z and 1200Z, 50-meter interval analysis (c).

b. Satellite data. (see Chapter II for details).

### C. FORECAST AIDS

These are listed in alphabetical order and priority of importance is not indicated.

#### 1. Climatology

Upon detection of a tropical cyclone in a preparation for issuance of the initial warning, a track based on climatology is developed. This track is prepared for a time interval of 4 or 5 days at the speed indicated by climatology. The following climatological publications are utilized when constructing the original forecast track for each cyclone:

- a. Climatological Aid to Forecasting Typhoon Movement (1st Weather Wing)
- b. Annual Typhoon Report, 1963 (covering years 1953 - 1963; FWC/JTWC)
- c. Western Pacific Typhoon Tracks 1950 - 1959 (FWC/JTWC)
- d. Far East Climatic Atlas (1st Weather Wing-February 1963)
- e. Tropical Cyclones in the Western Pacific and China Sea Area (Royal Observatory, Hong Kong). This comprehensive publication covers 78 years of typhoon tracks.

Next, the track is modified in accordance with the existing and forecast upper air pattern, after which the initial warning is prepared and issued. The forecast track is extended and modified with time, as reconnaissance



fixes are received and the synoptic upper air pattern changes.

## 2. Computer Products

During the 1964 Typhoon Season the following computer products were received and used extensively by JTWC:

### a. From FNWF

(1) Steering computations, or forecast positions, for 6, 12, 18, 24, 36, 48 and 72 hours for TD's, TS's and Typhoons (as requested by JTWC). These computations are prepared at 0000Z, 0600Z, 1200Z and 1800Z daily.

(2) 700mb, 500mb, 300mb, and 200mb height and wind analyses

(3) 700mb, 500mb, 300mb, and 200mb 24-hour prognoses

(4) 700mb, 500mb, 300mb, and 200mb 36-hour prognoses

(5) 48-hour 500mb height and wind prognosis.

(6) 72-hour 500mb height and wind prognosis.

Note: The 72-hour computer products were discontinued late in the season, due to changes at FNWF.

### b. From NMC, Suitland

(1) NWP Barotropic prog positions for typhoons for 12, 24, 36, 48, 60 and 72-hours were received when, in the opinion of NWP, the progs were reasonable.

NMC items were received twice daily for the synoptic times 0000Z and 1200Z.

c. JTWC utilized computer steering computations, computer prognostic constant pressure charts and synoptic analyses subjectively modified as the basis for forecasting typhoon movement during the 1964 season. (See Chapter II for an explanation and evaluation of techniques).

### 3. Coordination

When a circulation, for which warnings are being issued, is north of 25N, Fuchu Air Force Weather Central transmits coordination forecasts twice daily to JTWC. Coordination with other Air Force and Navy activities is on an "as required" basis depending upon the location of a particular tropical cyclone.

#### D. WARNINGS

Warnings are filed and transmitted every six hours at synoptic times of 0000Z, 0600Z, 1200Z and 1800Z. In accordance with CINCPAC Instruction 3140.1E the message contains the present warning position of the tropical cyclone which is valid for the scheduled transmission time. Therefore the 24 and 48-hour warning forecast positions are actually 30 and 54 hour forecasts from the last synoptic time.

The warning position of a tropical cyclone is actually a short range forecast from the last "best" position. The last "best" position is usually about 2 hours old based on land radar or reconnaissance fixes, 3 to 6 hours old based on surface synoptic reports or 6 to 12 hours old based on upper air synoptic reports. It is for this reason that the 0600Z warning, for example, may not agree with the position of the tropical cyclone as indicated by the 0600Z analysis. Amendments are issued when this difference is significant.

The numbers of tropical warnings run consecutively regardless of whether the cyclone is upgraded or downgraded from tropical depression, tropical storm or typhoon. If warnings are discontinued and the circulation regenerates, the new series of warnings are numbered consecutively from the number of the last warning of the previous series. Amendments and corrections are issued as required and these are numbered the same as the warning which they amend or correct.

All 24, 48 and 72-hour forecasts made when a tropical cyclone is of tropical storm or typhoon intensity are verified against the "best tracks" as determined in post-cyclone analysis.

The 1964 verification summary is contained in Chapter IV.

CHAPTER II

EVALUATION OF TECHNIQUES

## A. GENERAL

Aerial reconnaissance is the only method available which provides sufficient data for the proper analysis of a tropical system. Land stations in the Tropical Pacific are widely scattered and ship reports are concentrated along the shipping lanes which do not generally pass through areas of formation and development of tropical systems. Since most of the ships which are near developing systems take evasive action as soon as the first warning is issued, surface data is generally sparse in the vicinity of a typhoon. Aerial reconnaissance, being mobile, provides the position, intensity, indications of past movement, significant features such as eye shape, size and slope, and any changes which occur while the aircraft is near the storm. By using dropsondes, the reconnaissance aircraft are able to obtain the lapse rate profile to the surface, sea level pressure, and surface temperature and dew point at any point.

The accuracy of warnings is directly related to the quality and quantity of aircraft reconnaissance of tropical systems. Continuous surveillance is required on all tropical systems so that initial warnings may be issued in time to insure proper preparations for safeguarding life and property. In the future, part of this early surveillance may be covered by use of satellites equipped with Automatic Picture Transmission. (APT)

## B. SURVEILLANCE METHODS

During 1964, two aircraft squadrons were assigned the primary responsibility for tropical reconnaissance under requirements of the Joint Typhoon Warning Center, Guam. These units were the U. S. Navy Airborne Early Warning Squadron One (VW-1) which is based at Naval Air Station, Agana, Guam, and the U. S. Air Force 54th Weather Reconnaissance Squadron (54WRS) which is based at Andersen AFB, Guam.

The U. S. Air Force 56th Weather Reconnaissance Squadron (56WRS) based at Yokota Air Base, Japan is the primary backup for the 54WRS and provided all low level fixes assigned the 54WRS during 1964. The U. S. Air Force 315th Air Division based at Tachikawa Air Base, Japan was the normal CINCPACAF theater air backup.

The aircraft used by the various squadrons were the EC121K Warning Star by VW-1, the WB-47 Stratojet by 54WRS, and the WB-50 by the 56WRS.

Land radar was utilized as a backup for aerial reconnaissance when a tropical system was within radar range. This information was available from various weather radar and tactical radar sites.

TIROS and NIMBUS satellite reports were utilized during the 1964 season and were especially useful to JTWC in locating areas of possible storm formation. The APT system was installed during the year, and was used for 10 days during the operational life of the NIMBUS system in September, 1964.

### C. EVALUATION OF AERIAL RECONNAISSANCE

During the 1964 season four fixes per day were scheduled on all typhoons and at least two fixes per day on all tropical storms. To allow sufficient lead time for aircraft deployment on developing systems, many tropical storms, which were expected to develop into typhoons within 24 hours or were in critical areas, were also scheduled for four fixes per day. Tropical depressions and cyclones were scheduled for one or more fixes per day depending on location and potential. In general, 1500 ft or 700mb fixes were made by VW-1 at 1000Z and 1600Z, and both high level (300mb) and low level (700mb) fixes were made by the 54WRS and the 56WRS respectively at 0400Z and 2200Z.

Both VW-1 and 54WRS flew synoptic tracks and investigations throughout the season. The bulk of the synoptic tracks over the Trust Territory islands were covered by 54WRS and most of the investigative flights were handled by VW-1.

In spite of problems associated with higher priority missions, a large percentage of the fixes and investigations requested were completed. VW-1 had an outstanding record for the year, with only one requirement not met out of 318 fixes and investigations requested. 54WRS made 192 fixes and investigations with 20 requirements not met, and 56WRS made 263 fixes and investigations with 25 requirements not met.

1964 was the first full season of reconnaissance for the WB-47 aircraft of the 54WRS. It was found that these aircraft could give good radar coverage of any storm which had developed enough to produce a radar picture. In addition, visual reports were obtained when cirrus or middle clouds did not obscure the lower clouds and it was possible in some cases to detect areas of surface calm by the change in the radar "Sea return". In addition, the 300mb doppler winds and temperatures were a valuable addition to the analysis at that level, and amazingly accurate surface wind estimates were obtained when the sea surface was visible. However, since the WB-47 dropsonde system was inoperative throughout the season, no other lower level data was obtained. Other problems encountered were inability to hold station on a storm under most circumstances, and limited range. Also, a blackout of communications occurred whenever the aircraft passed through a cloud. Since most penetrations of mature storms were made through the cirrus cap this meant a delay in receipt of the eye report itself.

During 1964 a VW-1 aircraft established a record by making four fixes on one flight. During the time Typhoons Kathy and Marie were both east of Okinawa the storms were close enough to each other to be both held on radar at the same time. By taking station between the storms and making one fix 30 minutes early and the other 30 minutes late one aircraft was able to move close enough to each in turn for an accurate radar fix.

#### D. EVALUATION OF DATA

##### 1. Aerial reconnaissance data

Aerial reconnaissance data can be divided into three categories, peripheral, eye data from penetration, and eye data from radar.

Peripheral data is all information reported enroute to a storm and outside the eye of the storm. It includes weather, clouds, flight altitude wind, temperature and dew point, and surface wind if the sea surface is visible. Dropsonde data is also provided by WB-50 aircraft and occasionally by EC121K aircraft, giving lapse rate below the aircraft, surface temperature, pressure and dew point, and the height, temperature and

dew point of standard levels below the aircraft. This same type of data is provided on all synoptic tracks and special investigations. All peripheral data from WB-47 aircraft is obtained at 300mb, that from WB-50 aircraft is usually from 700mb but may on occasion be from 500mb or 1500 ft. EC121K aircraft usually fly at 700mb or 1500 ft. unless flight over mountainous islands requires flight at 500mb.

Eye data from penetration includes all information reported in peripheral data plus eye size, shape, description, slope, cloudiness, maximum flight level and surface wind and surge (if any), and any other remarks which might be of help to the forecaster such as feeder band description, present direction and speed of movement of the center, etc. If possible a dropsonde is also made in the eye. If the wind, cloud, pressure and radar eye do not coincide, the type eye reported is specified and bearing and distance given to any others.

Eye data from radar provides a description of the radar eye and its location, including description of spiral bands and height of wall clouds. Also included is the aircraft position at the time the radar observation is taken, and maximum observed winds if possible.

On all eye messages an estimate of the accuracy of the fix and a statement of the type of navigation fix used by the aircraft were given. These were used as a guide by JTWC in estimating fix accuracy, but it is felt that they were more representative of the accuracy of the aircraft position than that of the typhoon eye, especially with radar fixes from a considerable distance, where attenuation can distort the radar image considerably.

During 1964, daylight penetration of typhoons was accomplished on all but a few of the most severe storms by WB-50 aircraft, with daylight overflights on most storms by WB-47 aircraft. When possible, EC121K aircraft also penetrated the storms, largely on daylight or evening fixes, but often also on nighttime fixes.

The data obtained by the various squadrons was good with a very few exceptions. Crew experience varied widely through all

the squadrons, with enough "old hands" carried over from the 1963 season at VW-1 and 56WRS to train the newcomers. Due to the phase-in of a new aircraft, crew experience in typhoon work was low in the 54WRS early in the year. However, due to an aggressive training program, there was a rapid increase in effectiveness through the season. One difficulty faced by all three squadrons was that of obtaining good navigational fixes in those areas where loran navigation is poor. The opening of additional loran stations should help this problem.

SUMMARY OF RECON ERROR FOR 1964  
(Vector Error of Fix from Best Track)

	<u>54WRS</u>	<u>56WRS</u>	<u>VW-1</u>
As Tropical Depression	29 MI*	17 MI	15 MI
As Tropical Storm	29 MI*	16 MI	19 MI
As Typhoon Only	11 MI	08 MI	08 MI
For All Fixes	16 MI	11 MI	12 MI

Average for the year for all fixes for all squadrons= 12 MI

\* This table does not include several cases in which tropical systems were located on pressure profile by low level aircraft and could not be located at all by WB-47 aircraft.

The information received from all reconnaissance aircraft was continually checked for consistency and accuracy. Where possible, JTWC graphs and other aids were used to check for continuity with previous reports. Any apparent discrepancy was checked with the observing aircraft when possible.

## 2. Land Radar

Land radar reports were used in conjunction with aircraft reports whenever possible. These reports included range and bearing of the eye from the station, eye characteristics and occasionally direction and speed of movement of the eye. A combination of attenuation, operator inexperience, and the fact



that the radar could "see" only the top of the storm made distant land radar reports often inaccurate. However, as the storm approached the station, the accuracy usually improved markedly.

### 3. Satellite Reports

Miscellaneous satellite bulletins giving information on tropical systems were received periodically throughout the season. While many of these bulletins provided only a verification of past fixes, on a few occasions they were very useful as the basis for scheduling investigative missions, and led indirectly to the location of several tropical storms. These bulletins could be much more useful to JTWC if their receipt was more timely.

Due to the small time lag involved, the APT system was very useful during its brief life. Typhoon TILDA developed northwest of Guam during this period, and was picked up as a "comma configuration" on APT pictures over 24 hours before it reached the tropical storm stage. APT satellite pictures, if regularly received, would reduce the need for synoptic tracks and investigative missions, and with a backlog of interpretive experience, would eventually cut down the number of fixes needed on developed tropical storms.

### E. COMMUNICATIONS

Radiotelegraph (CW) is the primary means of communication between the ground and aircraft for VW-1 and 56WRS. For the WB-47's of 54WRS, the primary contact is by voice broadcast. For all aircraft, AIE2, Andersen AFB, Guam, is the primary air-ground contact, with AIF-8, Yokota AB, Japan, and AIC-2, Clark AB, Republic of the Philippines, secondary stations. In all cases AIE-2 is responsible for relay of reports to JTWC via local circuit 3L28. This circuit also serves VW-1 and 54WRS.

When aircraft were in contact with AIE-2, most reports were received in JTWC in sufficient time to enable the forecaster to make a comprehensive study of the data before warning time. However, when the aircraft was working secondary stations, the reports were quite frequently unavailable at JTWC before warning time, and had to be tracked down by the forecaster through use of long distance telephone links or "wirenotes." This was

especially true of AIC-2, where the use of regular AIROPNET messages often led to a delay of up to 24 hours in time of receipt. This situation was encountered with practically all fixes in the South China Sea, and without the use of Fleet Weather Facility, Sangley Point as an alternate relay point, it would have been even more of a problem. It is hoped that the establishment of a cable connection between Guam and the Philippines will help reduce this problem.

F. SUMMARY OF RECONNAISSANCE SUPPORT

A summary of the aircraft reconnaissance support provided during 1964 as well as a comparison of reconnaissance provided in recent years is shown in the following table:

1964 AIRCRAFT RECONNAISSANCE DATA

UNIT	<u>TROPICAL CYCLONES (52)</u>			<u>SYNOPTIC TRACKS</u>
	<u>NO. OF SORTIES</u>	<u>NO. OF FIXES/ INVESTIGATIONS</u>	<u>BONUS</u>	<u>NO. OF SORTIES</u>
VW-1	238	317	16	114
54WRS	192	192	6	218
56WRS	186	263	11	2
OTHER USAF	-	-	2	-
CIVILIAN	-	-	1	-
TOTALS				
1964	616	772	36	334
1963	356	465	8	170
1962	373	496	10	126
1961	304	350	27	---

G. EVALUATION OF NUMERICAL WEATHER PRODUCTS

During 1964 operational steering forecasts based on numerical prognoses were received at JTWC from the Fleet Numerical Weather Facility (FNWF) Monterey, California and

occasionally from the National Meteorological Center (NMC), Suitland, Maryland. Due to the proximity of most typhoon tracks to the boundary of the NMC grid, the NMC forecasts were of limited use. However, on storms which moved well north of Guam, the NMC forecast was compared with the FNWF product.

Operational steering predictions were furnished by FNWF on 40 storms during 1964. According to verification performed by FNWF "Average errors were comparable to the previous season's experience; however, the JTWC Guam forecasts as issued showed significantly lower error than the numerical product on which they were based contrary to previous experience."

For the 1965 season FNWF plans to make further refinements in the steering computations using three different steering levels. These refinements combined with greater familiarity with the possible errors inherent in the system should lead to increased forecast accuracy in 1965.

#### H. EVALUATION OF OPERATIONAL FORECAST PROCEDURES

The basic forecasting technique used throughout the 1964 season was a subjective modification of the numerical steering prediction. Modifications were based on climatology (see Chapter I), and subjective evaluation of micro-analyzed 700, 500, 300 and 200mb charts, with emphasis on the 700mb chart.

In all cases the steering forecast was first checked for abnormal cyclonic curvature, since the steering model used in 1964 did not remove the storm circulation successfully on large storms. If the steering forecast looked reasonable from this standpoint, it was then checked for consistency with climatology and past history. Finally the upper air charts were checked for areas of maximum divergence, areas offering the least resistance to the forward motion of the storm and the 700mb height criteria of Wang.

A subjective integration of all the factors listed above was then used to establish or modify the forecast track of the system. Speed of movement was then forecast from history, climatology, and the steering forecast.

It is felt that this subjective modification of the numerical product is at present superior to any available regression type forecast and offers the best hope for improved typhoon forecasting. In all tests made by this organization the present system has consistently beaten all objective techniques. As further experience is developed in the interpretation of numerical forecasts the accuracy of this type of forecast should improve considerably.

CHAPTER III

JTWC STUDIES

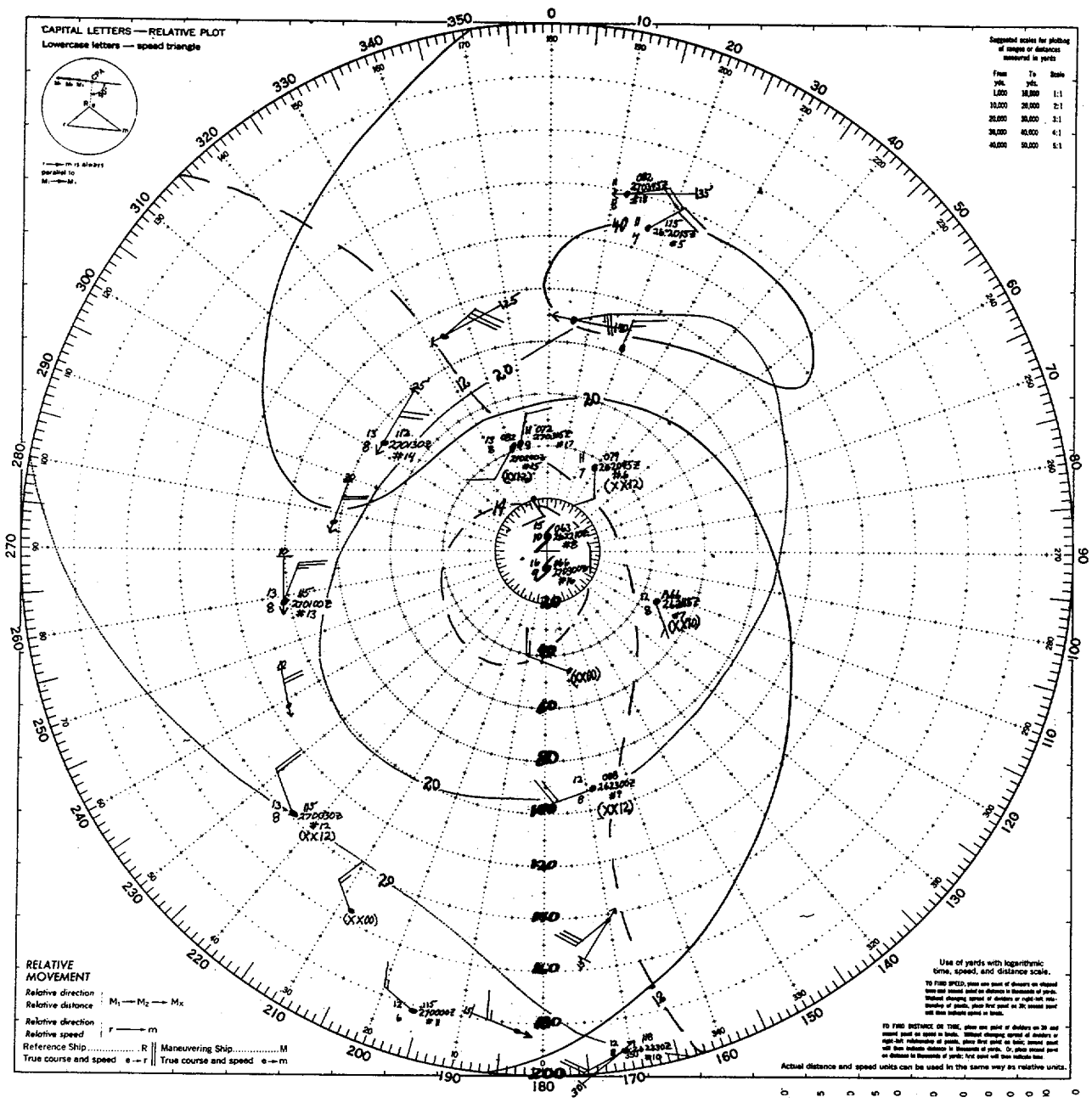
## AN EXAMPLE OF "EXTRA-TROPICAL SURGE" IN TYPHOON HOPE

Since the advent of 700mb typhoon reconnaissance, many cases of low level wind surge have been reported. In most cases, these are of relatively short duration and cause at most a 50% increase in wind speeds. However, there appears to be a surge of 6-12 hours duration connected with the first intrusion of extra-tropical air into the system which can increase wind speeds by as much as 300% near the surface. The following example is based on daylight reconnaissance of Typhoon Hope.

The three charts are based on low level (700mb) reconnaissance tracks flown over three successive days by the 56th Weather Recon Sqdn, MATS, using WB-50 aircraft. Supplementary data has been obtained from high level (300mb) tracks flown by the 54th Weather recon sqdn using WB-47 aircraft. On each day the WB-50 was on station in the storm area for approximately 8 hours. The data have been plotted using a moving co-ordinate system based on the typhoon center, with center positions obtained from the JTWC "Best track". Since two penetrations were made on each day, the eye data reports have been plotted above and below the chart center. The charts have been analysed for temperature and isotach values at 700mb and isotach values at the surface.

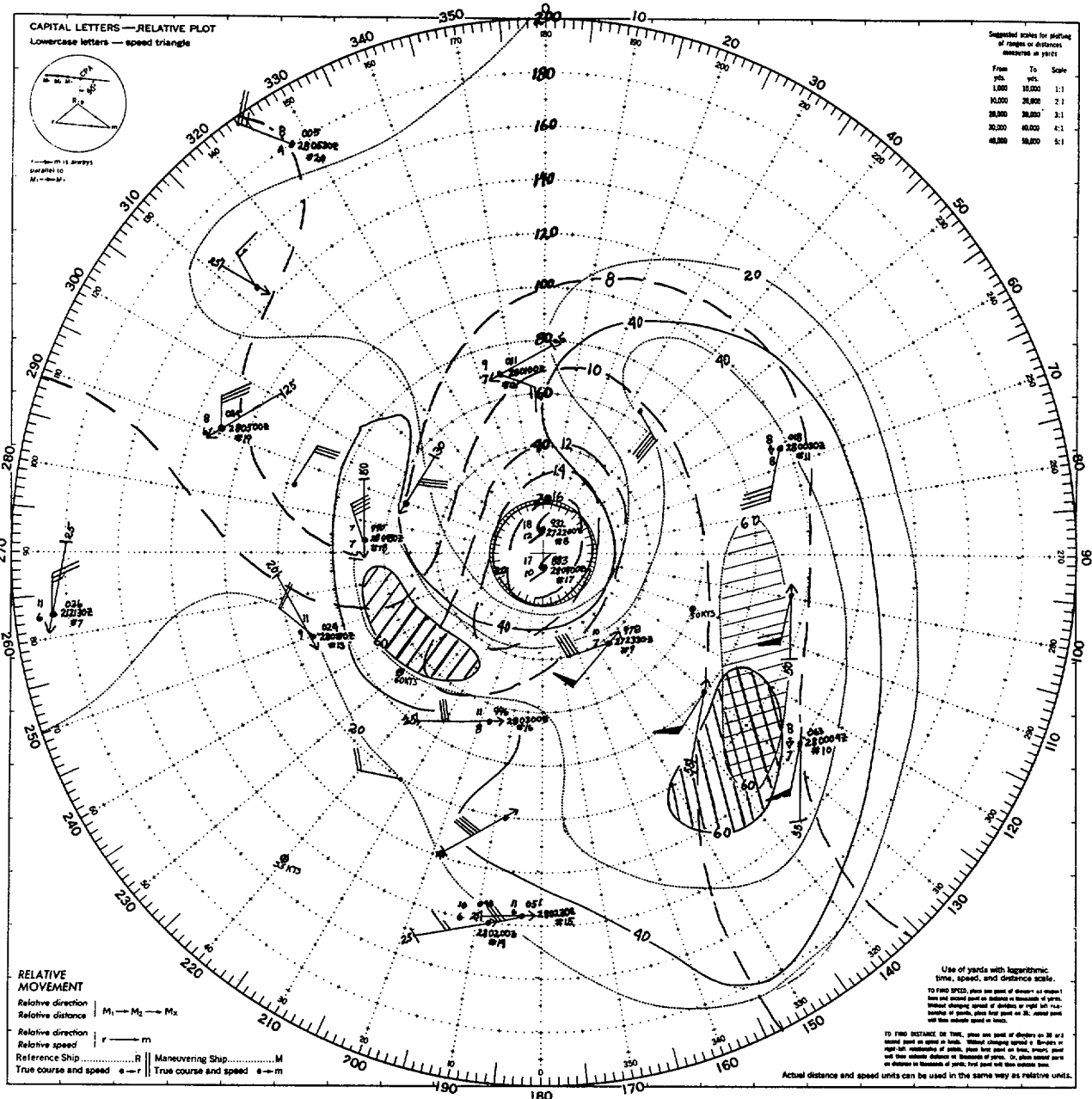
Chart #1 covers the daylight recon for 27 October. At this time Hope had been moving slowly northward through the subtropical ridge for 24 hours with little change of intensity. The 700mb temperature gradient was almost flat, with a slight max over the storm center. Strongest surface winds were 40-45 knots in the north quadrant, with no 700mb winds above 30 knots reported.

By the next day (Chart #2) Hope was travelling NNE and forward movement had increased from 7 knots to about 15 knots. A wedge of cold air at 700mb was moving south in the west quadrant, while the warm air was being carried north with the storm in the east quadrant. Temperatures and dew points had actually increased in the eye, possibly due to the deepening of the storm center and consequent lowering of the 700mb surface. At this time two surface isotach max centers were observed. One



#1 HOPE  
 27 OCT. 1964

--- 700MB TEMPERATURE  
 ——— SURFACE ISOTACH  
 - - - 700MB ISOTACH

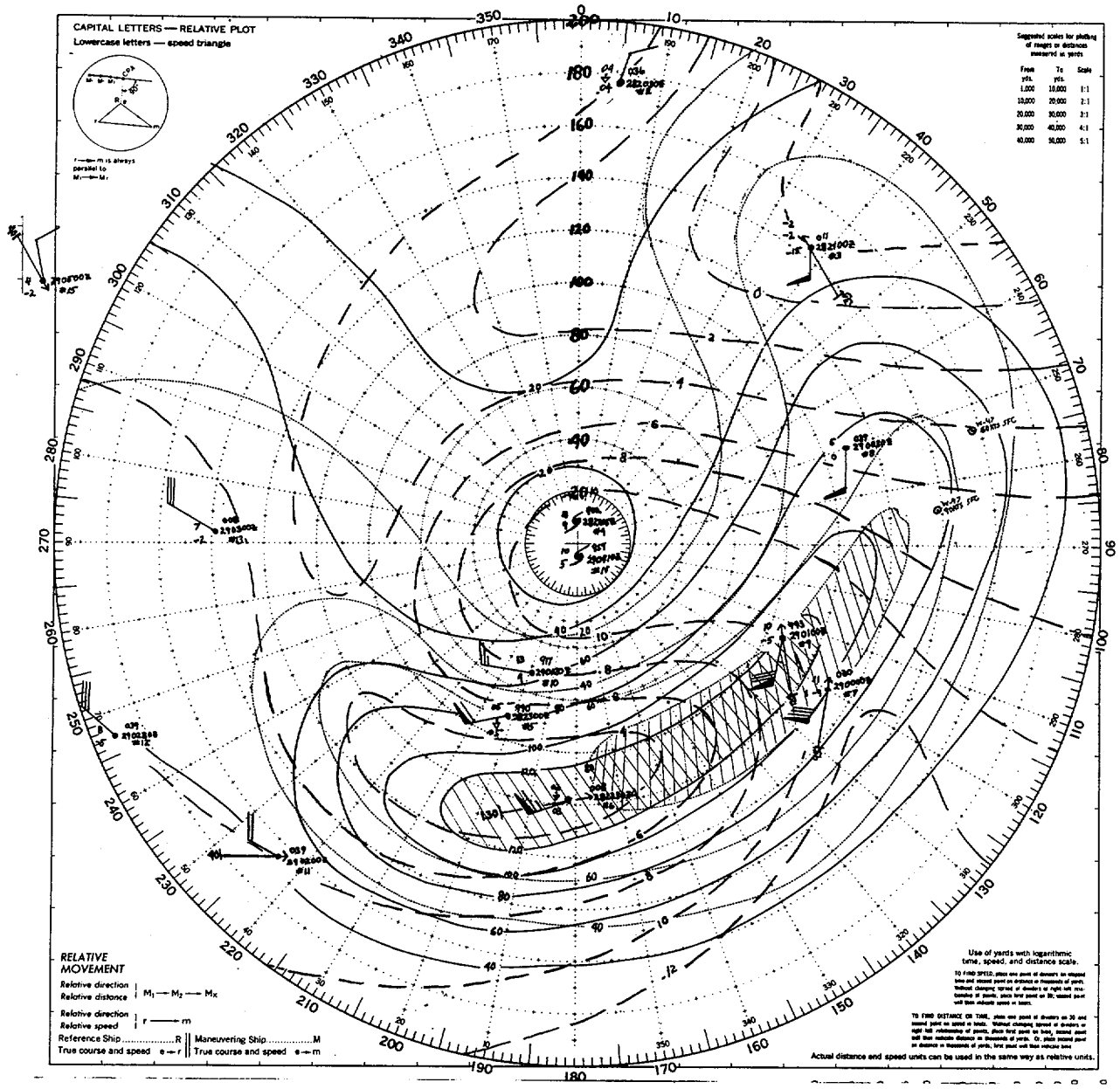


#2

HOPE  
28 OCT. 1964

- 700MB TEMPERATURE
- SURFACE ISOTACH
- 700MB ISOTACH





# 3  
HOPE  
29 OCT. 1964

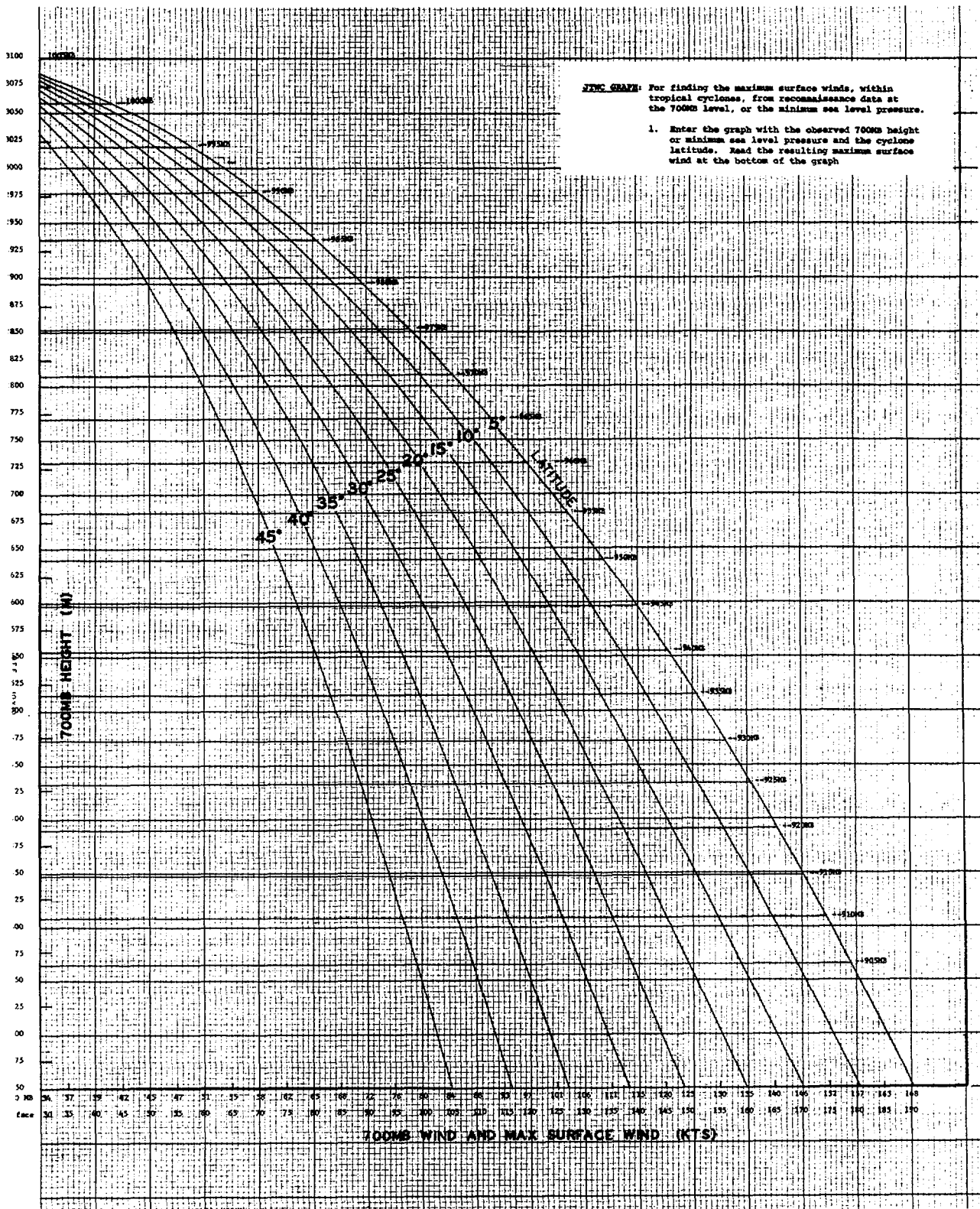
--- 700MB TEMPERATURE  
--- SURFACE ISOTACH  
--- 700MB ISOTACH

near the leading edge of the warm air being carried north with the storm, the other on the "nose" of the cold air moving to the south. Both centers showed values of approximately 60 knots at the surface, with the eastern center also showing 60 knots at 700mb.

On the third day (Chart #3) the storm was accelerating from 24 to 30 knots toward the NE. The cold air had now penetrated to the south quadrant, and the warm air pocket at the center was weakening and was almost cut off. At this time a single isotach max of at least 80 knots at 700mb was located on the "nose" of the cold air wedge, with a 130 knot surface isotach max below and slightly upwind toward the colder air. An interesting feature of this chart is the tremendous indrafting observed at the surface. Even discounting forward motion of the storm, values as high as 40 knots are found in the southeast quadrant.

Unfortunately, the aircraft aborted on the 30th of October and no recon data is available for the fourth day. However, analysis of a fairly dense network of surface ships showed an extra-tropical system with maximum surface winds of 45 knots.

It is felt by JTWC that this is a classic example of a recurrent event. Since this phenomenon was first identified by Lt. Col. R. C. Lane during the 1963 typhoon season, it has been observed in every case when a typhoon became extra-tropical over open water and reconnaissance aircraft were in the area at the time. While no direct cause has been found for this surge, it is believed to be connected in some manner with the increase in release of latent heat caused by the under-running cold air. If 700mb daylight reconnaissance is available for the 1965 season, further research is planned on this phenomenon.



## JTWC GRAPH

The graph for finding maximum surface winds was based on seven years of reconnaissance data. The data, 1956 through 1962, was used to modify the equation of Captain L. E. Fortner, Jr. (1956), Typhoon SARA, Bulletin of the American Meteorological Society, Vol. 39, pp. 633-639. The present graph includes a change in one of the constants in the basic equation. The refinement modifies the graph in the area of higher pressures and lower wind speeds.

The resulting equation is:

$$V_{\max} = (19 - \frac{\theta}{5}) \sqrt{\frac{364 - H_7 \text{ (FT)}}{28}}$$

Which was obtained from a best fit of the data from the years 1956 through 1962.

Where:  $V_{\max}$  = Maximum surface wind  
 $\theta$  = Latitude of tropical cyclone  
 $H_7$  = Minimum 700mb height in cyclone center

The equation for converting maximum 700mb wind observed during penetration to maximum surface wind within the cyclone is:

$$V_{\max} = -100 + \sqrt{500V_7}$$

Where:  $V_{\max}$  = Maximum surface wind  
 $V_7$  = Maximum 700mb wind observed during penetration\*

This equation utilized data for the years 1956 through 1962 also. The equation is not defined when the 700mb wind is less than 20 knots.

\*Note: Reconnaissance aircraft pick the weakest portion of the tropical cyclone for penetration; therefore, the observed 700mb wind will, in most cases, be less than the maximum 700mb wind for the cyclone.

## A 700mb NUMERICAL GRID FOR TYPHOON MOVEMENT FORECASTING

Since the installation of a CDC 160-A computer at FWC/JTWC Guam, research has been started on a steering forecast based on a hand micro-analysis of the 700mb surface. The 700mb surface was chosen for two reasons: first, because it is apparently one of the better predictors of typhoon movement, and second, because of the mass of additional data available locally as a result of reconnaissance flights.

At the present time, the 700mb surface is hand-analyzed for a 10-meter interval every 12 hours and heights picked off an eight (N-S) by nine (E-W) point grid centered over the storm are fed into the computer. At present a grid spacing of 1.4 inches is used on a 1:15,000,000 polar stereographic chart, giving a distance of approximately 180 NM between grid points at 10N. Experiments have indicated that this is the optimum spacing to include all significant features without introduction of extraneous "noise".

The computer program first replaces the value at the center point of the grid (i.e., directly over the storm) with an average of the four surrounding points. This removes most of the storm circulation from the grid on all but the largest storms. Then a smoother is run over the grid and a difference field between analysis and smoothed field produced. The computer then prints the original grid, the smoothed grid, and the difference field. These fields are then hand-analyzed for the grid values and compared to the actual movement of the storm in the next 24 hours.

At first a standard Fjortoft "Z-bar" field was used in place of a smoother, but it was found that considerable mechanical instability was introduced in systems with large circulation areas.

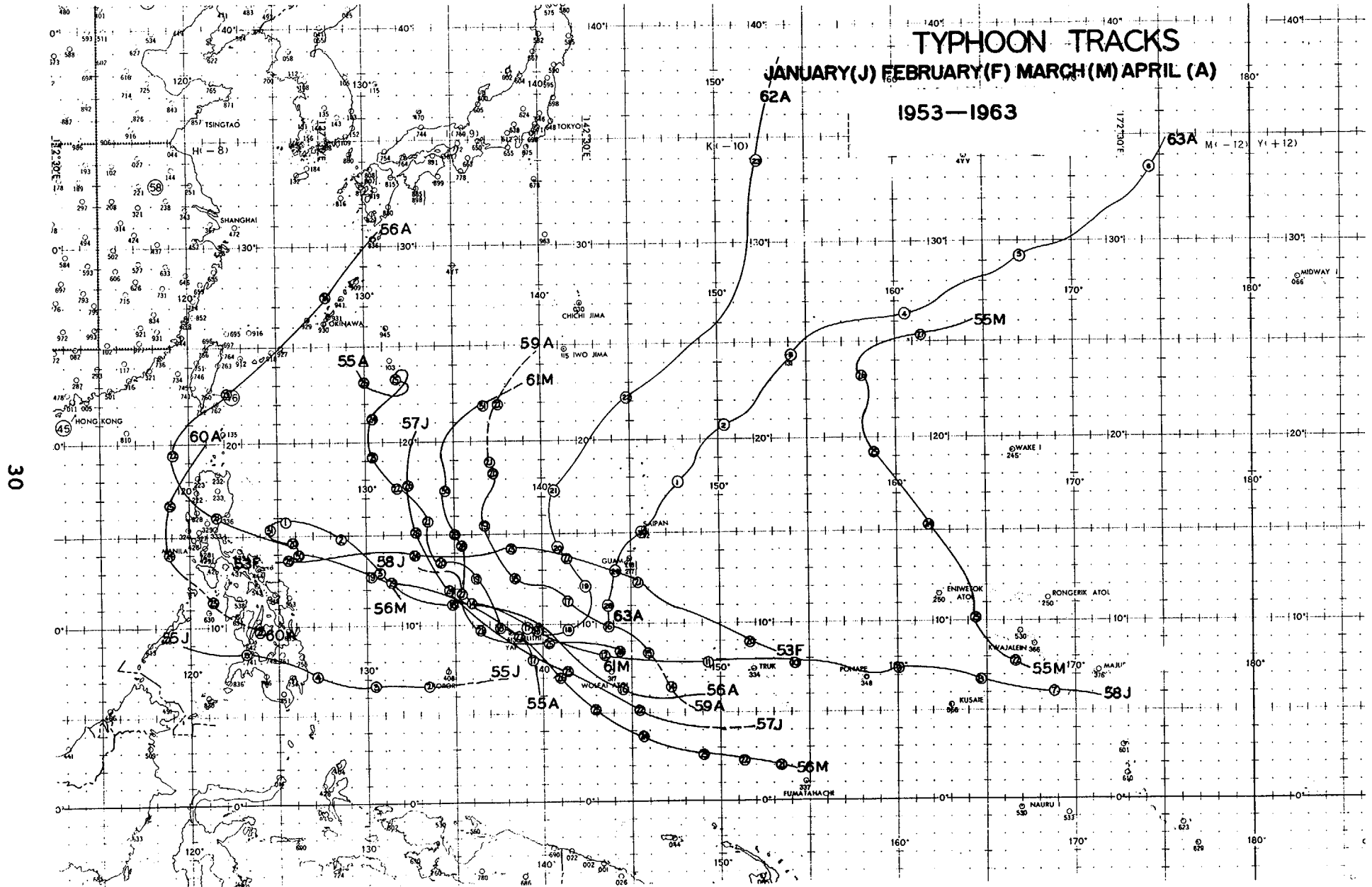
Preliminary experiments with Typhoon KATHY (12-25 Aug) indicate that a useful forecast of 24 hour direction of movement and a rough indication of speed of movement can be evolved from this technique. Experiments are being conducted on varied smoothers in an effort to overcome the instability mentioned above and the method will be tested on other storms before the start of the 1965 season. If further experiments seem justified, a set of objective rules will be drawn up for an operational test.

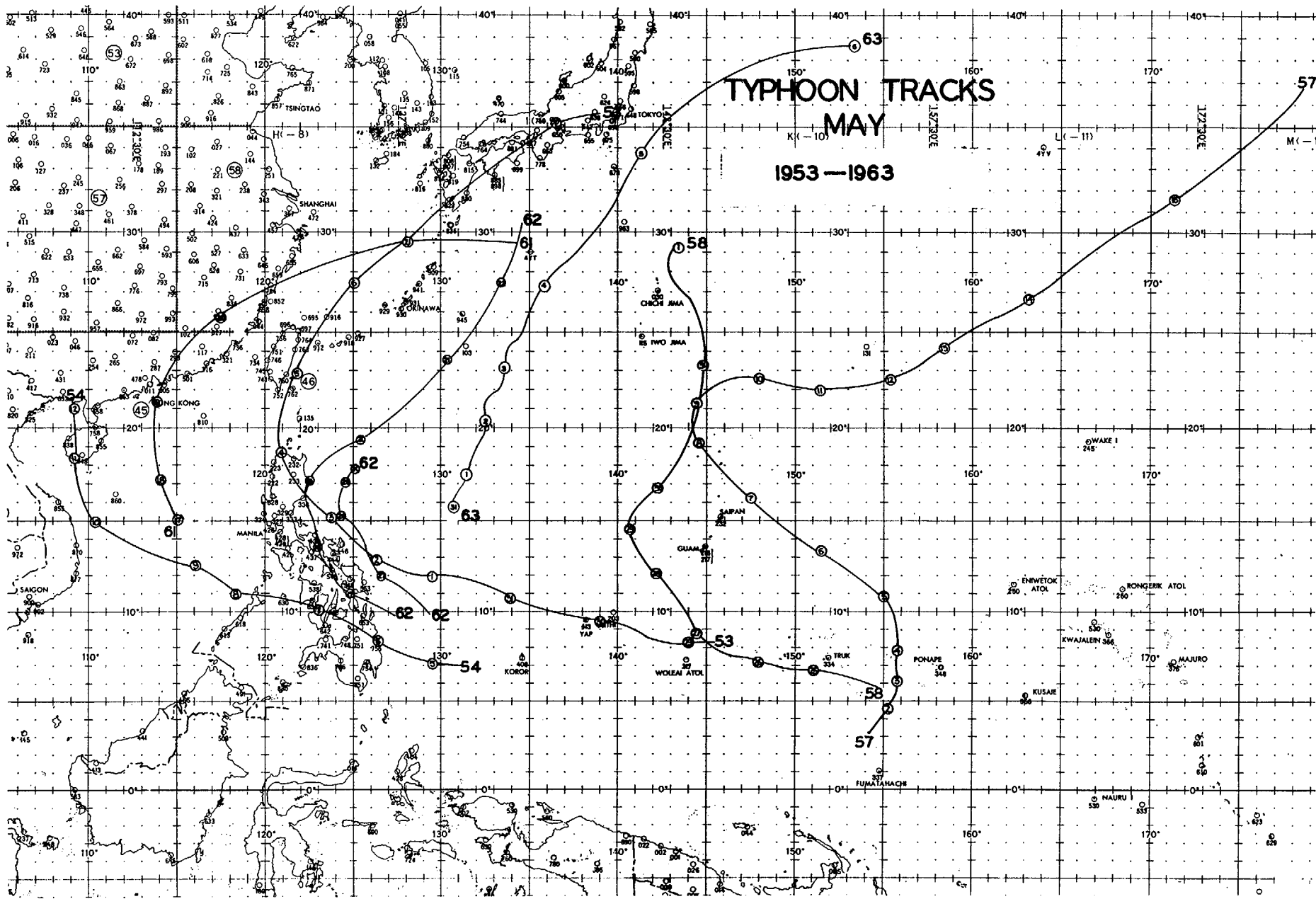
TYPHOON TRACKS 1953 - 1963

# TYPHOON TRACKS

JANUARY (J) FEBRUARY (F) MARCH (M) APRIL (A)

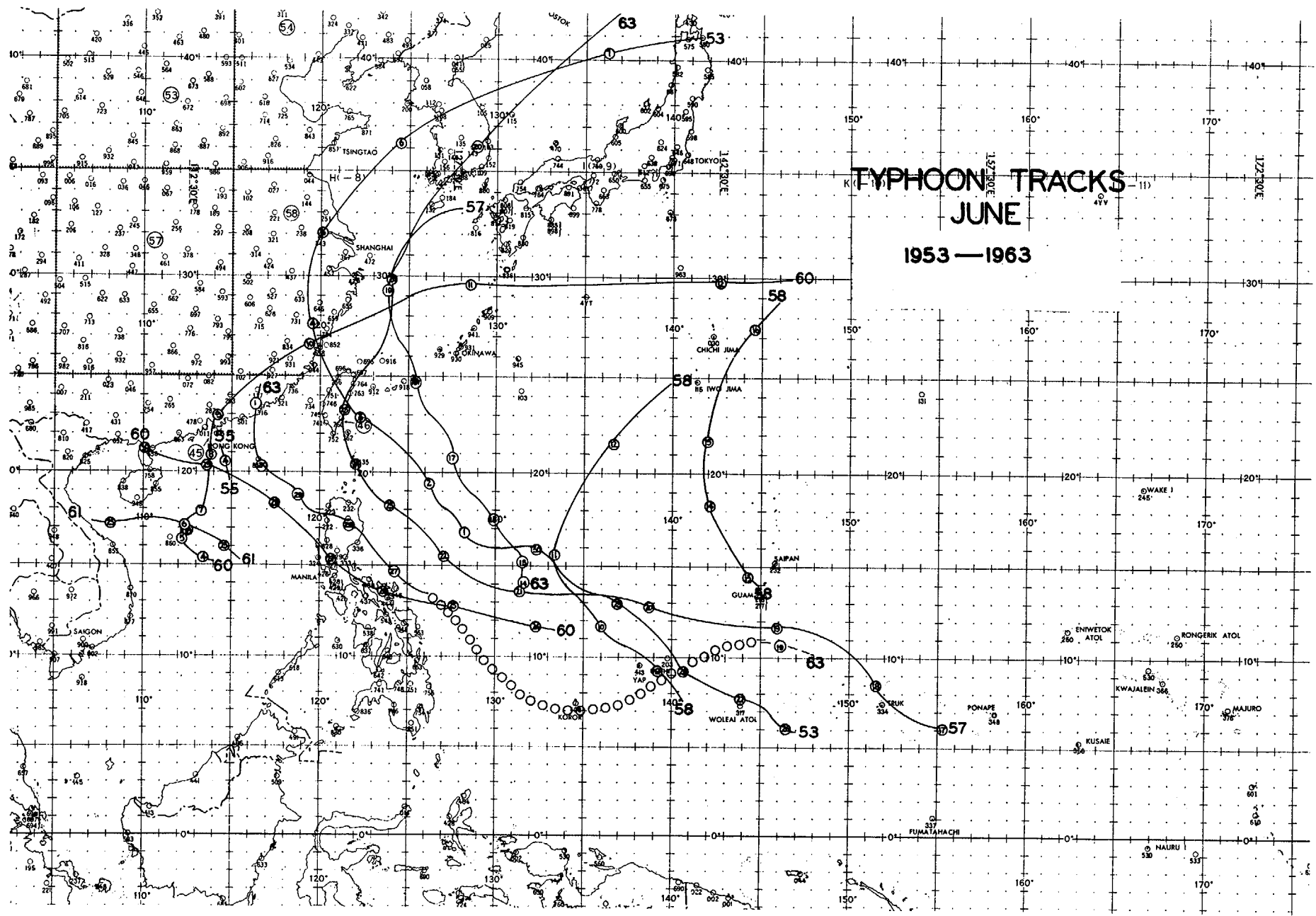
1953-1963

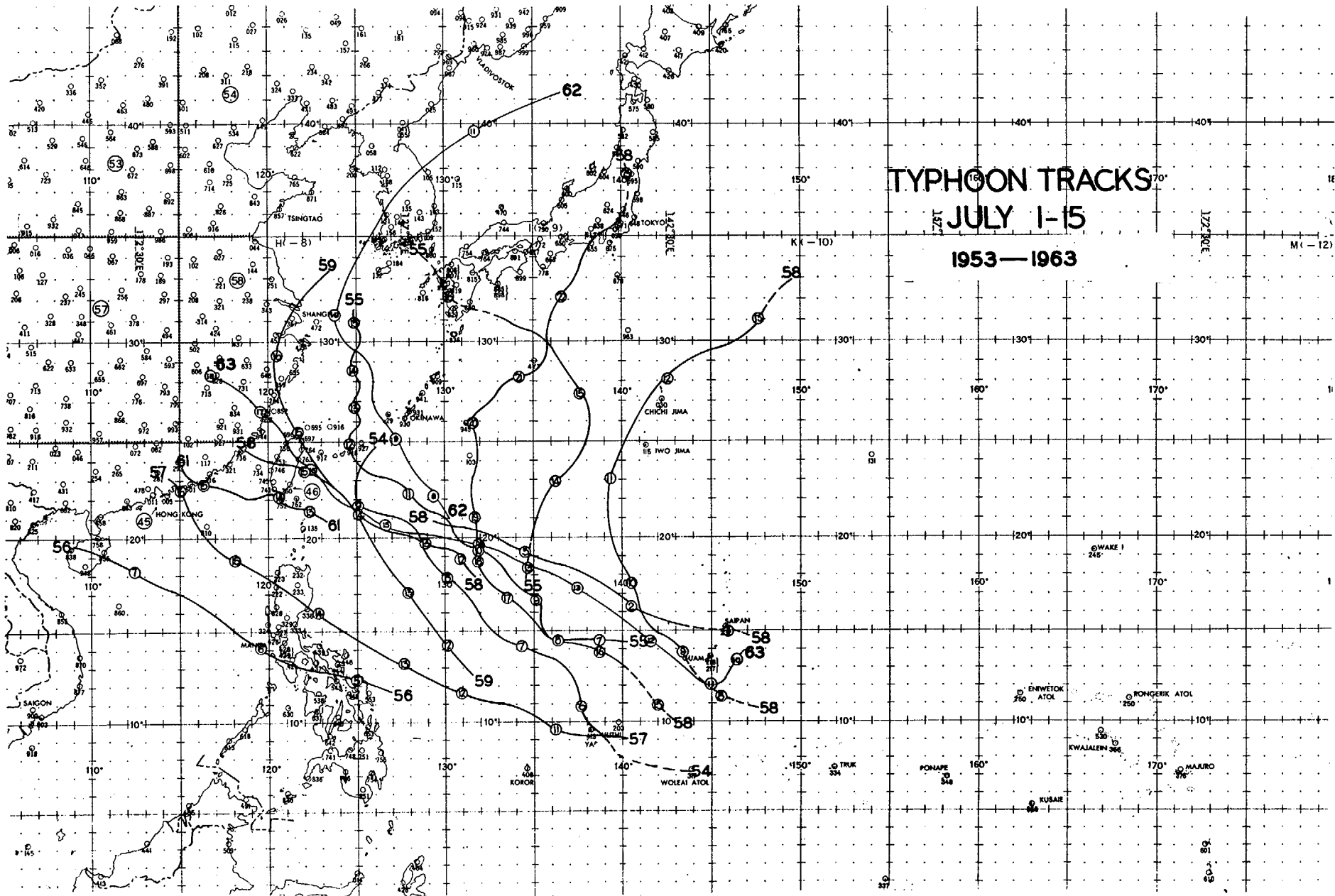






# TYPHOON TRACKS JUNE 1953 — 1963



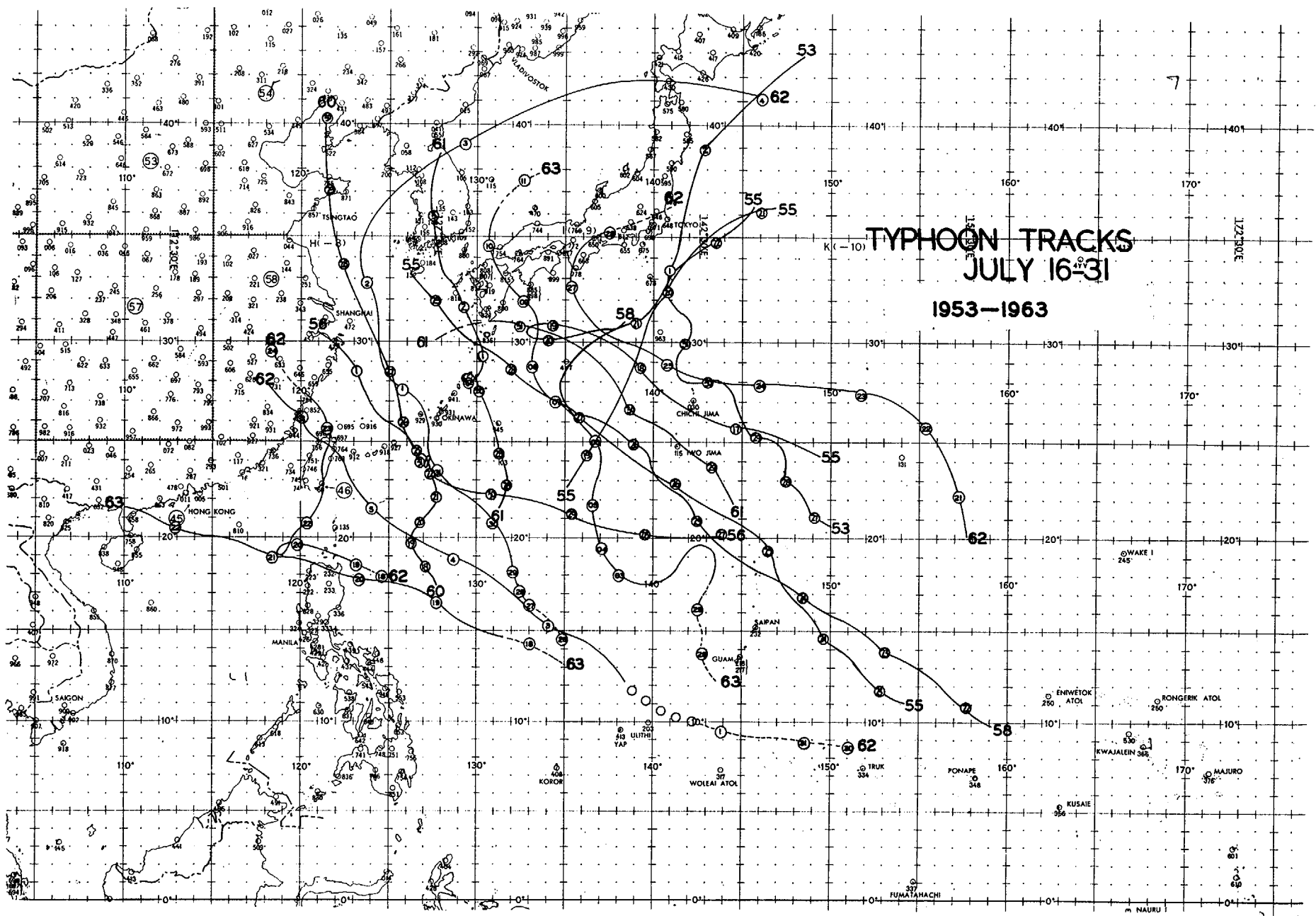


# TYPHOON TRACKS

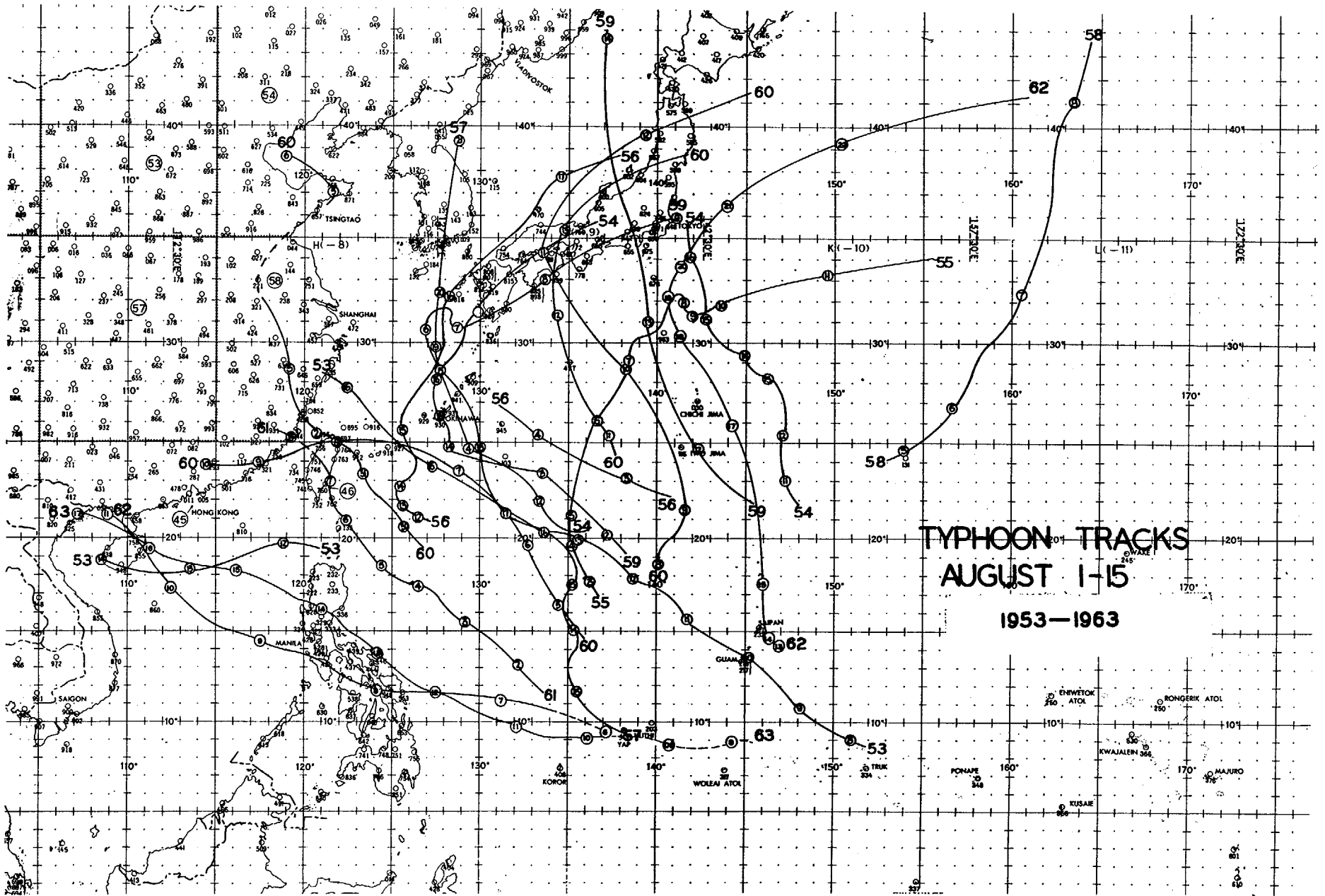
## JULY 1-15

### 1953-1963

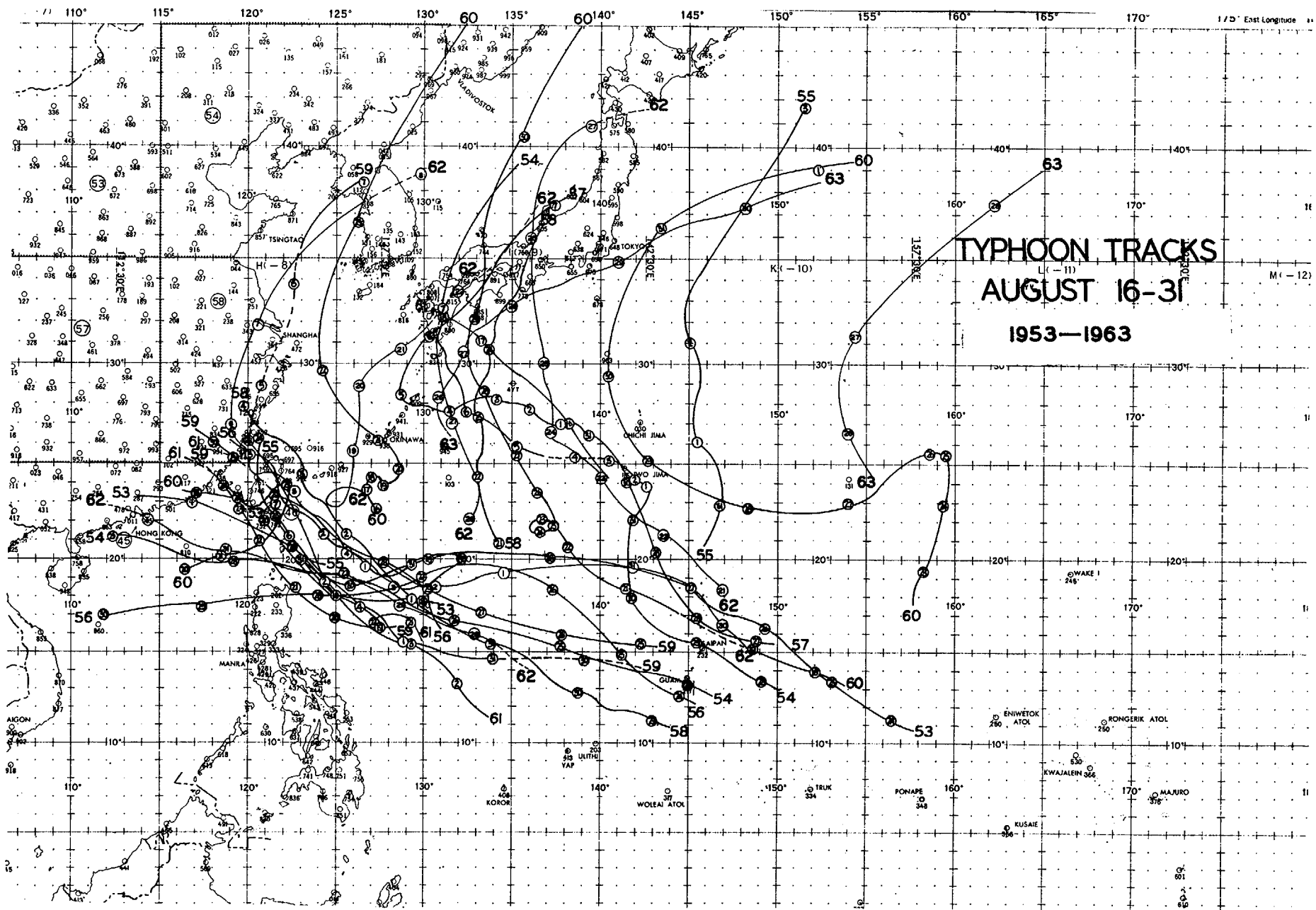
M (12)



# TYPHOON TRACKS JULY 16-31 1953-1963



TYPHOON TRACKS  
AUGUST 1-15  
1953-1963



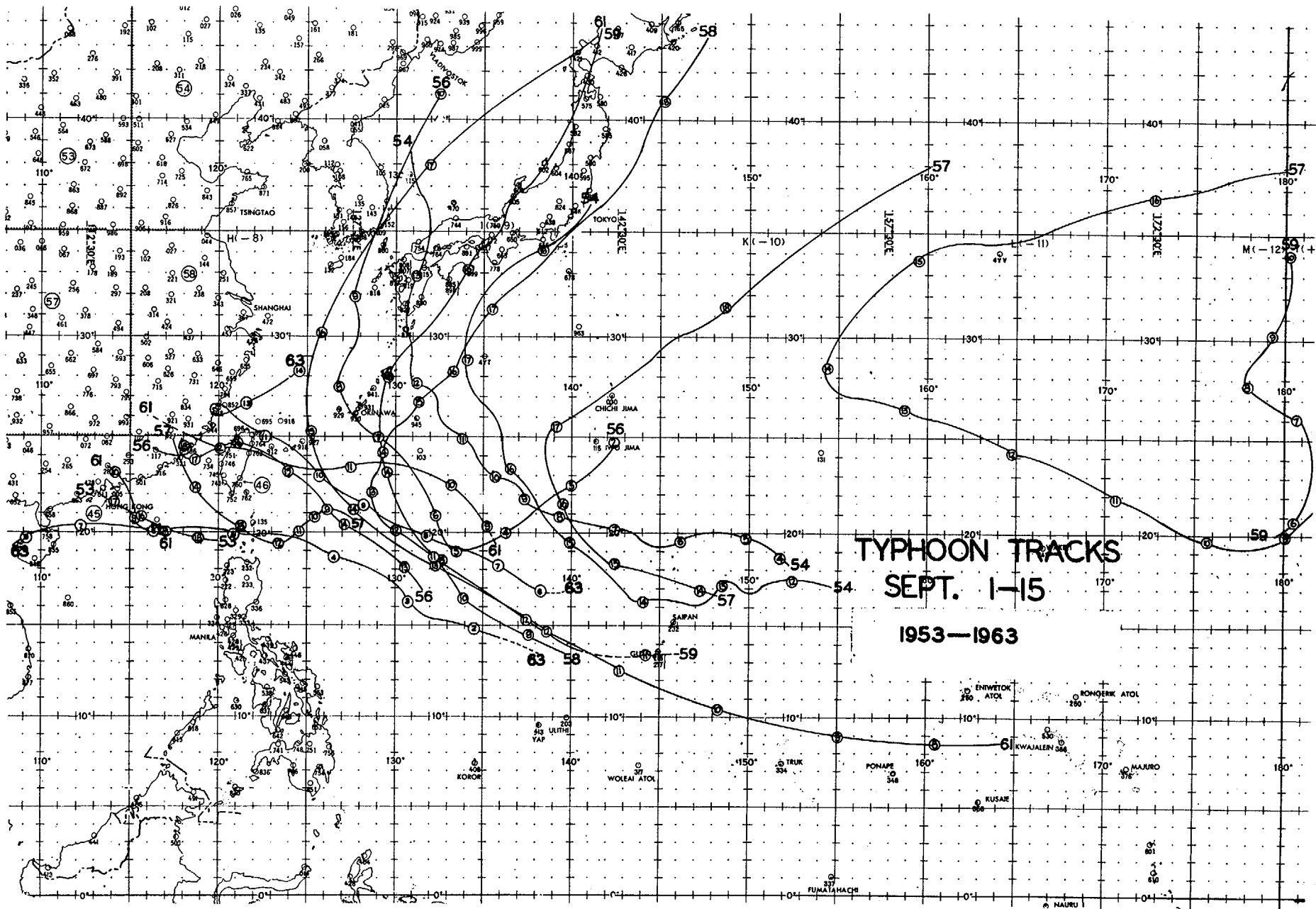
36

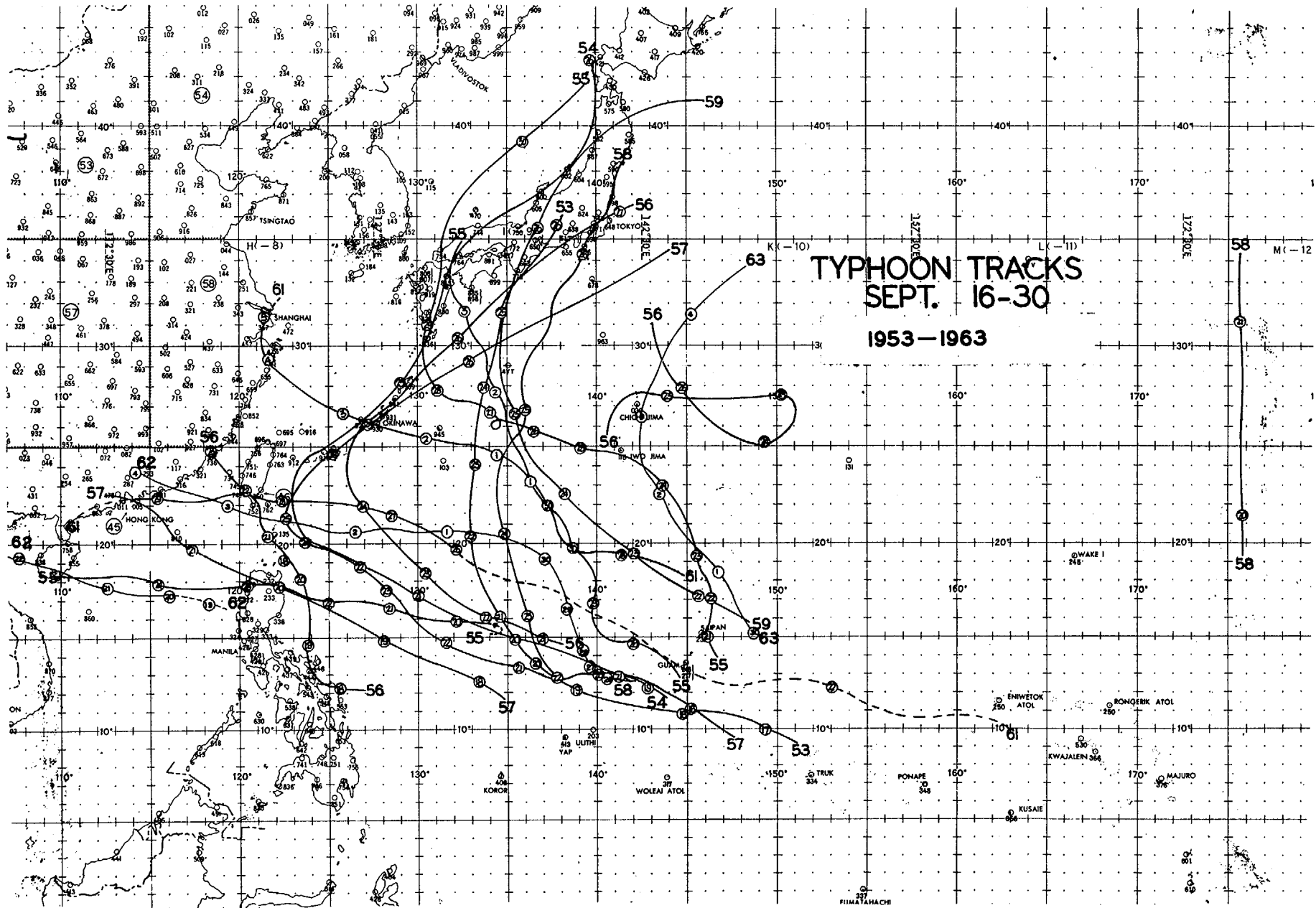
# TYPHOON TRACKS

L(-11)  
AUGUST 16-31  
1953-1963

M(-12)

170° East Longitude



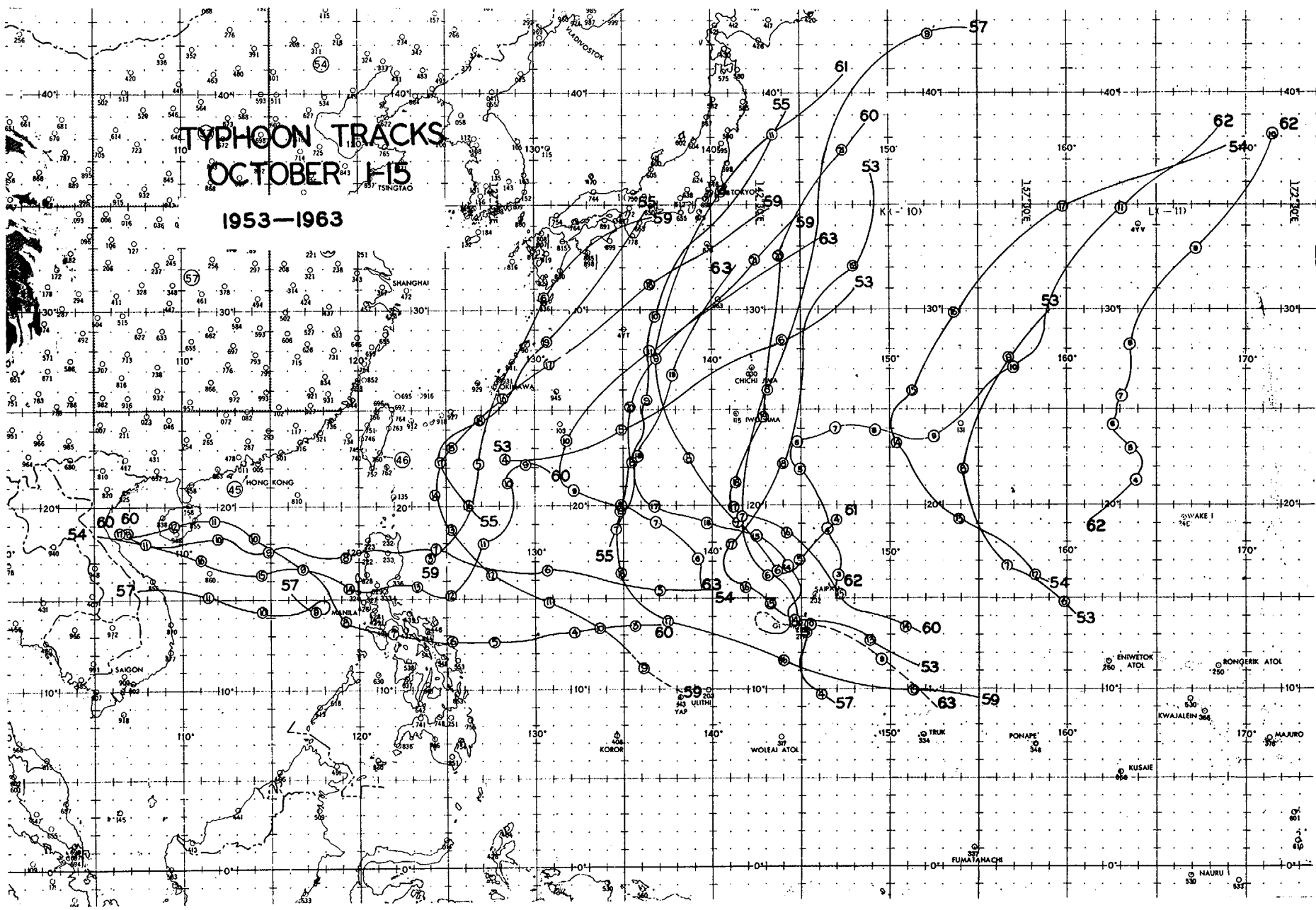


TYPHOON TRACKS  
SEPT. 16-30  
1953-1963

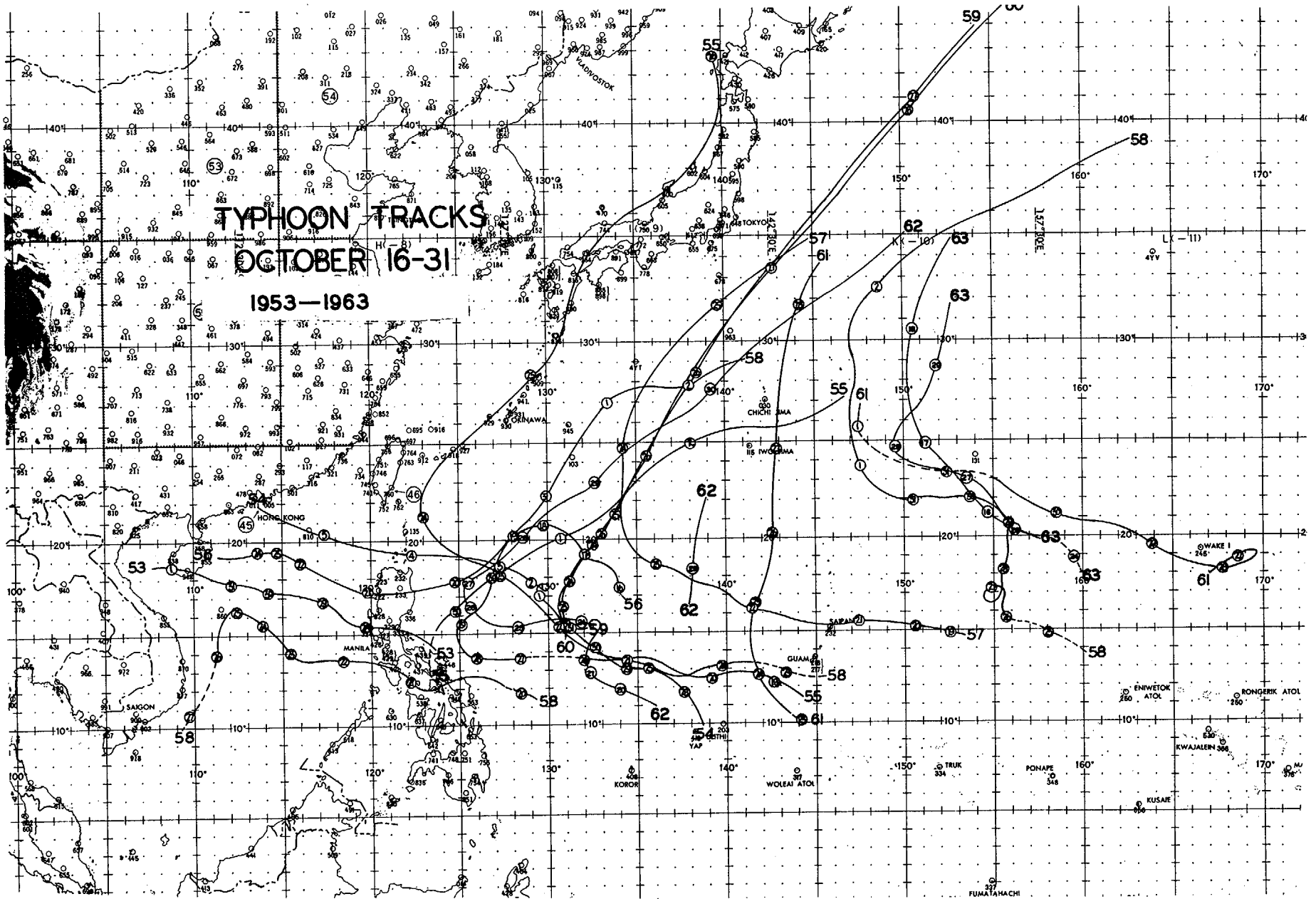
# TYPHOON TRACKS

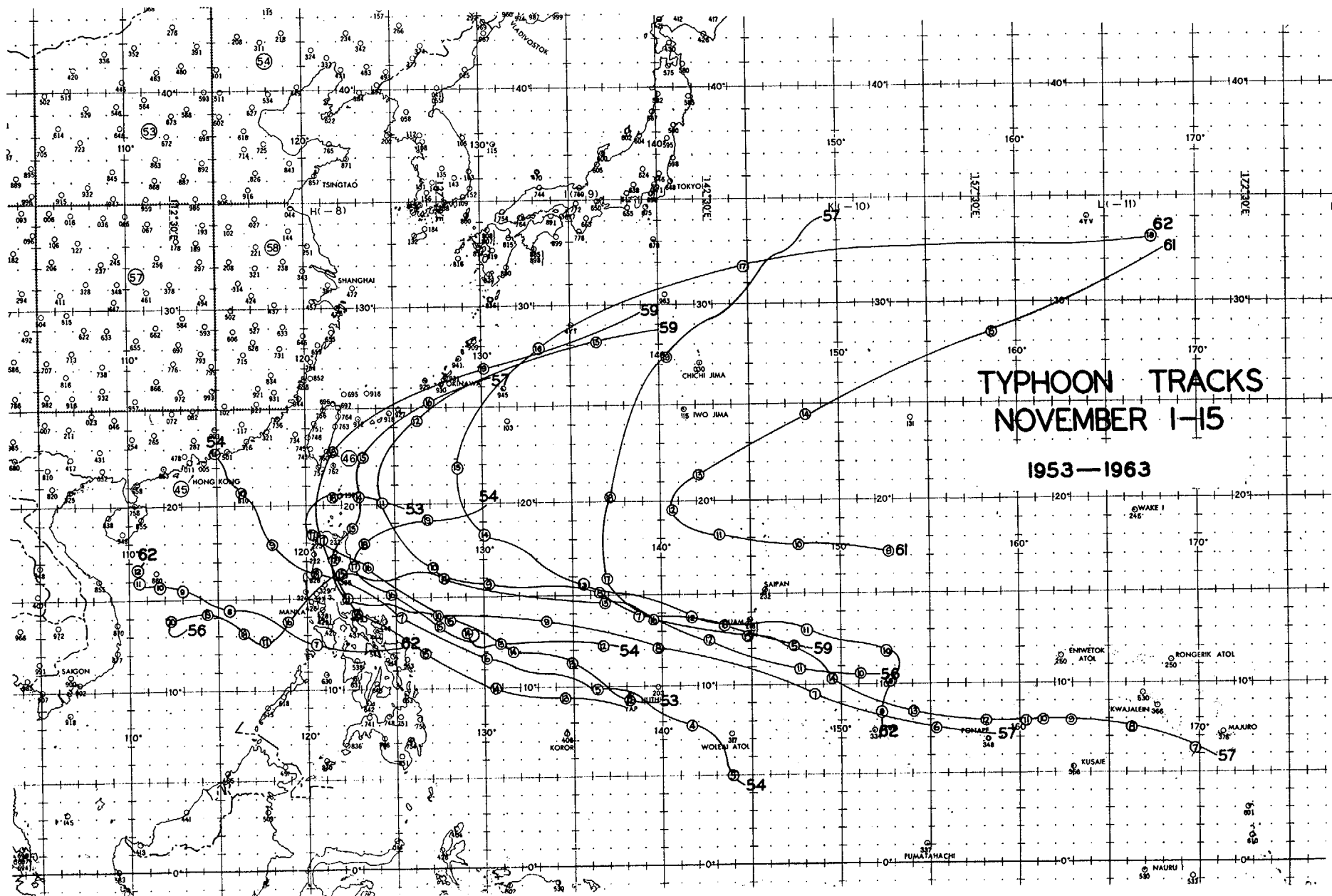
## OCTOBER 1-15

### 1953-1963

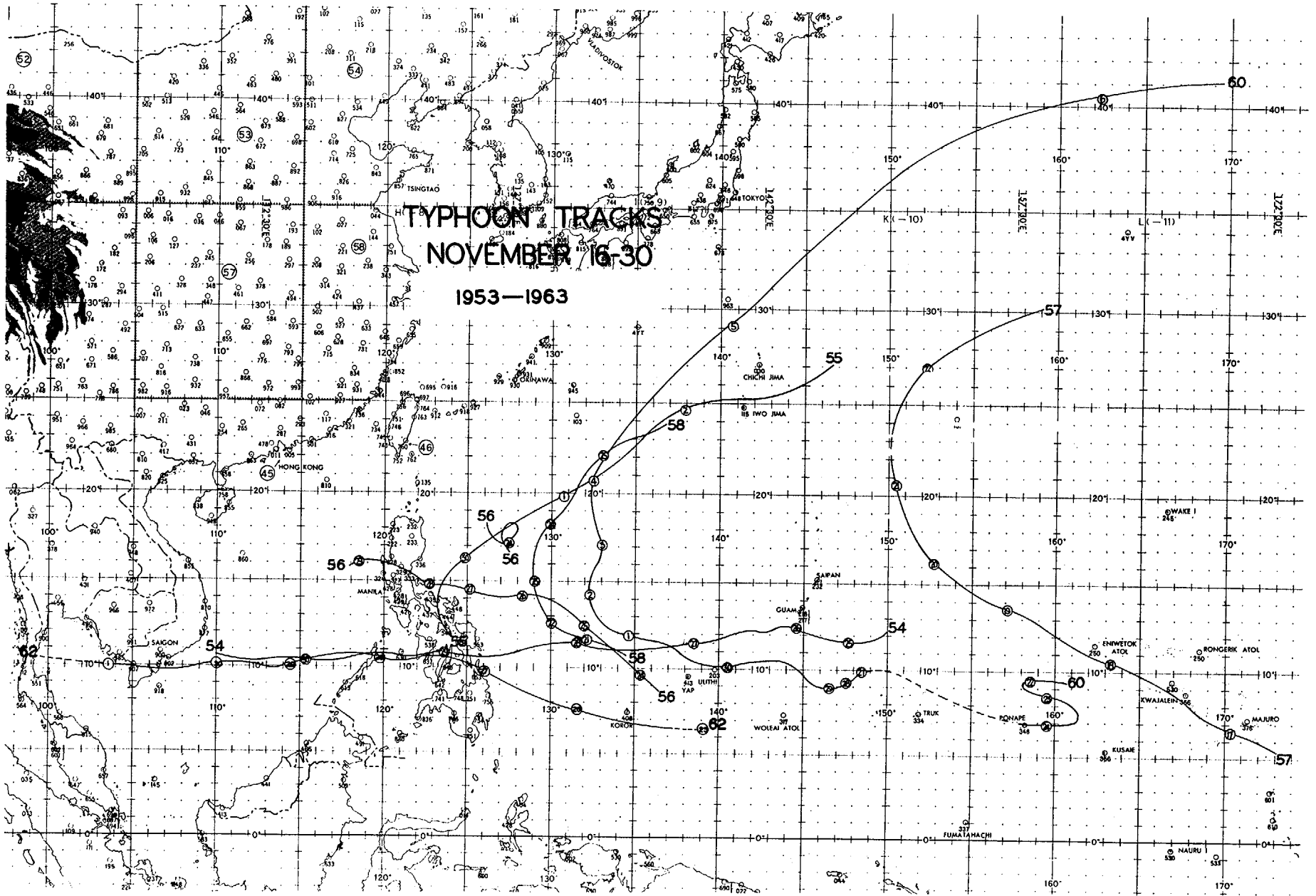


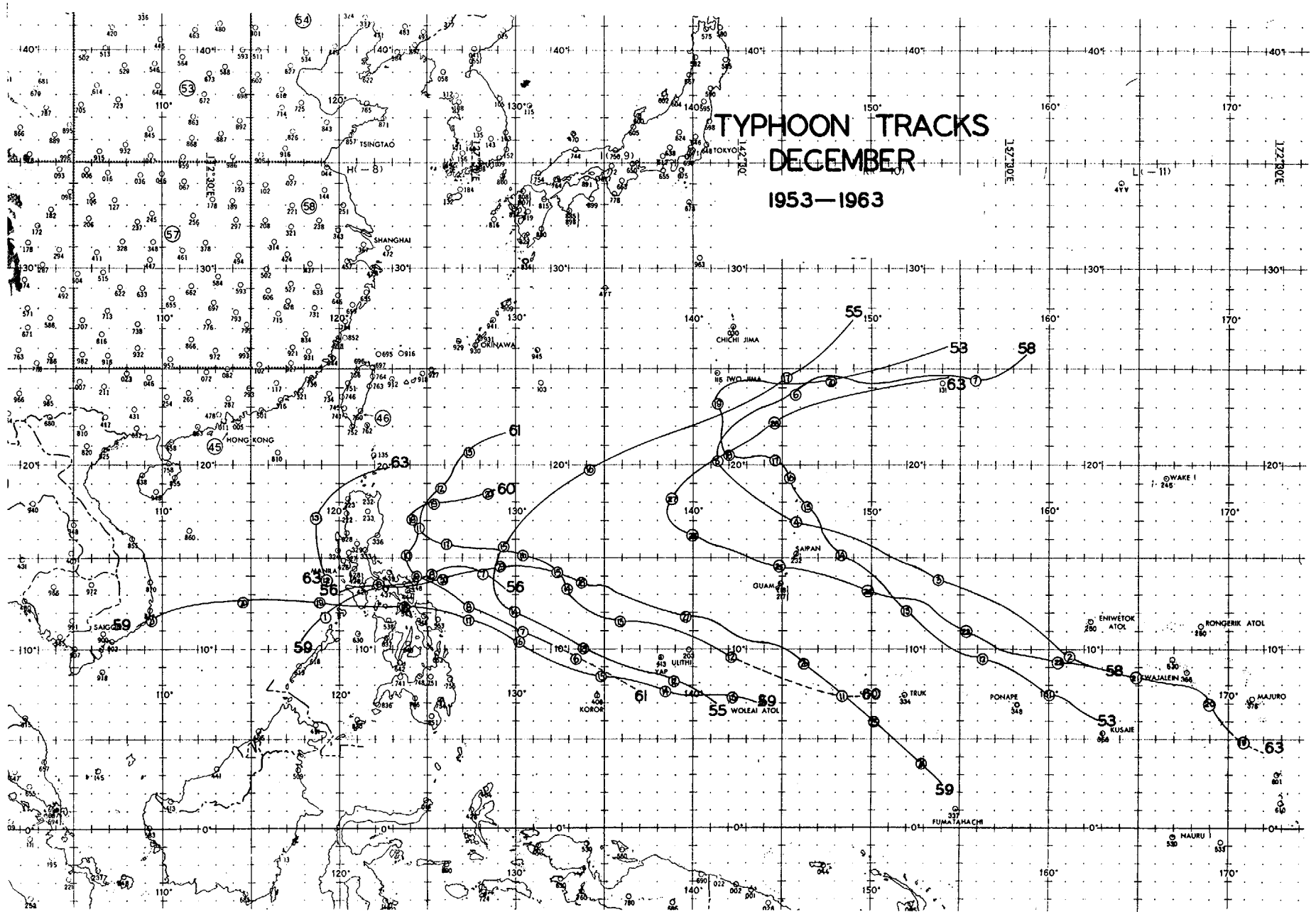






# TYPHOON TRACKS NOVEMBER 1-15 1953-1963





# TYPHOON TRACKS DECEMBER 1953-1963

TYPHOON DISTRIBUTION BY MONTH

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
1952						3	1	3	3	5	3	3	21
1953		1			1	1	1	5	2	4	1	1	17
1954					1		1	4	4	2	3		15
1955	1		1	1		1	5	3	3	2	1	1	19
1956			1	1			2	4	5	1	3	1	18
1957	1			1	1	1	1	2	5	3	3		18
44 1958	1				1	2	5	3	3	3	1	1	20
1959				1			1	5	3	3	2	2	17
1960				1		2	2	8		4	1	1	19
1961			1		2	1	3	3	5	3	1	1	20
1962				1	2		5	7	2	4	3		24
1963				1	1	2	3	3	3	4		2	19
1964					2	2	6	3	5	3	4	1	26
AVG.	.23	.08	.23	.54	.85	1.2	2.8	4.1	3.3	3.2	2.0	1.1	19.5

**CHAPTER IV**

**SUMMARY OF TROPICAL CYCLONES OF 1964**

The JTWC issued a total of 730 tropical warnings on 26 typhoons, 14 tropical storms and 5 tropical depressions in the Western Pacific Ocean in 1964. Seven additional tropical cyclones were investigated but did not intensify enough to substantiate the issuance of warnings. The development of 26 typhoons in the Western Pacific Ocean during 1964 is a new record. The previous record of 24 typhoons was established in 1962.

The following data for the JTWC area of responsibility is presented for comparison:

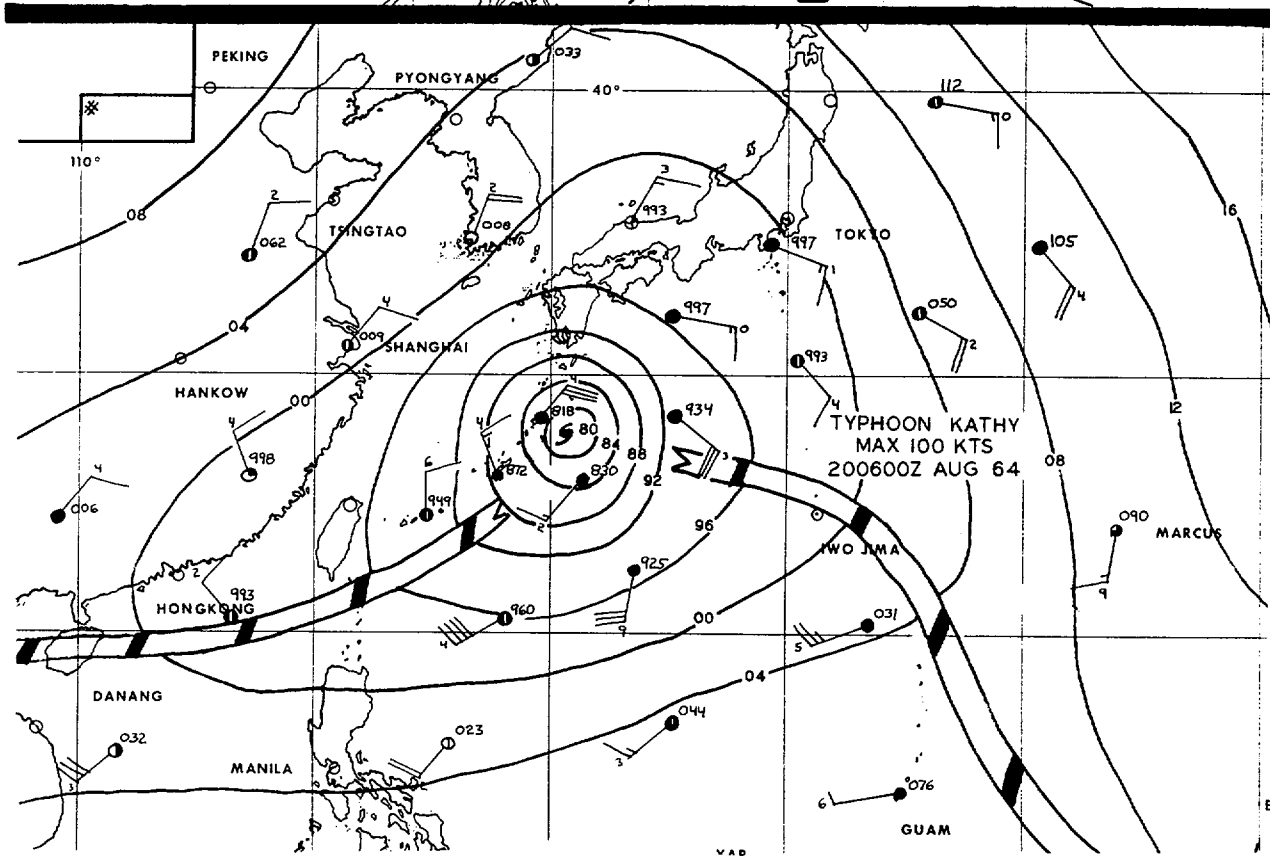
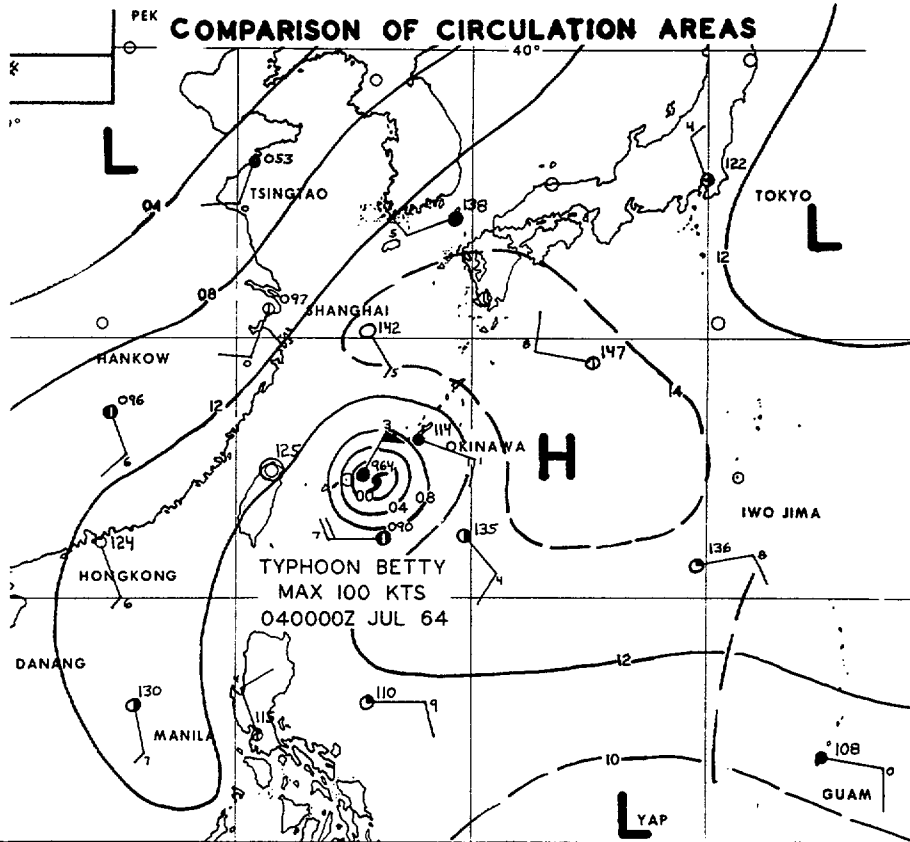
COMPARATIVE WESTERN PACIFIC TROPICAL CYCLONE DATA

	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>
TOTAL NUMBER OF WARNINGS	776	738	815	663	730
CALENDAR DAYS OF WARNINGS	157	165	154	146	153
SUSPECT CYCLONES	26	27	15	5	7
TROPICAL DEPRESSIONS	3	11	9	3	5
TROPICAL STORMS	8	11	6	6	14
TYPHOONS	19	20	24	19	26
TOTAL TROPICAL CYCLONES	56	69	56	33	52

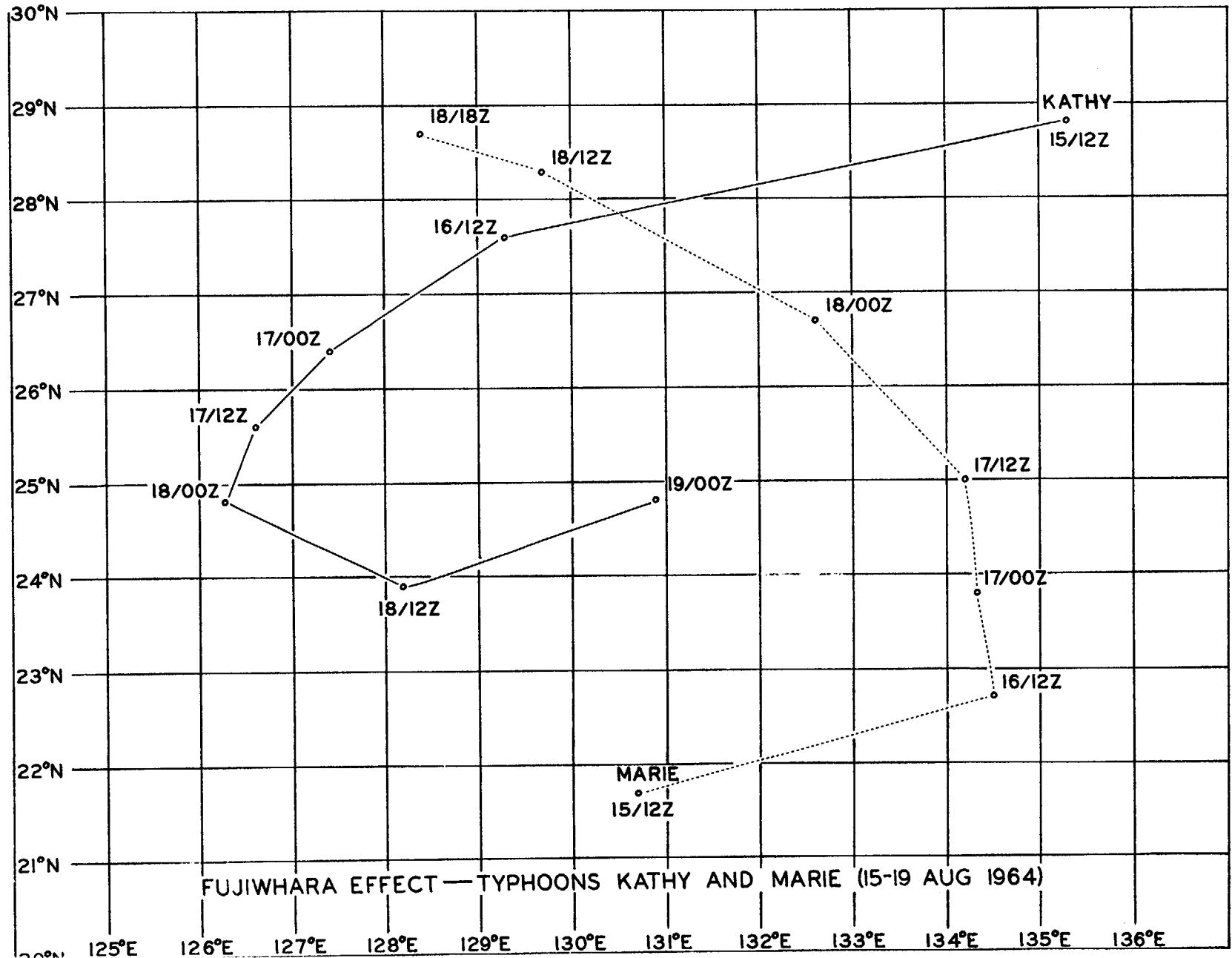
In the area of responsibility of the Joint Hurricane Warning Center, Hawaii, (North Pacific Ocean between 140°W and 180°) there were no cyclones which required tropical warnings.

The two most intense typhoons of 1964 were SALLY (03 Sep - 10 Sep) and OPAL (09 Dec - 16 Dec). Both had maximum sustained surface winds of 170 knots. These typhoons are classed as "super typhoons" (maximum surface winds in excess of 130 knots). Other typhoons in this class during 1964 were Typhoons CORA (06 Jul - 10 Jul), IDA (02 Aug - 09 Aug), WILDA (19 Sep - 25 Sep), and LOUISE (15 Nov - 20 Nov).

The circulation area of a tropical cyclone differs from system to system. As evidence of this fact, Typhoons BETTY (02 Jul - 06 Jul) and KATHY (12 Aug - 25 Aug) are depicted in the accompanying chart. Typhoon OPAL had the largest cyclonic surface circulation with a maximum radius of 650 miles. Typhoon ALICE (26 Jun - 28 Jun) was the smallest typhoon of 1964 with a maximum radius of 200 miles.







Typhoons KATHY, OPAL, TILDA, TESS and KATE performed cyclonic loops at some point during their lives. KATHY was the star performer when she executed a second minor loop while undergoing the first loop south of Japan. In a normal year a maximum of two or three typhoons can be expected to loop.

A classic example of the Fujiwhara Effect was observed between Typhoons KATHY and MARIE during the period 15 August through 18 August. KATHY became the predominate system and absorbed MARIE early on 19 August.

Another phenomenon noted during this record year was the rapid dissipation or disappearance of typhoons. Several typhoons, notably ALICE, ELSIE, and CORA, were observed by reconnaissance aircraft to have all the characteristics of a full blown typhoon and then within a matter of just a few hours to dissipate into a weak tropical low. There was no apparent reason for this rapid degeneration and no parameters have yet been established for forecasting it.

Of the 26 typhoons during the 1964 season, 15 dissipated over land, 5 dissipated over water, 2 were absorbed by other typhoons and only 4 became extratropical. (Characteristics of a tropical system becoming extratropical are covered in the 1963 Annual Typhoon Report.)

The South China Sea area saw "more than normal" typhoon activity in 1964. For the years 1959 through 1963, there were an average of 3.2 typhoons that traveled through the area west of the Philippines and south of 18.5°N (roughly the northern tip of Luzon). This compares to 10 typhoons in the same area in 1964.

Land areas affected by typhoons during the 1964 season are listed below:

Babuyan Islands.....SALLY and RUBY  
Bataan Island.....TILDA  
Bonin Islands.....KATHY and HOPE  
Caroline Islands.....OPAL, IDA and CORA  
China Mainland.....VIOLA, SALLY, RUBY, IDA, FLOSSIE,  
BETTY and DOT

Hainan Islands.....TILDA, WINNIE and CLARA  
 Hong Kong.....VIOLA, SALLY, RUBY, IDA and  
 DOT  
 Japan.....MARIE, KATHY, WILDA and HELEN  
 Korea.....HELEN, FLOSSIE and BETTY  
 Manchuria.....HELEN  
 Marcus Island.....TESS  
 Marianas Islands.....ALICE, SALLY and TESS  
 Palau Island.....OPAL, LOUISE and DOT  
 Philippine Islands.....SALLY, RUBY, OPAL, IDA, ELSIE,  
 CORA, WINNIE, LOUISE, DOT and  
 CLARA  
 Ryukyu Islands.....KATHY, FLOSSIE and BETTY  
 Vietnam.....IRIS, VIOLET, TILDA, WINNIE  
 and KATE  
 Volcano Islands.....HELEN

The 24, 48 and 72-hour mean forecast error for each typhoon was computed by two methods. In addition to the standard mean vector forecast error table shown below, a computation of closest-distance error from best track has been included for comparison. This error computation is based on the closest right angle distance of the forecast position to the best track without regard to time. Possibly this will give the user a better understanding of the ability of JTWC to forecast the effects of a typhoon on one particular area.

The following tabulation of the forecast vector error for the past 15 years is given for comparison:

FORECAST VERIFICATION  
 AVERAGE ERROR NAUTICAL MILES

	24 HR	48 HR	72 HR
1950-58	170	---	---
1959	117	267	---
1960	177	354	---
1961	136	274	---
1962	144	287	476
1963	127	246	374
1964	133	284	429

1964 FORECAST VECTOR ERRORS\*

TYPHOON	24 HR FORECASTS		48 HR FORECASTS		72 HR FORECASTS	
	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR
TESS	18	212	14	476	3	924
VIOLA	8	178	4	402	0	--
WINNIE	21	133	17	270	4	510
ALICE	0	--	0	--	0	--
BETTY	14	134	10	312	0	--
CORA	11	89	7	152	0	--
DORIS	11	151	7	298	1	480
ELSIE	9	108	5	213	1	346
FLOSSIE	11	58	7	121	1	332
HELEN	24	94	20	204	8	390
IDA	22	112	18	212	6	278
KATHY	50	180	45	423	17	663
MARIE	6	220	2	396	0	--
RUBY	14	117	10	157	0	--
SALLY	26	95	20	155	8	236
TILDA	33	139	22	357	0	--
VIOLET	1	108	--	--	0	--
WILDA	20	110	16	183	6	239
CLARA	19	100	15	176	4	166
DOT	25	148	21	336	4	657
HOPE	19	185	15	534	0	--
IRIS	5	88	1	38	0	--
JOAN	6	47	2	87	0	--
KATE	11	178	7	298	0	--
LOUISE	16	79	10	68	2	55
OPAL	24	123	20	227	8	320

AVERAGE ERROR - 24 HR FORECASTS (424 CASES)... 133MI

AVERAGE ERROR - 48 HR FORECASTS (315 CASES)... 284MI

AVERAGE ERROR - 72 HR FORECASTS ( 73 CASES)... 429MI

\*Includes Forecast Vector errors during tropical storm intensity as well as typhoon intensity

1964 FORECAST VECTOR ERRORS  
(TYPHOON INTENSITY ONLY)

TYPHOON	24 HR FORECASTS		48 HR FORECASTS		72 HR FORECASTS	
	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR
TESS	13	178	9	455	1	1135
VIOLA	5	175	1	382	0	--
WINNIE	19	126	15	251	4	510
ALICE	0	--	0	--	0	--
BETTY	13	135	9	287	0	--
CORA	10	85	6	148	0	--
DORIS	5	140	1	242	0	--
ELSIE	5	94	1	255	0	--
FLOSSIE	10	43	6	96	0	--
HELEN	19	85	15	203	5	270
IDA	19	106	15	193	5	294
KATHY	40	191	35	461	13	750
MARIE	4	233	0	--	0	--
RUBY	13	107	9	149	0	--
SALLY	25	96	19	162	8	236
TILDA	21	133	16	343	0	--
VIOLET	0	--	0	--	0	--
WILDA	20	110	16	183	6	239
CLARA	16	78	12	137	4	166
DOT	17	147	13	424	2	1032
HOPE	7	219	3	518	0	--
IRIS	2	62	0	--	0	--
JOAN	2	55	0	--	0	--
KATE	6	138	2	277	0	--
LOUISE	14	65	8	59	1	68
OPAL	19	104	15	197	5	285

AVERAGE ERROR - 24 HR FORECASTS (324 CASES)..... 123MI  
AVERAGE ERROR - 48 HR FORECASTS (226 CASES)..... 267MI  
AVERAGE ERROR - 72 HR FORECASTS ( 54 CASES)..... 431MI

1964 FORECAST ERRORS\*  
(IN TERMS OF CLOSEST DISTANCE TO BEST TRACK)

TYPHOON	24 HR FORECASTS		48 HR FORECASTS		72 HR FORECASTS	
	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR
TESS	18	72	14	126	3	267
VIOLA	8	121	4	309	--	--
WINNIE	21	114	17	238	4	405
ALICE	0	--	0	--	0	--
BETTY	14	103	10	253	0	--
CORA	11	53	7	87	0	--
DORIS	11	111	7	212	1	336
ELSIE	9	51	5	133	1	176
FLOSSIE	11	21	7	30	1	8
HELEN	24	74	20	167	8	285
IDA	22	54	18	104	6	131
KATHY	50	100	45	165	17	220
MARIE	6	201	2	380	0	--
RUBY	14	97	10	104	0	--
SALLY	26	43	20	59	8	93
TILDA	33	61	22	208	0	--
VIOLET	1	55	0	--	0	--
WILDA	20	79	16	140	6	188
CLARA	19	47	15	84	4	111
DOT	25	90	21	236	4	499
HOPE	19	115	15	246	0	--
IRIS	5	80	1	07	0	--
JOAN	6	14	2	13	0	--
KATE	11	92	7	188	0	--
LOUISE	16	55	10	46	2	28
OPAL	24	98	20	180	8	256

AVERAGE ERROR - 24 HR FORECASTS (424 CASES)..... 80MI  
 AVERAGE ERROR - 48 HR FORECASTS (315 CASES)..... 160MI  
 AVERAGE ERROR - 72 HR FORECASTS ( 73 CASES)..... 221MI

\*Includes Forecast errors during tropical storm intensity as well as typhoon intensity

1964 FORECAST ERRORS (TYPHOON INTENSITY ONLY)  
 (IN TERMS OF CLOSEST DISTANCE TO BEST TRACK)

TYPHOON	24 HR FORECASTS		48 HR FORECASTS		72 HR FORECASTS	
	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR	NO. OF CASES	MEAN ERROR
TESS	13	41	9	75	1	133
VIOLA	5	109	1	295	0	--
WINNIE	19	105	15	217	4	510
ALICE	0	--	0	--	0	--
BETTY	13	135	9	287	0	--
CORA	10	53	6	82	0	--
DORIS	5	140	1	242	0	--
ELSIE	5	45	1	184	0	--
FLOSSIE	10	17	6	31	0	--
HELEN	19	62	15	158	5	154
IDA	19	49	15	101	5	120
KATHY	40	108	35	192	13	264
MARIE	4	214	0	--	0	--
RUBY	13	85	9	93	0	--
SALLY	25	42	19	61	8	93
TILDA	21	52	16	207	0	--
VIOLET	0	--	0	--	0	--
WILDA	20	79	16	140	6	188
CLARA	16	52	12	85	4	111
DOT	17	107	13	343	2	911
HOPE	7	94	3	98	0	--
IRIS	2	40	0	--	0	--
JOAN	2	23	0	--	0	--
KATE	6	82	2	240	0	--
LOUISE	14	38	8	36	1	28
OPAL	19	79	15	135	5	202

AVERAGE ERROR - 24 HR FORECAST (324 CASES)..... 76 MI.  
 AVERAGE ERROR - 48 HR FORECAST (226 CASES)..... 153 MI.  
 AVERAGE ERROR - 72 HR FORECAST ( 54 CASES)..... 225 MI.

DISTANCE BETWEEN OPERATIONAL WARNING  
POSITS AND BEST TRACK POSITS

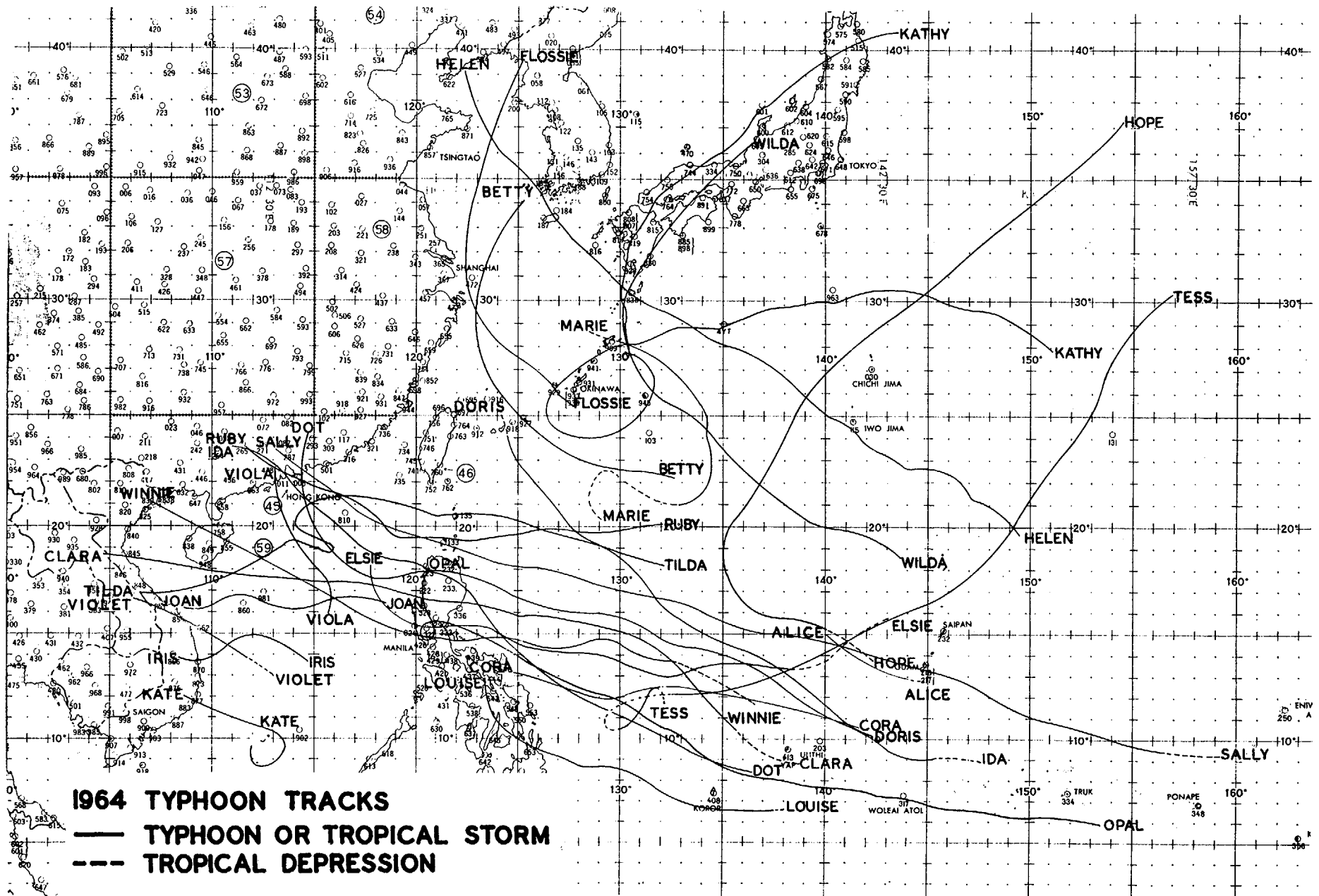
TYPHOON	CASES	AVERAGE	MAX	MIN
TESS	26	39	145	05
VIOLA	12	36	74	05
WINNIE	21	27	76	05
ALICE	4	11	24	06
BETTY	18	20	68	00
CORA	15	18	48	05
DORIS	15	27	92	03
ELSIE	13	32	80	05
FLOSSIE	15	12	30	03
HELEN	28	22	121	03
IDA	26	19	70	05
KATHY	54	18	100	00
MARIE	10	38	105	03
RUBY	18	35	82	06
SALLY	30	27	204	02
TILDA	37	18	70	00
VIOLET	5	23	48	09
WILDA	24	20	142	00
CLARA	23	28	172	00
DOT	29	27	202	03
HOPE	23	42	113	00
IRIS	9	16	40	05
JOAN	10	26	90	05
KATE	15	80	367*	05
LOUISE	20	29	113	00
OPAL	28	20	87	00
<b>AVERAGE</b>	<b>510</b>	<b>26MI</b>	<b>106MI</b>	<b>03MI</b>

\*Data received after warning time indicated development of a center other than that center described in the warning. This necessitated a relocation of the storm.



1964 TYPHOON DATA SUMMARY

TYPHOON	MONTH	FROM WARNINGS		
		MAX RADIUS 100KT WND	MAX RADIUS 50KT WND	MAX RADIUS 30KT
TESS	MAY	100	175	400
VIOLA	MAY	---	100	400
WINNIE	JUN-JUL	---	200	500
ALICE	JUN	---	25	200
BETTY	JUL	30	100	200
CORA	JUL	30	100	200
DORIS	JUL	---	75	200
ELSIE	JUL	30	75	150
FLOSSIE	JUL	---	100	300
HELEN	JUL-AUG	75	150	350
IDA	AUG	80	250	600
KATHY	AUG	30	150	500
MARIE	AUG	---	100	300
RUBY	SEP	25	100	200
SALLY	SEP	70	125	300
TILDA	SEP	40	125	500
VIOLET	SEP	---	50	150
WILDA	SEP	50	200	600
CLARA	OCT	---	150	250
DOT	OCT	70	175	350
HOPE	OCT	100	250	500
IRIS	NOV	---	50	450
JOAN	NOV	---	100	500
KATE	NOV	50	200	450
LOUISE	NOV	50	300	450
OPAL	DEC	120	250	500
AVERAGE		59MI	141MI	365MI



**1964 TYPHOON TRACKS**  
—— TYPHOON OR TROPICAL STORM  
- - - TROPICAL DEPRESSION

## 1964 TYPHOONS

NAME	DATE	MAX SFC WND	MIN OBS SLP	MAX RADIUS SFC CIRC	CALENDAR WARNINGS/TYPHOONS	DAYS OF TYPHOONS	DISTANCE TRAVELED
TESS	14MAY-22MAY	85	965	600	8.75	3.00	2340
VIOLA	25MAY-28MAY	70	980	450	3.00	1.00	432
WINNIE	26JUN-03JUL	100	950	475	6.25	4.50	1872
ALICE	26JUN-28JUN	65	990	200	1.50	0.50	324
BETTY	02JUL-06JUL	110	958	225	4.75	3.75	1086
CORA	06JUL-10JUL	140	967	325	4.00	3.00	1026
DORIS	11JUL-15JUL	80	974	350	4.25	1.25	1416
ELSIE	13JUL-18JUL	100	992	350	5.25	1.25	1632
FLOSSIE	26JUL-29JUL	80	974	300	4.75	3.00	984
HELEN	27JUL-03AUG	130	931	450	7.00	4.75	1920
IDA	02AUG-09AUG	135	927	575	7.25	4.75	2358
KATHY	12AUG-25AUG	115	945	850	13.50	10.00	3114
MARIE	14AUG-18AUG	70	976	325	4.75	1.00	1068
RUBY	01SEP-05SEP	120	963	400	4.50	3.25	1254
SALLY	03SEP-10SEP	170	894	425	8.00	6.50	2832
TILDA	13SEP-22SEP	110	952	500	9.50	5.75	1800
VIOLET	14SEP-15SEP	75	---	325	1.75	0.50	456
WILDA	19SEP-25SEP	150	905	675	6.25	5.50	1578
CLARA	02OCT-08OCT	80	979	525	6.50	4.00	2106
DOT	06OCT-13OCT	90	976	400	7.50	4.25	1734
HOPE	23OCT-29OCT	130	973	650	6.00	1.75	2088
IRIS	02NOV-04NOV	65	994	400	2.25	0.50	414
JOAN	06NOV-08NOV	70	999	325	4.50	0.50	528
KATE	13NOV-16NOV	80	986	375	4.00	1.50	492
LOUISE	15NOV-20NOV	165	914	500	6.00	4.25	1032
OPAL	08DEC-16DEC	170	903	650	7.75	5.75	2352
AVERAGE		105KTS	959MB	447MI	5.75	3.30	1471MI

TROPICAL CYCLONES OF 1964

<u>CYCLONE</u>	<u>*PERIOD</u>
01. Typhoon TESS	14 MAY - 22 MAY
02. Tropical Depression	16 MAY - 18 MAY
03. Typhoon VIOLA	25 MAY - 28 MAY
04. Typhoon WINNIE	26 JUN - 03 JUL
05. Typhoon ALICE	26 JUN - 28 JUN
06. Investigation	29 JUN - 02 JUL
07. Typhoon BETTY	02 JUL - 06 JUL
08. Typhoon CORA	06 JUL - 10 JUL
09. Typhoon DORIS	11 JUL - 15 JUL
10. Typhoon ELSIE	13 JUL - 18 JUL
11. Tropical Depression	21 JUL - 23 JUL
12. Typhoon FLOSSIE	26 JUL - 29 JUL
13. Tropical Storm GRACE	26 JUL - 30 JUL
14. Typhoon HELEN	27 JUL - 03 AUG
15. Typhoon IDA	02 AUG - 09 AUG
16. Tropical Storm GRACE**	03 AUG - 04 AUG
17. Tropical Storm JUNE	10 AUG - 13 AUG
18. Tropical Storm LORNA	12 AUG - 13 AUG
19. Typhoon KATHY	12 AUG - 25 AUG
20. Typhoon MARIE	14 AUG - 18 AUG
21. Tropical Storm NANCY	17 AUG - 19 AUG
22. Tropical Storm OLGA	24 AUG - 25 AUG
23. Investigation	25 AUG
24. Tropical Storm PAMELA	25 AUG - 26 AUG
25. Typhoon RUBY	01 SEP - 05 SEP
26. Tropical Depression	02 SEP - 03 SEP
27. Typhoon SALLY	03 SEP - 10 SEP
28. Investigation	07 SEP
29. Typhoon TILDA	13 SEP - 22 SEP
30. Typhoon VIOLET	14 SEP - 15 SEP

TROPICAL CYCLONES OF 1964 (CONT'D)

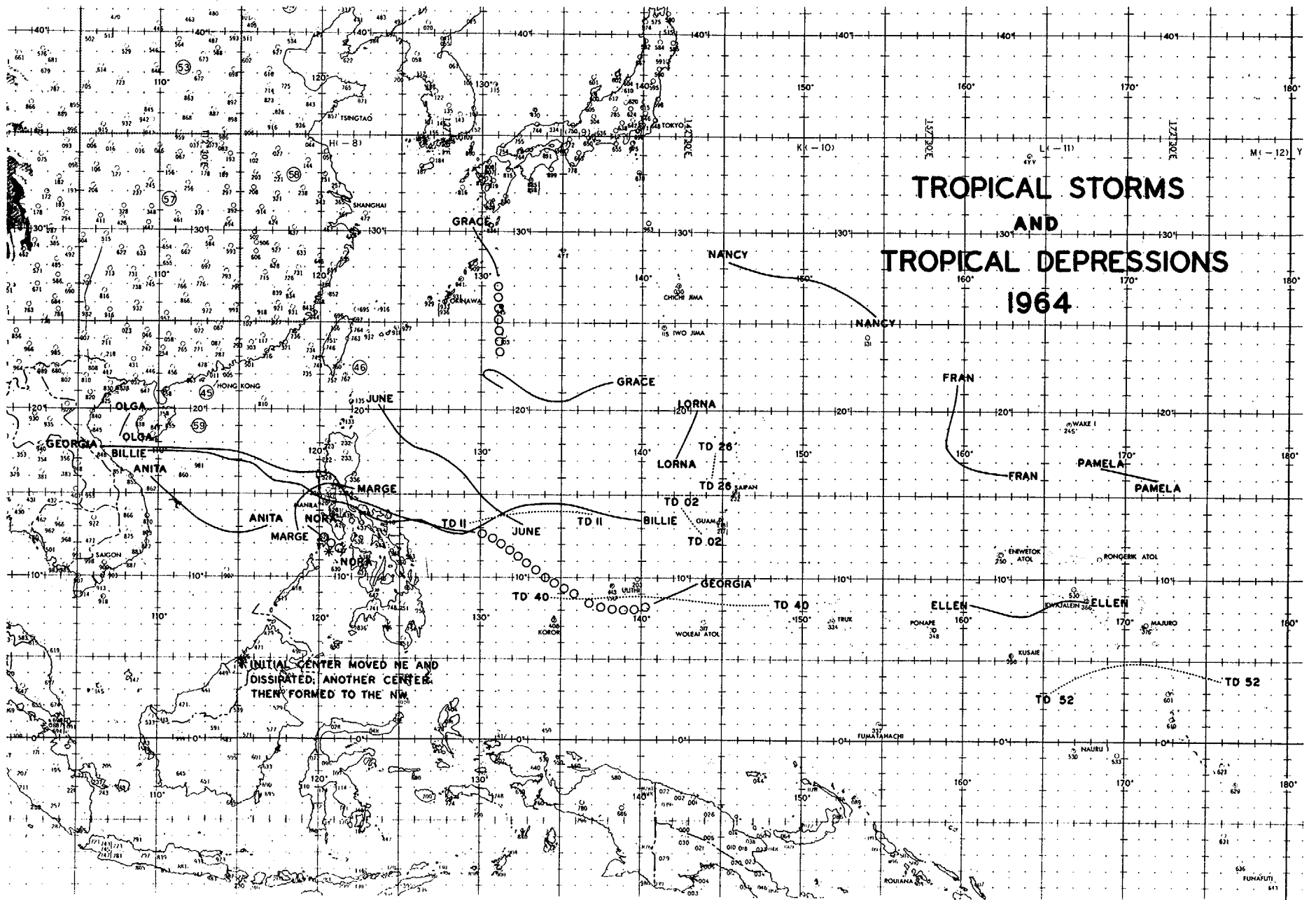
<u>CYCLONE</u>	<u>*PERIOD</u>
31. Investigation	15 SEP
32. Typhoon WILDA	19 SEP - 25 SEP
33. Tropical Storm ANITA	24 SEP - 26 SEP
34. Tropical Storm BILLIE	25 SEP - 01 OCT
35. Typhoon CLARA	02 OCT - 08 OCT
36. Typhoon DOT	06 OCT - 13 OCT
37. Tropical Storm ELLEN	08 OCT - 13 OCT
38. Tropical Storm FRAN	15 OCT - 17 OCT
39. Tropical Storm GEORGIA	17 OCT - 24 OCT
40. Tropical Depression	20 OCT - 24 OCT
41. Typhoon HOPE	23 OCT - 29 OCT
42. Investigation	30 OCT - 04 NOV
43. Typhoon IRIS	02 NOV - 04 NOV
44. Typhoon JOAN	06 NOV - 08 NOV
45. Typhoon KATE	13 NOV - 16 NOV
46. Typhoon LOUISE	15 NOV - 20 NOV
47. Investigation	19 NOV - 20 NOV
48. Tropical Storm MARGE	21 NOV - 23 NOV
49. Tropical Storm NORA	27 NOV - 28 NOV
50. Investigation	05 DEC
51. Typhoon OPAL	09 DEC - 16 DEC
52. Tropical Depression	10 DEC - 12 DEC

\* The period shown covers the period from the date the cyclone was first assigned a cyclone number until the final warning was issued, or if no warnings were issued, the date the cyclone dissipated.

\*\*Tropical storm Grace dissipated on 30 July and on 03 August reformed north of the 30 July position.

# TROPICAL STORMS AND TROPICAL DEPRESSIONS 1964

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INITIAL CENTER MOVED NE AND DISSIPATED; ANOTHER CENTER THEN FORMED TO THE NW

TROPICAL STORMS 1964  
POSITION DATA

TROPICAL STORM GRACE  
26 JUL-29 JUL

DTG	LAT	LONG	DTG	LAT	LONG
261200Z	21.7N	138.2E	280000Z	21.6N	132.3E
261800Z	21.4N	137.3E	280600Z	22.3N	131.2E
270000Z	21.1N	136.5E	281200Z	21.9N	130.6E
270600Z	20.7N	135.7E	281800Z	21.6N	130.8E
271200Z	20.5N	134.6E	290000Z	21.4N	131.0E
271800Z	20.8N	133.3E	290600Z	21.2N	131.3E
03 AUG					
030000Z	27.6N	131.0E	031200Z	29.4N	130.1E
030600Z	28.5N	130.7E	031800Z	30.2N	129.5E

TROPICAL STORM JUNE  
10 AUG-13 AUG

DTG	LAT	LONG	DTG	LAT	LONG
100600Z	13.3N	132.7E	111800Z	17.4N	127.0E
101200Z	13.8N	131.6E	120000Z	17.9N	125.9E
101800Z	14.4N	130.7E	120600Z	18.5N	125.0E
110000Z	15.2N	129.8E	121200Z	19.1N	124.6E
110600Z	16.1N	129.1E	121800Z	19.7N	124.2E
111200Z	16.8N	128.1E	130000Z	20.2N	123.8E

TROPICAL STORM LORNA  
12 AUG-13 AUG

DTG	LAT	LONG	DTG	LAT	LONG
120000Z	17.2N	142.0E	121800Z	19.3N	143.1E
120600Z	17.8N	142.4E	130000Z	20.1N	143.3E
121200Z	18.6N	142.8E			

TROPICAL STORMS 1964  
POSITION DATA

TROPICAL STORM NANCY  
17 AUG-19 AUG

DTG	LAT	LONG	DTG	LAT	LONG
170600Z	25.4N	154.5E	181200Z	27.1N	151.6E
171200Z	25.7N	154.2E	181800Z	27.6N	149.8E
171800Z	25.9N	153.8E	190000Z	27.8N	147.5E
180000Z	26.2N	153.4E	190600Z	29.4N	145.3E
180600Z	26.5N	152.8E			

TROPICAL STORM OLGA  
23 AUG-24 AUG

DTG	LAT	LONG	DTG	LAT	LONG
231800Z	19.8N	108.3E	240600Z	18.9N	107.8E
240000Z	19.4N	108.0E	241200Z	18.4N	107.7E

TROPICAL STORM PAMELA  
25 AUG-26 AUG

DTG	LAT	LONG	DTG	LAT	LONG
250000Z	16.0N	172.0E	251800Z	16.5N	169.4E
250600Z	16.2N	171.2E	260000Z	16.7N	168.5E
251200Z	16.4N	170.3E			

TROPICAL STORM ANITA  
24 SEP-26 SEP

DTG	LAT	LONG	DTG	LAT	LONG
241200Z	13.1N	116.8E	251800Z	13.6N	112.4E
241800Z	12.9N	116.3E	260000Z	14.1N	111.8E
250000Z	12.8N	115.4E	260600Z	14.6N	111.2E
250600Z	12.8N	114.2E	261200Z	15.2N	110.5E
251200Z	13.2N	113.1E	261800Z	16.0N	109.6E



TROPICAL STORM BILLIE  
25 SEP-30 SEP

DTG	LAT	LONG	DTG	LAT	LONG
251200Z	13.5N	140.0E	280600Z	12.8N	127.7E
251800Z	13.7N	138.8E	281200Z	13.5N	125.7E
260000Z	13.9N	137.7E	281800Z	13.5N	123.8E
260600Z	14.2N	136.5E	290000Z	14.3N	122.2E
261200Z	14.4N	135.3E	290600Z	14.8N	120.2E
261800Z	14.6N	134.2E	291200Z	15.8N	118.2E
270000Z	14.5N	132.9E	291800Z	16.2N	116.7E
270600Z	14.2N	131.9E	300000Z	16.9N	115.4E
271200Z	13.7N	131.1E	300600Z	17.2N	113.6E
271800Z	13.2N	130.2E	301200Z	17.5N	111.4E
280000Z	12.8N	129.2E	301800Z	17.6N	109.3E

TROPICAL STORM ELLEN  
08 OCT-10 OCT

DTG	LAT	LONG	DTG	LAT	LONG
080000Z	08.6N	167.8E	090600Z	07.8N	163.9E
080600Z	08.8N	166.9E	091200Z	07.8N	163.1E
081200Z	08.6N	166.2E	091800Z	07.9N	162.3E
081800Z	08.3N	165.4E	100000Z	08.2N	161.4E
090000Z	08.0N	164.8E	100600Z	08.4N	160.5E

TROPICAL STORM FRAN  
15 OCT-17 OCT

DTG	LAT	LONG	DTG	LAT	LONG
150600Z	16.2N	162.7E	161200Z	17.6N	159.2E
151200Z	16.3N	161.9E	161800Z	18.6N	158.9E
151800Z	16.5N	161.2E	170000Z	19.8N	159.3E
160000Z	16.7N	160.4E	170600Z	20.7N	159.5E
160600Z	17.1N	159.8E	171200Z	21.5N	159.7E

TROPICAL STORM GEORGIA  
17 OCT-23 OCT

DTG	LAT	LONG	DTG	LAT	LONG
171200Z	09.8N	143.5E	211800Z	16.5N	117.6E
171800Z	09.1N	142.1E	220000Z	17.3N	115.8E
180000Z	08.5N	140.7E	220600Z	17.7N	114.0E
200000Z	12.8N	129.8E	221200Z	17.8N	112.3E
200600Z	13.0N	128.0E	221800Z	17.8N	111.0E
201200Z	13.3N	126.2E	230000Z	17.8N	109.8E
201800Z	13.9N	124.4E	230600Z	17.8N	108.6E
210000Z	14.6N	122.7E	231200Z	17.8N	107.5E
210600Z	16.2N	120.9E	231800Z	17.9N	106.3E
211200Z	16.3N	119.3E			

TROPICAL STORM MARGE  
21 NOV-23 NOV

DTG	LAT	LONG	DTG	LAT	LONG
210000Z	15.3N	122.2E	220600Z	14.3N	118.5E
210600Z	15.6N	121.3E	221200Z	13.9N	118.5E
211200Z	15.6N	120.2E	221800Z	13.6N	118.5E
211800Z	15.3N	119.3E	230000Z	13.3N	118.6E
220000Z	14.7N	118.7E	230600Z	12.9N	118.7E

TROPICAL STORM NORA  
27 Nov-28 NOV

DTG	LAT	LONG	DTG	LAT	LONG
270000Z	11.3N	121.3E	271800Z	12.8N	119.7E
270600Z	11.7N	121.6E	280000Z	13.2N	119.3E
271200Z	12.6N	120.1E			

TROPICAL DEPRESSIONS 1964  
POSITION DATA

TROPICAL DEPRESSION ZERO TWO  
16 MAY-17 MAY

DTG	LAT	LONG	DTG	LAT	LONG
161800Z	12.8N	143.8E	171200Z	13.7N	142.7E
170000Z	13.1N	143.4E	171800Z	14.2N	142.4E
170600Z	13.4N	143.0E			

TROPICAL DEPRESSION ONE ONE  
21 JUL-22 JUL

DTG	LAT	LONG	DTG	LAT	LONG
211200Z	13.9N	137.0E	220600Z	13.8N	132.2E
211800Z	14.0N	135.3E	221200Z	13.6N	130.6E
220000Z	14.0N	133.7E	221800Z	13.4N	129.1E

TROPICAL DEPRESSION TWO SIX  
02 SEP-03 SEP

DTG	LAT	LONG	DTG	LAT	LONG
020600Z	16.1N	144.4E	021800Z	17.0N	144.6E
021200Z	16.5N	144.5E	030000Z	17.5N	144.7E

TROPICAL DEPRESSION FOUR ZERO  
20 OCT-24 OCT

DTG	LAT	LONG	DTG	LAT	LONG
201800Z	08.4N	148.0E	221200Z	08.9N	140.8E
210000Z	08.3N	147.0E	221800Z	08.9N	139.8E
210600Z	08.3N	145.9E	230000Z	08.9N	138.8E
211200Z	08.4N	144.9E	230600Z	08.9N	137.8E
211800Z	08.7N	143.9E	231200Z	08.9N	136.8E
220000Z	08.8N	142.9E	231800Z	08.9N	135.8E
220600Z	08.9N	141.9E	240000Z	08.9N	134.7E

TROPICAL DEPRESSIONS 1964  
POSITION DATA

TROPICAL DEPRESSION FIVE TWO  
10 DEC-12 DEC

DTG	LAT	LONG	DTG	LAT	LONG
101200Z	03.8N	176.0E	111200Z	04.8N	169.8E
101800Z	04.3N	174.5E	111800Z	04.5N	168.3E
110000Z	04.7N	172.9E	120000Z	03.9N	166.8E
110600Z	04.9N	171.4E	120600Z	03.0N	165.5E

**CHAPTER V**

**INDIVIDUAL TYPHOONS OF 1964**

The following define and clarify certain words and phrases that appear in the Eye Data Summaries in this chapter:

- A. FIX NO. - This number corresponds to the number of the fix plotted on the "Best Track Chart."
- B. TIME - The date-time group of the fix
- C. POSIT - Latitude and longitude of the fix
- D. UNIT, METHOD & ACCY -
  - (1) UNIT - The unit that made the fix: 54 - 54WRS; 56 - 56 WRS; VW1 - VW-1
  - (2) METHOD - The method used to make the fix: P - penetration; R - radar; V - visual; LND/RDR - land radar
  - (3) ACCY - The estimated accuracy of the fix in nautical miles
- E. FLT LVL - Altitude of aircraft at fix time
- F. FLT LVL WND - Maximum observed flight level wind in knots
- G. OBS SFC WND - Maximum observed surface wind in knots
- H. OBS MIN SLP - Minimum sea level pressure observed in mb
- I. MIN 700MB HGT - Minimum 700mb height observed (in meters)
- J. FLT LVL TT/TD - Flight level temperature/dew point at fix location (When flight level was near 700mb, 700mb temperature was recorded in place of flight level temperature)

TYPHOON TESS - 140600Z to 221800Z MAY

I. DATA

A. Statistics

1. Calendar days of tropical warning - 8 3/4
2. Calendar days of typhoon intensity - 3
3. Total distance traveled during tropical warning period - 2340 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 965mb, 210928Z
2. Minimum observed 700mb height - 2811m, 211555Z
3. Maximum surface wind - 85 kts
4. Max radius of surface circulation - 600 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of Polar Trough

B. Initial surface vortex

1. Junction vortex at 091800Z
2. Surface pressure less than 1006mb








C. 200mb flow above surface vortex

1. Initial - W quad of anticyclone
2. Upon reaching typhoon intensity - N quad of anticyclone

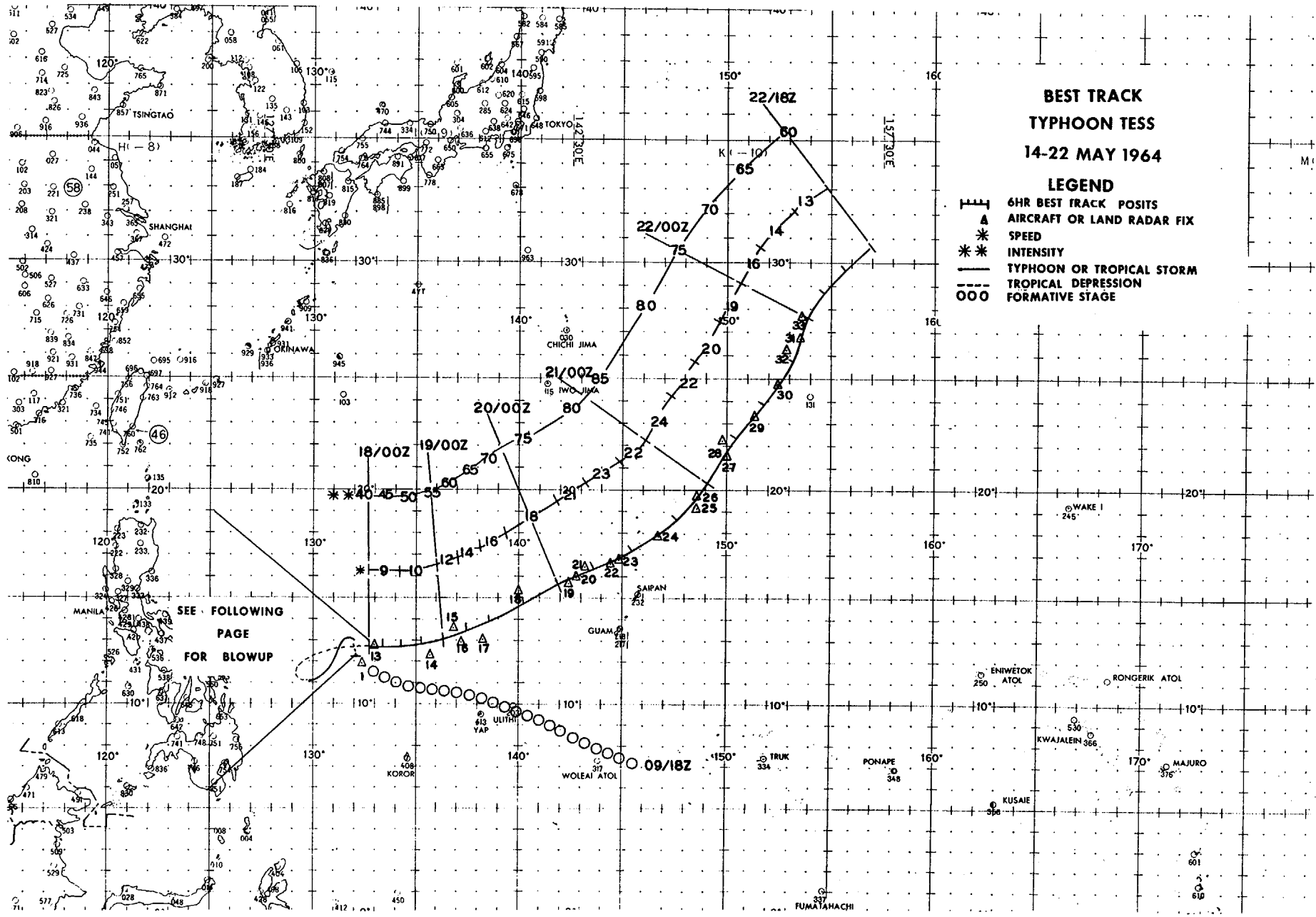
III. FINAL DISPOSITION

A. Extratropical

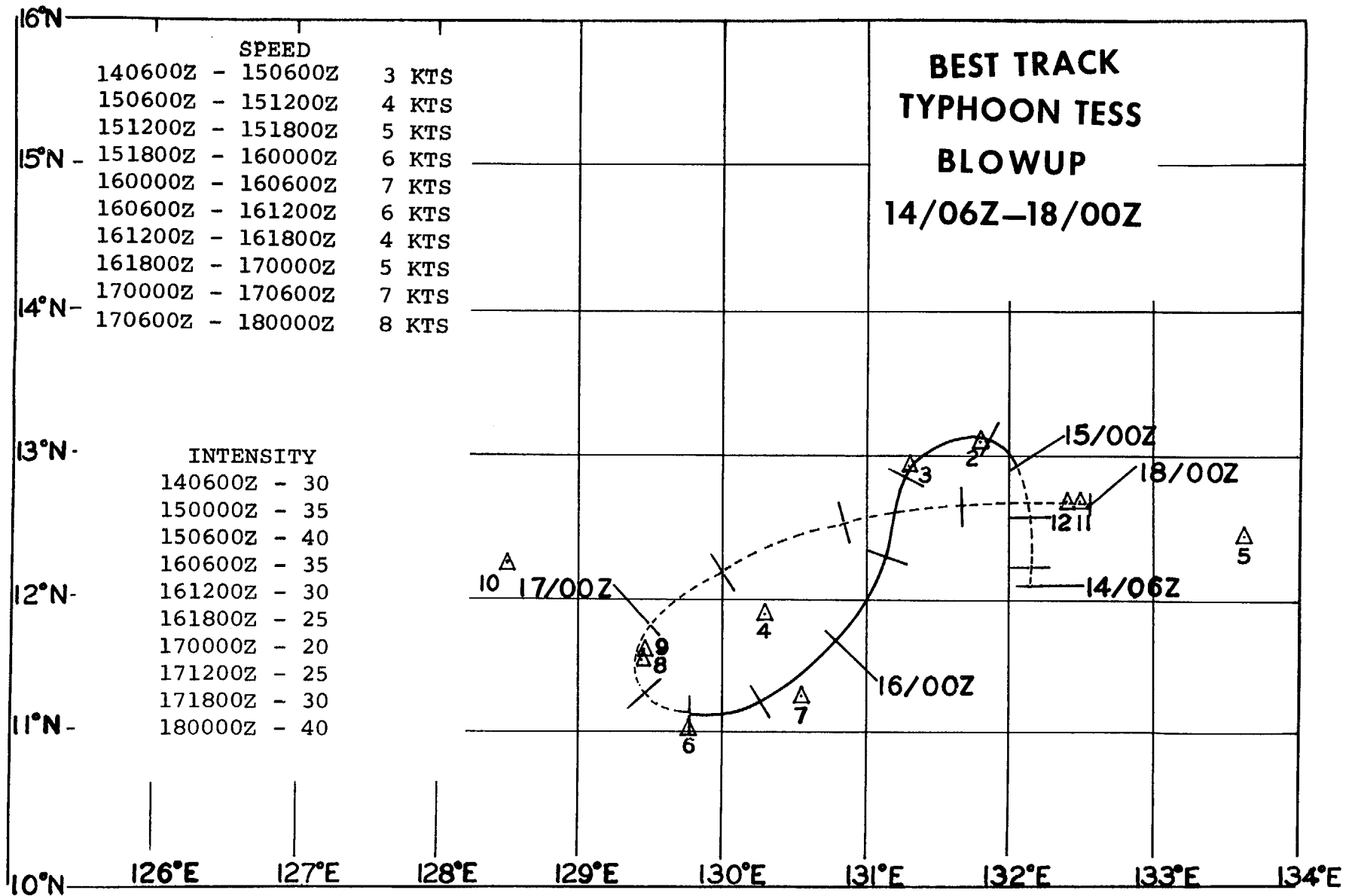
**BEST TRACK  
TYPHOON TESS  
14-22 MAY 1964**

- LEGEND**
-  6HR BEST TRACK POSITS
  -  AIRCRAFT OR LAND RADAR FIX
  -  SPEED
  -  INTENSITY
  -  TYPHOON OR TROPICAL STORM
  -  TROPICAL DEPRESSION
  -  FORMATIVE STAGE

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## EYE FIXES TYPHOON TESS

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	140400Z	11.9N 132.3E	VW1-P-U	700mb	25	25	1002	3124	16/--	NO RADAR PRESENTATION
2	150400Z	13.1N 131.8E	56-P-2	693mb	25	35	998	3063	14/14	ILL DEFINED OPEN S & SW
3	151030Z	12.9N 131.4E	VW1-P-5	9000ft	--	40	---	3112	15/--	700MB HEIGHT DOUBTFUL EYE ELLIP NW-SE 20 X 8 MI
4	160000Z	11.9N 130.3E	56-P-3	700mb	20	35	1003	3092	12/11	
5	160400Z	12.4N 133.6E	54-R-5	31900ft	--	--	---	---	-28/--	CIRC 10 MI DIA
6	160400Z	11.0N 129.8E	56-P-5	693mb	20	35	1000	3082	13/12	CIRC 75 MI DIA
7	161000Z	11.3N 130.5E	VW1-P-5	10000ft	--	30	1004	3087	16/--	NO DEFINITE CLD CENR
8	162200Z	11.5N 129.5E	56-P-5	693mb	20	20	1006	---	15/13	CIRC 50 MI DIA
9	170400Z	11.6N 129.5E	56-P-3	683mb	23	20	998	3063	14/--	CIRC 100 MI DIA
10	171010Z	12.3N 128.5E	VW1-P-15	1500ft	--	18	1003	---	--/--	NO CLSD CENTER
11	172300Z	12.6N 132.5E	VW1-P-2	1500ft	--	35	996	---	28/23	CIRC 15 MI DIA
12	180025Z	12.6N 132.4E	54-R-U	30000ft	--	--	---	---	--/--	CIRC 40 MI DIA
13	180935Z	12.7N 132.8E	VW1-P-5	1500ft	--	35	---	---	24/15	CIRC 28 MI DIA
14	190135Z	12.5N 135.8E	56-P-3	685mb	43	55	996	3008	14/10	CIRC 20 MI DIA
15	190400Z	13.5N 136.9E	56-P-1	688mb	45	55	987	2984	15/10	CIRC 20 MI DIA
16	100420Z	13.0N 137.2E	54-R-10	30000ft	--	50	---	---	-25/--	
17	190943Z	13.0N 138.2E	VW1-P-3	700mb	--	--	985	3028	18/--	ELLIP 14 X 9 MI; 2ND EYE 035/90 MI 6 MI DIA

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
18	191620Z	15.2N 140.0E	VW1-R-5	10000ft	--	--	---	---	--/--	RAGGED 15 MI DIA OPEN SE
19	200100Z	15.7N 142.3E	56-P-3	675mb	50	75	978	2920	15/11	CIRC 20 MI DIA
20	200315Z	16.0N 142.7E	56-P-3	671mb	70	75	970	2908	15/11	CIRC 20 MI DIA
21	200400Z	16.3N 143.2E	54-R-7	30000ft	--	--	---	---	--/--	
22	200905Z	16.7N 144.6E	VW1-P-1	1500ft	--	65	979	---	26/21	CIRC 27 MI DIA
23	201000Z	16.8N 144.9E	VW1-P-5	10000ft	--	--	---	2896	13/11	
24	201535Z	17.9N 146.8E	VW1-P-5	10000ft	--	--	---	2883	14/5	CNTR OPEN
25	202200Z	19.2N 148.6E	54-R-10	30000ft	75	--	---	---	-30/--	OVAL 20 MI N-S 10MI E-W
26	202225Z	19.7N 148.7E	VW1-P-U	700mb	--	90	969	2864	17/--	CIRC 25 MI DIA OPEN NW
27	210402Z	21.7N 150.0E	54-R-30	31640ft	65	--	---	---	-27/--	CIRC 50 MI DIA
28	210505Z	22.1N 149.9E	56-P-10	700mb	63	95	972	2874	19/13	INDEFINITE EYE
29	210928Z	23.2N 151.2E	VW1-P-3	900ft	65	65	965	---	24/--	CIRC
30	211555Z	24.8N 152.7E	VW1-P-5	10000ft	73	--	---	2811	14/--	CIRC 13 MI DIA OPEN S
31	212200Z	26.8N 153.6E	54-R-10	31890ft	--	--	---	---	--/--	OVAL OPEN SW
32	212230Z	26.2N 152.9E	56-P-10	700mb	40	35	969	2841	22/9	OPEN S
33	220345Z	27.6N 153.8E	56-P-5	700mb	50	50	973	2862	18/8	NO DEFINITE EYE

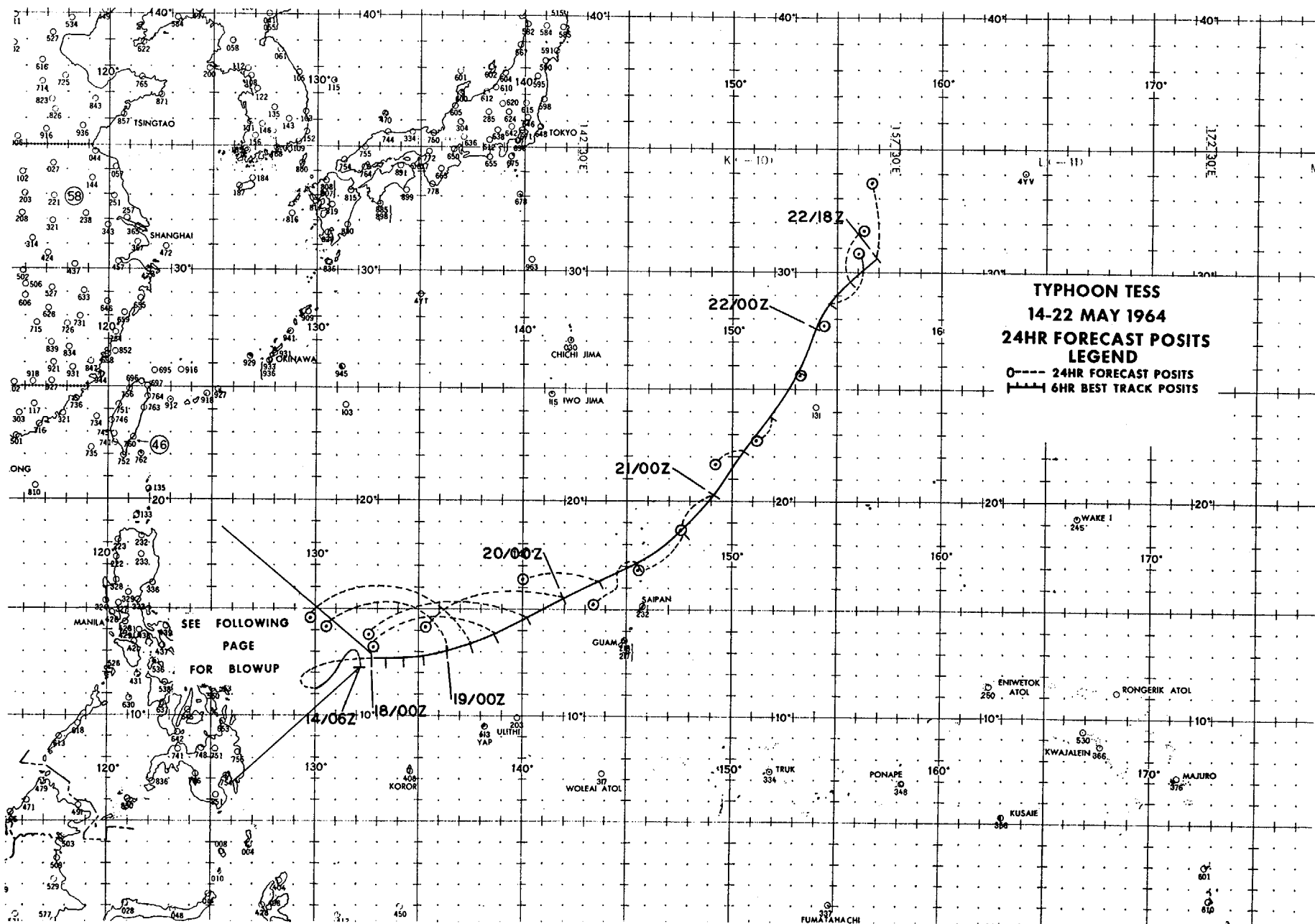
TYPHOON TESS 14 MAY-22 MAY 1964  
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
140600Z	12.1N	132.2E	-----		-----	
141200Z	12.3N	132.2E	-----		-----	
141800Z	12.6N	132.2E	-----		-----	
150000Z	12.9N	132.1E	-----		-----	
150600Z	13.1N	131.8E	-----		-----	
151200Z	12.8N	131.3E	-----		-----	
151800Z	12.3N	131.2E	-----		-----	
160000Z	11.7N	130.8E	335-275		-----	
160600Z	11.2N	130.3E	015-248		-----	
161200Z	11.1N	129.8E	-----		-----	
161800Z	11.2N	129.5E	-----		-----	
170000Z	11.8N	129.5E	-----		-----	
170600Z	12.2N	130.0E	-----		-----	
171200Z	12.5N	130.8E	-----		-----	
171800Z	12.6N	131.6E	-----		-----	
180000Z	12.6N	132.6E	-----		329-137	
180600Z	12.6N	133.3E	-----		257-480	
181200Z	12.6N	134.2E	-----		-----	
181800Z	12.7N	135.2E	-----		-----	
190000Z	13.0N	136.3E	280-345		-----	
190600Z	13.4N	137.5E	280-452		-----	
191200Z	13.9N	138.8E	265-350		-----	
191800Z	14.7N	140.2E	265-445		-----	
200000Z	15.5N	141.8E	260-395		271-775	
200600Z	16.3N	143.6E	275-210		270-916	
201200Z	17.2N	145.5E	230-185		256-795	
201800Z	18.5N	147.6E	230-145		255-885	
210000Z	20.2N	149.0E	220-125		250-760	
210600Z	22.3N	150.3E	240-78		246-372	
211200Z	23.9N	151.9E	215-87		220-435	
211800Z	25.6N	153.1E	080-05		208-350	

TYPHOON TESS 14 MAY-22 MAY 1964  
 POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
220000Z	27.3N	153.8E	057-38	203-286
220600Z	28.7N	154.8E	025-143	218-105
221200Z	29.7N	155.8E	008-113	246-111
221800Z	30.6N	157.0E	355-174	355-270

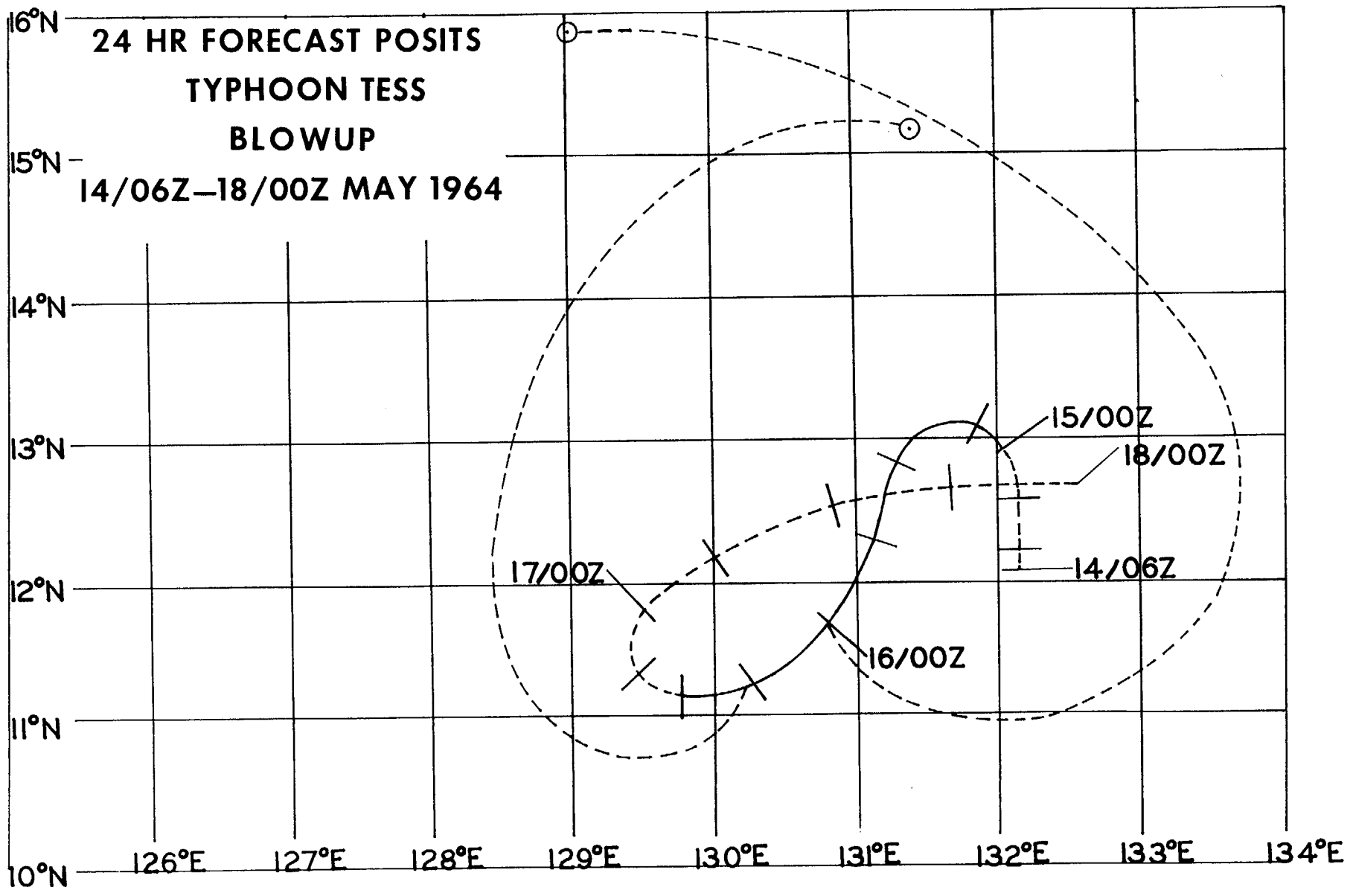
AVERAGE 24 HOUR ERROR 212 MI  
 AVERAGE 48 HOUR ERROR 476 MI



**TYPHOON TESS**  
**14-22 MAY 1964**  
**24HR FORECAST POSITS**  
**LEGEND**  
 ○--- 24HR FORECAST POSITS  
 —●— 6HR BEST TRACK POSITS

**24 HR FORECAST POSITS  
TYPHOON TESS  
BLOWUP  
14/06Z-18/00Z MAY 1964**

08



TYPHOON VIOLA - 251200Z to 280600Z MAY

I. DATA

A. Statistics

1. Calendar days of tropical warning - 3
2. Calendar days of typhoon intensity - 1
3. Total distance traveled during tropical warning period - 432 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 980mb, 270400Z and 271025Z
2. Minimum observed 700mb height - 2918m, 271025Z
3. Maximum surface wind - 70 kts
4. Max radius of surface circulation - 450 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of Polar Trough followed by intensification of high level outdraft

B. Initial surface vortex

1. Junction vortex at 240000Z
2. Surface pressure less than 1004mb

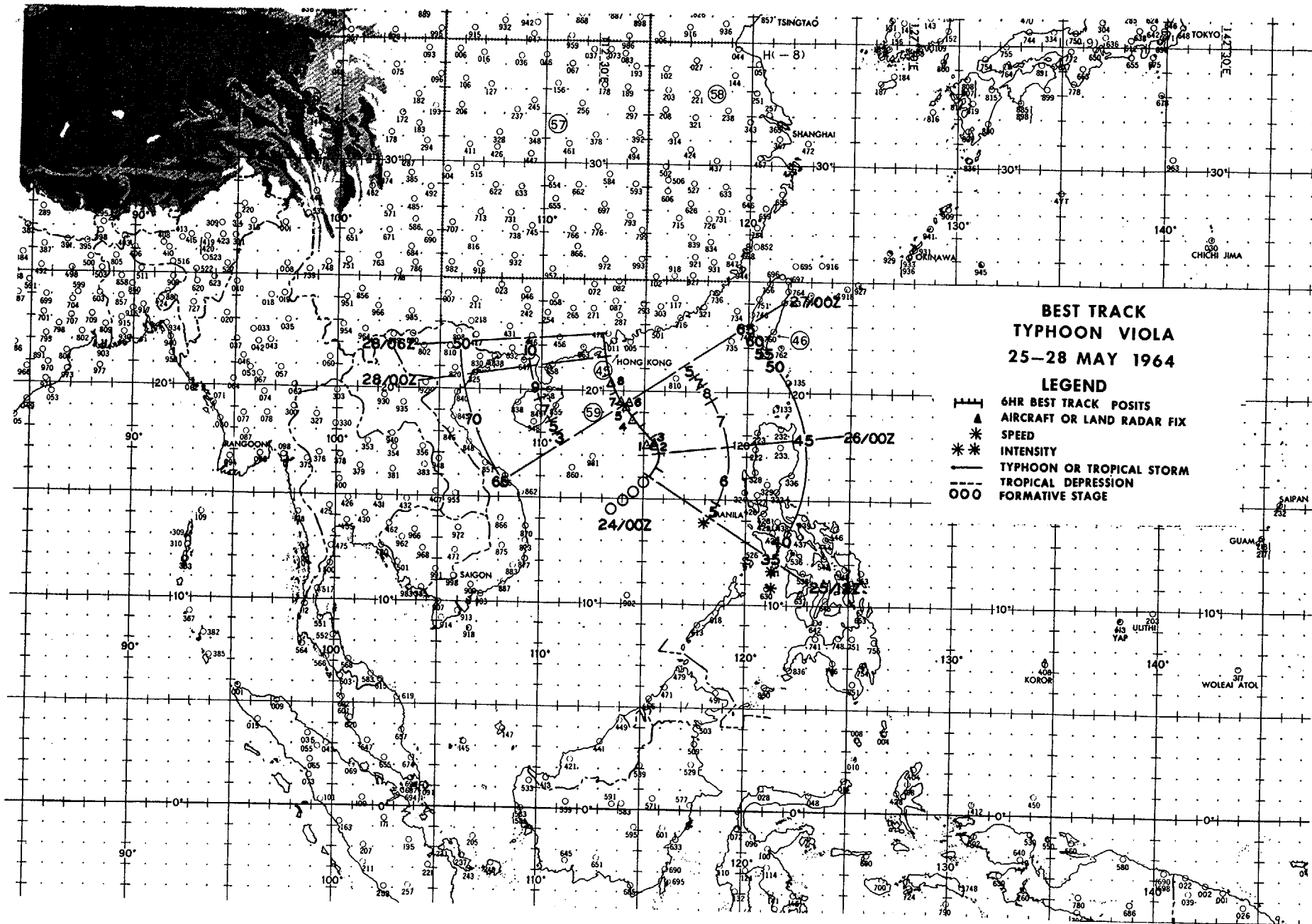
C. 200mb flow above surface vortex

1. Initial - SE quadrant of anticyclone
2. Upon reaching typhoon intensity - SSW quadrant of anticyclone

III. FINAL DISPOSITION








- A. Dissipated over land





**BEST TRACK  
TYPHOON VIOLA  
25-28 MAY 1964**

**LEGEND**

-  6HR BEST TRACK POSITS
-  AIRCRAFT OR LAND RADAR FIX
-  SPEED
-  INTENSITY
-  TYPHOON OR TROPICAL STORM
-  TROPICAL DEPRESSION
-  FORMATIVE STAGE

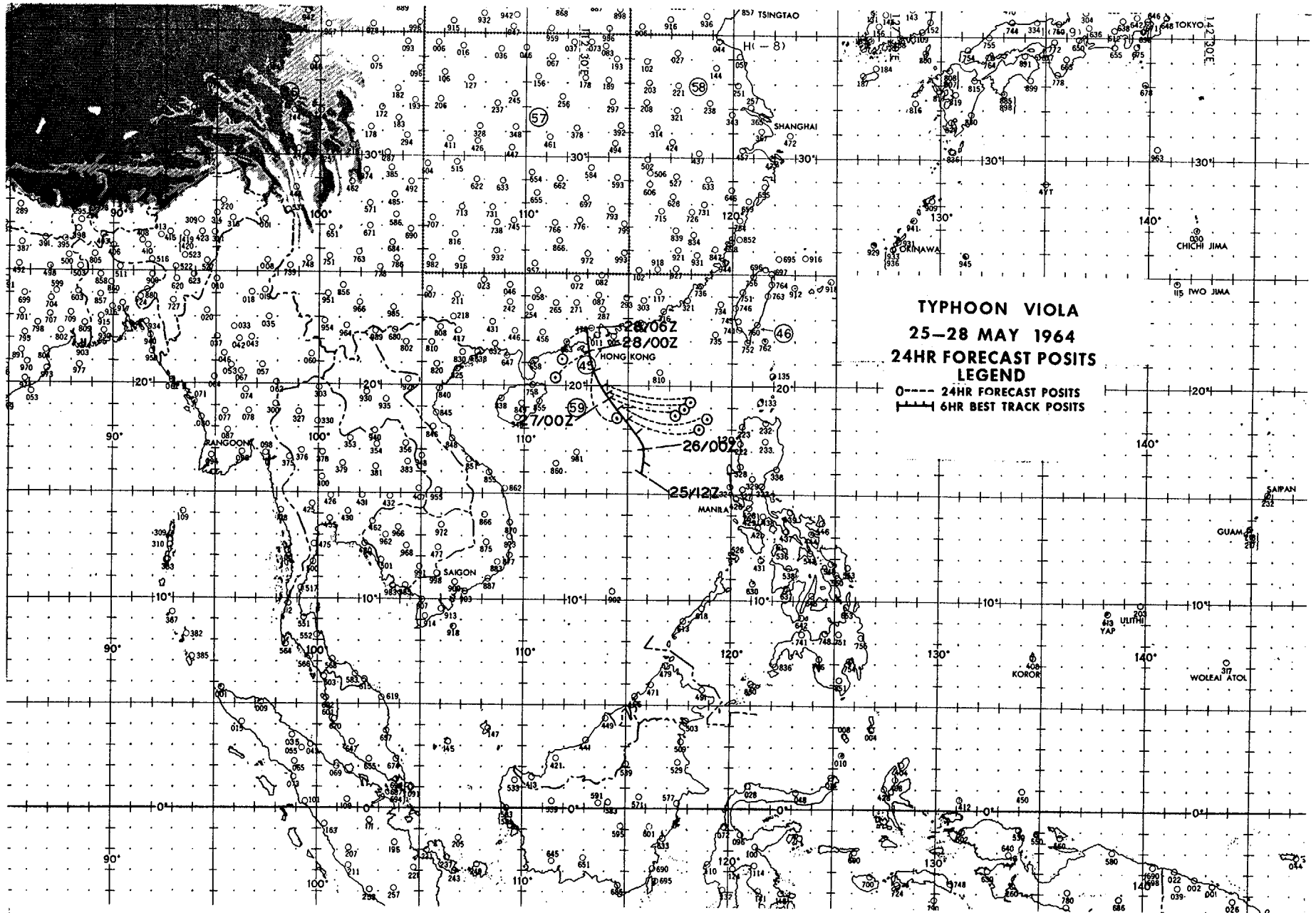
## EYE FIXES TYPHOON VIOLA

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	252200Z	17.5N 115.3E	VW1-P-5	1500ft	--	35	991	---	--/--	CIRC 20 MI DIA
2	260330Z	17.5N 115.6E	VW1-P-5	1500ft	--	40	990	---	--/--	CIRC 40 MI DIA
3	260400Z	17.4N 115.6E	54-R-10	31000ft	15	--	---	---	-28/--	CIRC 30 MI DIA
4	261710Z	18.8N 114.6E	VW1-P-5	1050ft	--	--	984	---	26/18	ELLIP ENE/WSW 50X40 MI
5	262130Z	19.1N 114.2E	VW1-R-12	1500ft	--	--	---	---	--/--	ELLIP NNW/SSE 50X40 MI
6	270400Z	19.5N 114.3E	56-P-5	700mb	60	50	980	2923	14/10	CIRC 55 MI DIA
7	271025Z	19.5N 114.0E	VW1-P-U	UNK	--	65	980	2918	14/7	
8	271530Z	20.3N 113.5E	VW1-R-5	9000ft	--	--	---	---	--/--	ELLIP NE/SW 45X30 MI

TYPHOON VIOLA 25 MAY-28 MAY 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
251200Z	16.1N	115.4E	-----	-----
251800Z	16.5N	115.7E	-----	-----
260000Z	17.1N	115.8E	-----	-----
260600Z	17.7N	115.4E	-----	-----
261200Z	18.3N	114.9E	095-197	-----
261800Z	18.8N	114.5E	097-250	-----
270000Z	19.3N	114.2E	101-181	-----
270600Z	19.5N	114.0E	101-203	-----
271200Z	19.9N	113.7E	101-245	095-378
271800Z	20.6N	113.4E	152-130	096-429
280000Z	21.5N	113.1E	234-115	100-382
280600Z	22.4N	112.9E	220-103	106-418

AVERAGE 24 HOUR ERROR 178 MI  
 AVERAGE 48 HOUR ERROR 402 MI



TYPHOON WINNIE - 260000Z to 030000Z JUNE-JULY

I. DATA

A. Statistics

1. Calendar days of tropical warning - 6 $\frac{1}{4}$
2. Calendar days of typhoon intensity - 4 $\frac{1}{2}$
3. Total distance traveled during tropical warning period - 1872 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 950mb, 011005Z
2. Minimum observed 700mb height - 2819m, 302200Z
3. Maximum surface wind - 100 kts
4. Max radius of surface circulation - 475 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of MPT

B. Initial surface vortex

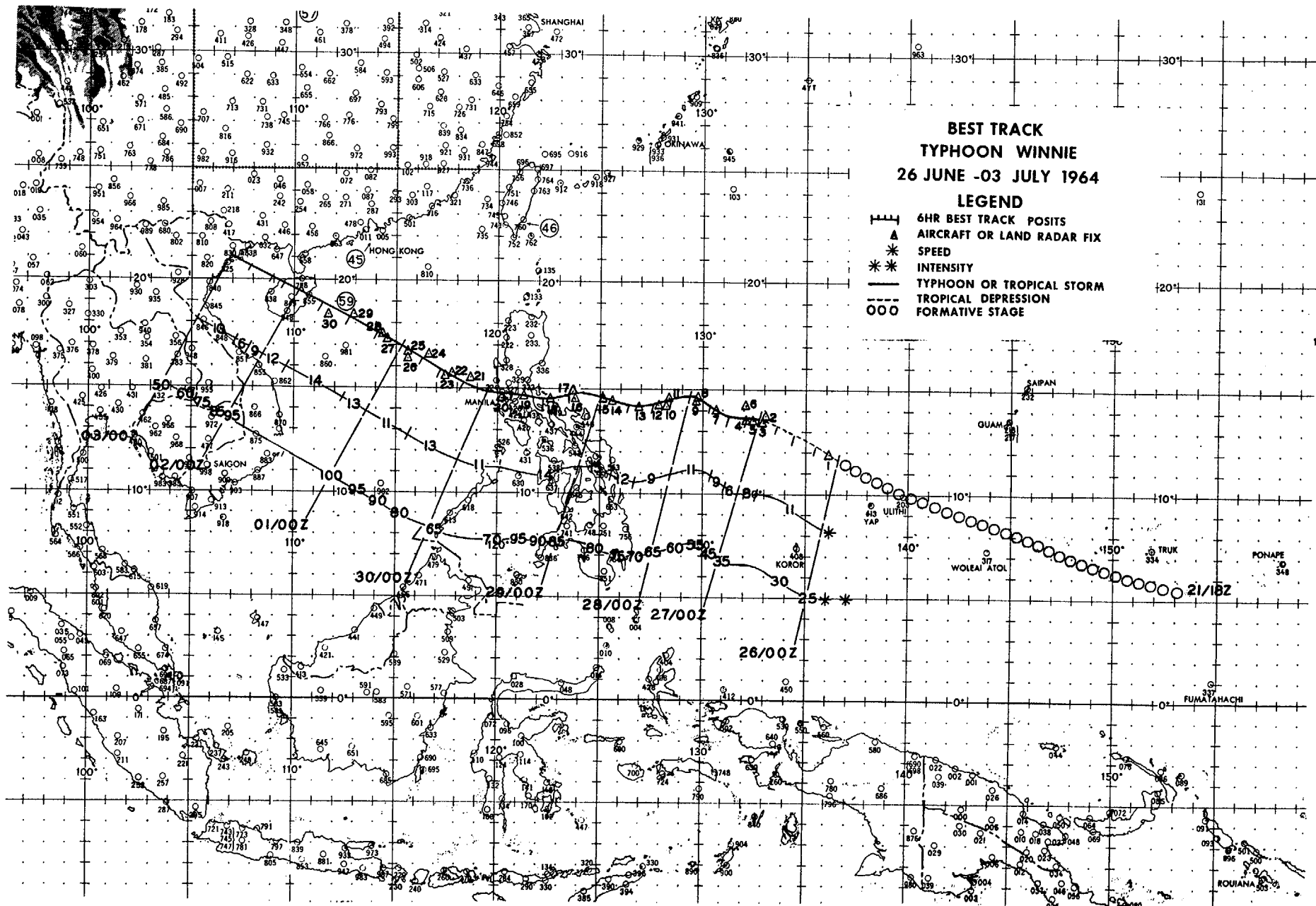
1. Junction vortex at 211800Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - Divergent S portion of neutral point
2. Upon reaching typhoon intensity - W quad of anticyclone

III. FINAL DISPOSITION

- A. Dissipated over land



EYE FIXES TYPHOON WINNIE

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	260200Z	11.8N 136.3E	VW1-P-3	UNK	--	30	1003	---	--/--	CIRC 15 MI DIA
2	262148Z	13.7N 133.1E	56-P-7	700mb	20	35	994	3036	10/10	CIRC 10 MI DIA
3	262200Z	13.4N 133.0E	54-R-3	30000ft	--	--	---	---	--/--	
4	270400Z	13.4N 132.4E	54-R-5	30000ft	50	--	---	---	-31/--	CIRC 9 MI DIA CLSD
5	270400Z	13.4N 132.6E	56-P-3	690mb	20	30	985	3007	12/12	OVAL NW/SE
6	271006Z	14.1N 132.3E	VW1-P-5	1500ft	--	35	991	---	--/--	OVAL E/W 20X15 MI
7	271550Z	13.9N 130.7E	VW1-R-10	10000ft	--	--	---	3017	11/--	CIRC 20 MI DIA
8	272200Z	14.7N 129.9E	54-R-10	30000ft	35	--	---	---	-28/--	CIRC 10 MI DIA OPEN E
9	272200Z	14.6N 129.9E	56-P-10	700mb	40	65	986	2981	13/10	CIRC 10 MI DIA OPEN E SEMI
10	280350Z	14.1N 128.3E	56-P-10	700mb	35	55	987	2990	12/12	CIRC 30 MI DIA
11	280400Z	14.6N 128.5E	54-R-15	30000ft	25	60	---	---	-28/--	CIRC 20 MI DIA
12	281013Z	14.2N 128.0E	VW1-P-5	1000ft	--	50	981	---	--/--	CIRC 7 MI DIA
13	281510Z	14.1N 127.0E	VW1-R-5	10000ft	--	--	---	---	--/--	CIRC 10 MI DIA
14	282200Z	14.5N 125.7E	56-P-3	675mb	40	80	976	2905	13/11	CIRC 80 MI DIA
15	282208Z	14.6N 125.2E	54-R-10	30000ft	--	--	---	---	--/--	OVAL NNW/SSE 25X20 MI
16	290400Z	14.6N 123.9E	56-P-5	673mb	65	75	972	2856	14/11	CIRC 50 MI DIA
17	290400Z	14.8N 123.8E	54-R-5	30000ft	60	--	---	---	--/--	CIRC 40 MI DIA

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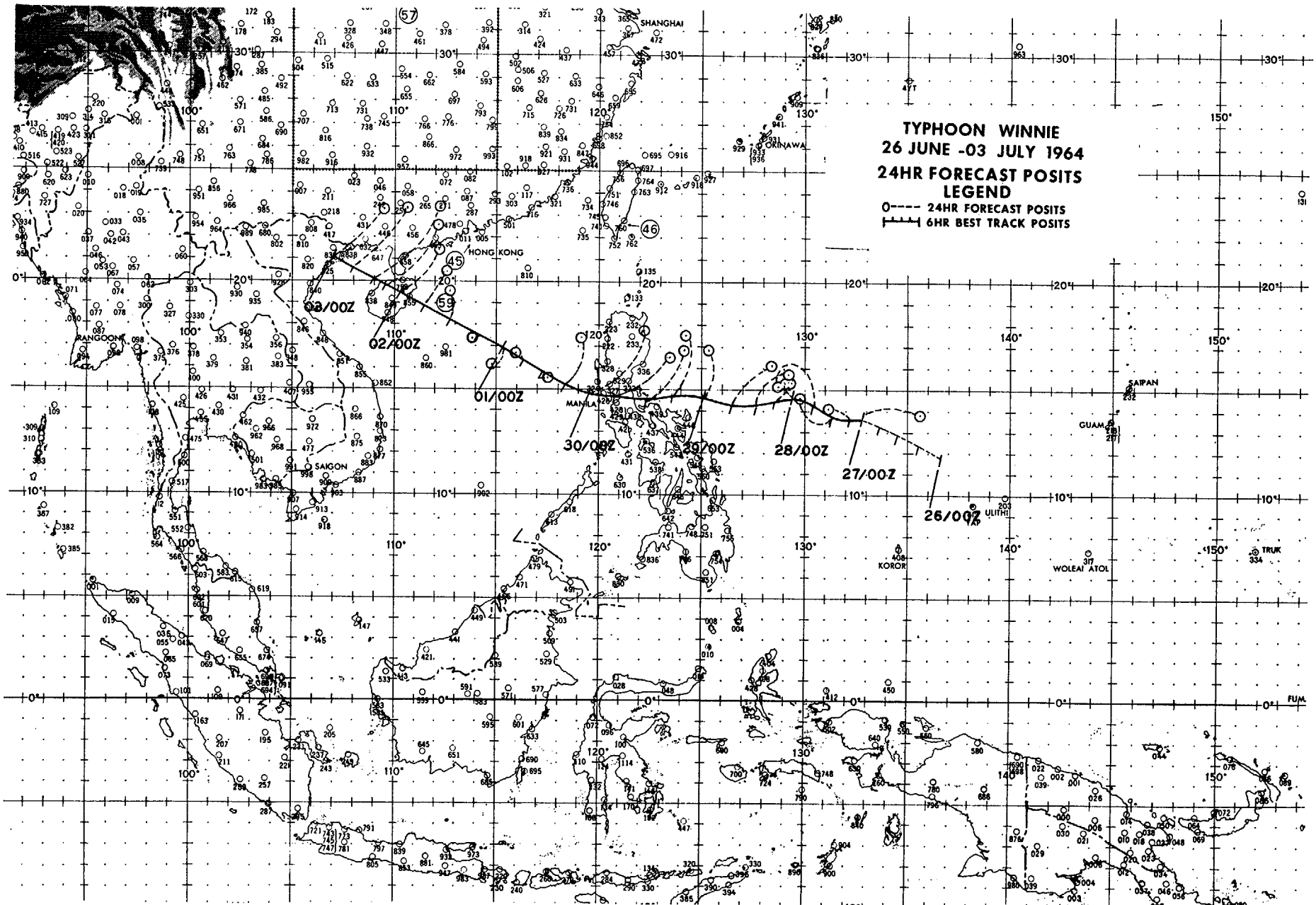
FLX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
18	291020Z	14.5N 122.6E	VW1-P-3	UNK	--	75	968	---	--/--	CIRC 35 MI DIA
19	291526Z	14.6N 121.5E	VW1-R-5	1000ft	--	--	---	---	--/--	CIRC 30 MI DIA
20	292200Z	14.5N 120.2E	54-R-3	30000ft	30	--	---	---	--/--	CIRC 30 MI DIA OPEN N
21	300400Z	15.4N 118.8E	54-R-0	30000ft	50	--	---	---	-24/--	CIRC 50 MI DIA OPEN NW & W
22	300715Z	15.7N 117.9E	56-P-3	700mb	80	80	971	2841	14/13	CIRC 50 MI DIA ILL DEFINED
23	300958Z	15.6N 117.5E	VW1-P-3	1500ft	--	65	970	---	25/16	CIRC 60 MI DIA
24	301540Z	16.5N 116.7E	VW1-R-10	10000ft	--	--	---	---	--/--	OVAL E/W 60 X 50 MI
25	302200Z	16.7N 115.7E	54-R-U	31000ft	--	100	---	---	-25/--	OVAL 15 X 10 MI
26	302200Z	16.3N 115.7E	56-P-2	674mb	65	85	969	2819	15/13	CIRC 100 MI DIA
27	010310Z	17.2N 114.6E	56-P-3	674mb	65	85	969	2832	14/11	CIRC 70 MI DIA
28	010400Z	17.4N 114.4E	54-R-10	31000ft	40	--	---	---	-23/--	INDEFINITE 30 MI DIA
29	011005Z	18.3N 113.0E	VW1-P-10	1500ft	--	90	950	---	22/--	OVAL 43 MI E/W 47 MI N/S
30	011539Z	18.5N 111.8E	VW1-R-10	5000ft	--	--	---	---	--/--	OVAL NW/SE 45 MI NE/SW 40 MI WALL CLD 20 MI THICK



TYPHOON WINNIE 26 JUN-03 JUL 1964  
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
260000Z	11.7N	136.6E	-----		-----	
260600Z	12.2N	135.7E	-----		-----	
261200Z	12.8N	134.7E	-----		-----	
261800Z	13.2N	133.8E	-----		-----	
270000Z	13.5N	132.9E	-----		-----	
270600Z	13.6N	132.3E	-----		-----	
271200Z	13.6N	131.4E	-----		-----	
271800Z	14.2N	130.5E	-----		-----	
280000Z	14.6N	129.5E	322-46		-----	
280600Z	14.5N	128.6E	034-54		-----	
281200Z	14.2N	127.8E	042-118		-----	
281800Z	14.3N	126.5E	041-154		-----	
290000Z	14.7N	125.1E	007-134		009-135	
290600Z	14.7N	123.7E	012-174		045-177	
291200Z	14.5N	122.3E	038-182		051-285	
291800Z	14.7N	120.8E	055-198		056-328	
300000Z	14.7N	119.7E	038-233		029-300	
300600Z	15.2N	118.4E	015-143		032-374	
301200Z	15.8N	117.3E	157-25		045-372	
301800Z	16.3N	116.3E	321-23		055-395	
010000Z	16.9N	115.3E	205-50		054-490	
010600Z	17.5N	114.1E	212-15		020-237	
011200Z	18.3N	112.8E	004-83		192-28	
011800Z	18.8N	111.4E	037-112		322-11	
020000Z	19.4N	110.3E	041-158		188-54	
020600Z	19.8N	109.5E	042-218		044-218	
021200Z	20.1N	109.0E	042-268		035-360	
021800Z	20.5N	108.0E	043-218		042-390	
030000Z	21.0N	107.0E	048-195		048-442	

AVERAGE 24 HOUR ERROR 133 MI  
AVERAGE 48 HOUR ERROR 270 MI



**TYPHOON ALICE - 261800Z to 280000Z JUNE**

**I. DATA**

**A. Statistics**

1. Calendar days of tropical warning -  $1\frac{1}{2}$
2. Calendar days of typhoon intensity -  $\frac{1}{2}$
3. Total distance traveled during tropical warning period - 324 mi

**B. Characteristics as a typhoon**

1. Minimum observed SLP - 990mb, 262210Z and 271610Z
2. Minimum observed 700mb height - 3082m, 270950Z
3. Maximum surface wind - 65 kts
4. Max radius of surface circulation - 200 mi

**II. DEVELOPMENT**

**A. Initial impetus - Increased divergence at 200mb over easterly wave**

**B. Initial surface vortex**

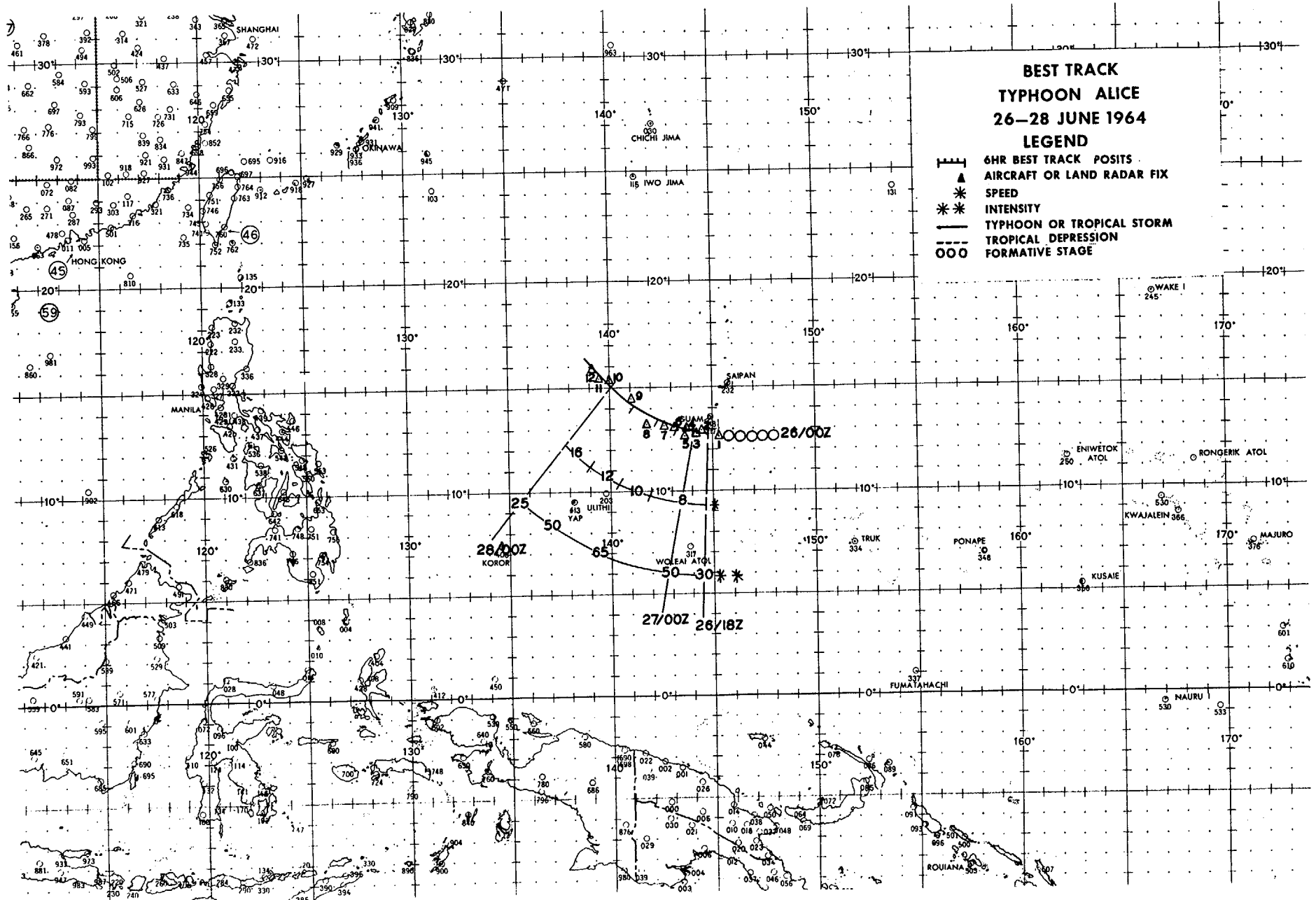
1. Junction vortex at 260000Z
2. Surface pressure less than 1009mb

**C. 200mb flow above surface vortex**








1. Initial - SE quad of anticyclone
2. Upon reaching typhoon intensity - E quad of anticyclone

**III. FINAL DISPOSITION**

**A. Absorbed in circulation of Typhoon Winnie**



**BEST TRACK  
TYPHOON ALICE  
26-28 JUNE 1964  
LEGEND**

-  6HR BEST TRACK POSITS
-  AIRCRAFT OR LAND RADAR FIX
-  SPEED
-  INTENSITY
-  TYPHOON OR TROPICAL STORM
-  TROPICAL DEPRESSION
-  FORMATIVE STAGE

## EYE FIXES TYPHOON ALICE

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	261415Z	12.5N 145.4E	VW1-P-5	1200ft	--	--	998	3185	24/--	OVAL N/S 25X13 MI OPEN TO NE
2	262210Z	12.8N 144.5E	VW1-P-5	---	--	50	990	---	--/--	WALL CLD E THRU SW QUAD ONLY 8 MI THICK
3	262350Z	12.8N 144.2E	54-R-U	30000ft	--	45	---	---	--/--	
4	270215Z	13.1N 143.8E	54-R-U	30000ft	--	50	---	---	--/--	
5	270400Z	12.6N 143.8E	VW1-P-2	700mb	--	60	993	3088	15/11	ELLIP 10MI NE/SW 6 MI NW/SE
6	270624Z	13.1N 143.2E	VW1-R-U	1500ft	--	--	---	---	--/--	
7	270950Z	13.3N 142.7E	VW1-P-3	700mb	--	55	995	3082	14/9	POORLY DEFINED ELLIP 11 MI N/S 18 MI E/W
8	271610Z	13.3N 141.8N	VW1-P-5	700mb	--	--	990	3165	13/6	OVAL 30 MI E/W 19 MI N/S OPEN TO N WALL CLDS 8 MI THICK
9	271937Z	14.4N 141.1E	54-R-U	30000ft	--	--	---	---	--/--	
10	280040Z	15.3N 140.1E	56-P-5	700mb	27	40	1002	3130	13/--	CIRC 8 MI DIA
11	280148Z	15.4N 139.5E	54-R-5	30000ft	--	40	---	---	--/--	CIRC 10 MI DIA CLSD
12	280349Z	15.9N 139.2E	56-P-5	700mb	22	45	1004	3127	12/--	CIRC 10 MI DIA

TYPHOON ALICE 26 JUN-28 JUN 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
261800Z	12.6N	144.9E	-----	-----
270000Z	12.8N	144.2E	-----	-----
270600Z	13.1N	143.3E	-----	-----
271200Z	13.4N	142.4E	-----	-----
271800Z	13.9N	141.3E	-----	-----
280000Z	15.0N	140.1E	-----	-----

TYPHOON BETTY - 020600Z to 061800Z JULY

I. DATA

A. Statistics

1. Calendar days of tropical warning - 4 3/4
2. Calendar days of typhoon intensity - 3 3/4
3. Total distance traveled during tropical warning period - 1086 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 958mb, 042200Z and 050400Z
2. Minimum observed 700mb height - 2737m, 050400Z
3. Maximum surface wind - 110 kts
4. Max radius of surface circulation - 225 mi

II. DEVELOPMENT

A. Initial impetus - Juxtaposition of Polar Trough with subsequent fracture and increased divergence at 200mb

B. Initial surface vortex

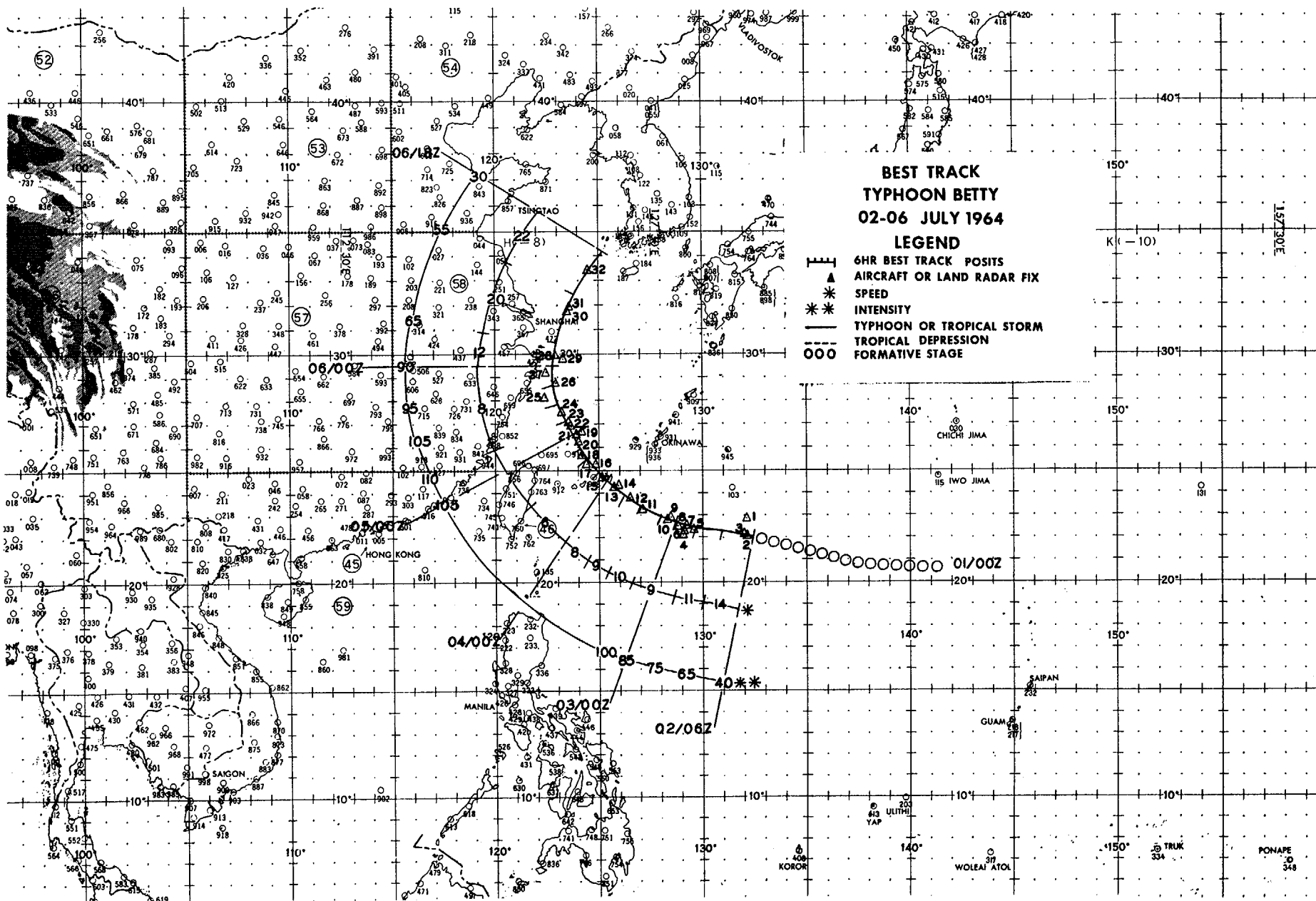
1. Embedded vortex at 010000Z
2. Surface pressure less than 1010mb

C. 200mb flow above surface vortex

1. Initial - SSW quad of anticyclone
2. Upon reaching typhoon intensity - SW quad of anticyclone

III. FINAL DISPOSITION

- A. Dissipated over water



**BEST TRACK  
TYPHOON BETTY  
02-06 JULY 1964**

**LEGEND**

- 6HR BEST TRACK POSITS
- ▲ AIRCRAFT OR LAND RADAR FIX
- \* SPEED
- \*\* INTENSITY
- TYPHOON OR TROPICAL STORM
- - - TROPICAL DEPRESSION
- OOO FORMATIVE STAGE

15730E

15730E

15730E

15730E



## EYE FIXES TYPHOON BETTY

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	020505Z	22.8N 132.1E	VW1-V-U	---	--	40	---	---	--/--	
2	020655Z	22.0N 132.2E	VW1-P-10	1500ft	--	70	990	---	23/--	CIRC 28 MI DIA OPEN E SEMI
3	020920Z	22.1N 132.0E	VW1-P-3	1500ft	--	55	992	---	26/--	CIRC 25 MI DIA OPEN E SEMI
4	021645Z	22.2N 129.1E	VW1-R-10	1500ft	--	--	---	---	--/--	EYE 40 MI DIA OPEN NE QUAD
5	021813Z	22.3N 129.7E	VW1-R-5	10000ft	--	--	---	---	--/--	EYE 40 MI DIA OPEN NE
6	022200Z	22.3N 129.2E	56-P-5	700mb	79	60	986	2994	15/10	CIRC 3 MI DIA CLSD
7	022215Z	22.4N 129.3E	54-R-5	30000ft	--	50	---	---	--/--	OVAL CLSD WALL CLD 3 TO 4 MI THICK
8	030000Z	22.4N 128.9E	56-P-10	700mb	70	85	990	2999	19/10	ELLIP 20 MI NE/SW CLSD
9	030400Z	22.9N 128.5E	56-P-4	701mb	60	100	986	2975	18/11	CIRC 25 MI DIA OPEN E
10	030405Z	22.8N 128.4E	54-R-10	30000ft	--	--	---	---	--/--	CIRC 20 MI DIA CLSD
11	031050Z	23.3N 127.1E	VW1-P-5	10000ft	--	75	970	2941	15/6	CIRC 20 MI DIA CLSD WALL CLDS 12 MI THICK
12	031546Z	23.7N 126.5E	VW1-R-3	9000ft	--	--	---	---	--/--	ELLIP 25 MI N/S 20 MI E/W CLSD WALL CLDS 8 MI THICK
13	032200Z	24.2N 125.7E	56-P-3	700mb	70	80	977	2926	15/9	ELLIP 30 MI N/S 20 MI E/W OPEN N
14	032240Z	24.2N 125.8E	54-R-3	31000ft	--	--	---	---	--/--	CIRC 15 MI DIA CLSD

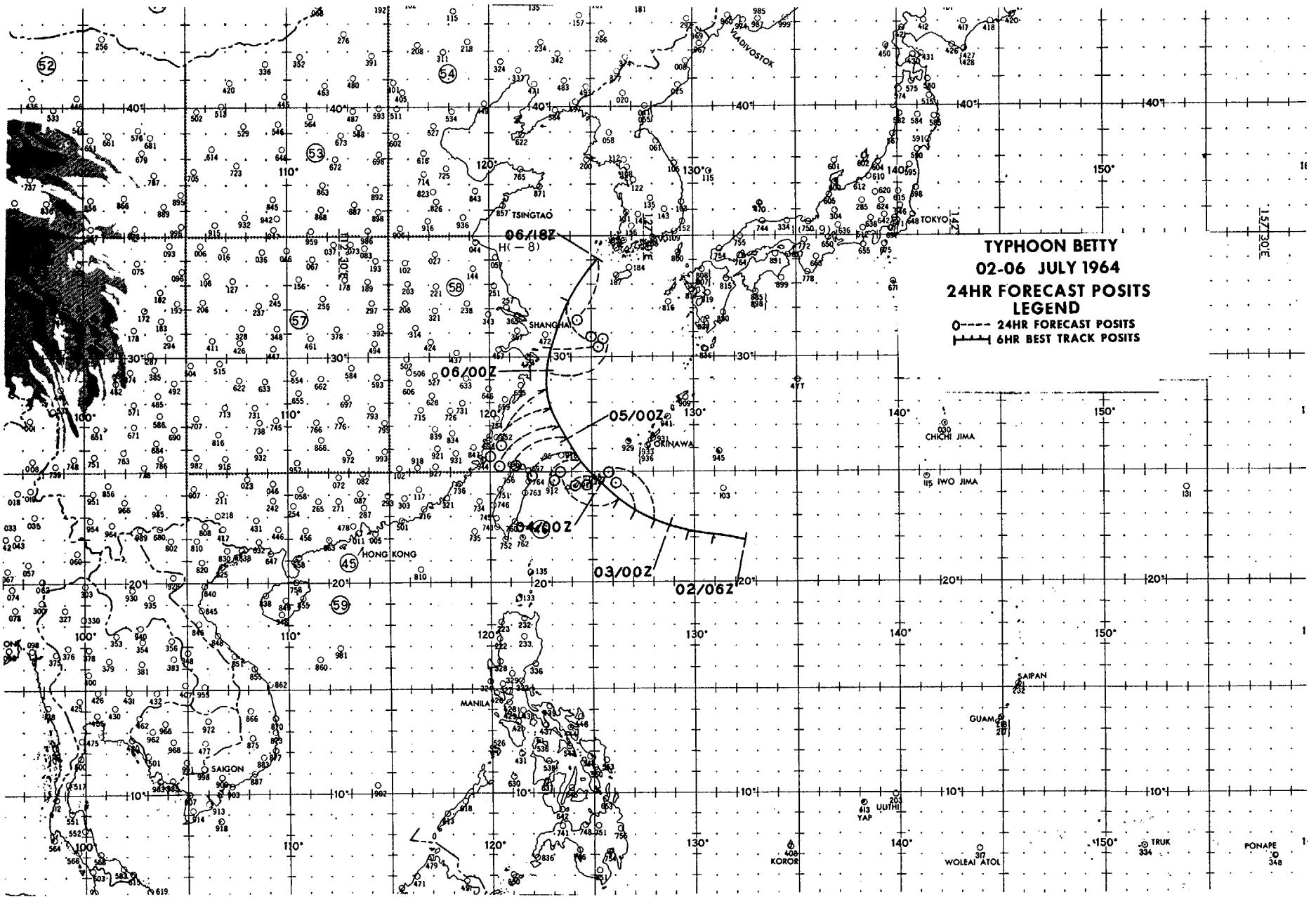
FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
15	040310Z	24.6N 125.2E	56-P-½	700mb	55	60	970	2835	17/11	CIRC 17 MI DIA WEAK WALL CLDS NW
16	040430Z	25.0N 125.0E	54-R-15	31000ft	--	--	---	---	--/--	CIRC 20 MI DIA OPEN NE
17	040915Z	25.0N 124.1E	VW1-P-5	1500ft	--	95	961	---	26/22	CIRC 20 MI DIA CLSD WALL CLDS 4 MI THICK
18	041530Z	25.5N 124.3E	VW1-R-5	2500ft	--	--	---	---	--/--	CIRC 23 MI DIA CLSD WALL CLDS 4 MI THICK
19	042155Z	26.5N 124.0E	54-R-0	30000ft	CALM	--	---	---	-23/--	CIRC 25 MI DIA CLSD WALL CLDS 3 MI THICK
20	042200Z	26.3N 124.0E	56-P-5	700mb	75	90	958	2746	20/11	EYE 20 MI DIA CLSD WALL CLDS 3 MI THICK
21	050100Z	26.4N 123.9E	56-R-U	700mb	--	--	---	---	--/--	
22	050400Z	26.8N 123.7E	56-P-3	700mb	95	110	958	2737	20/13	CIRC 20 MI DIA CLSD
23	050400Z	26.9N 123.6E	54-R-5	35000ft	CALM	--	---	---	-37/--	CIRC 20 MI DIA CLSD WALL CLD TOPS 37000FT
24	050945Z	27.5N 123.3E	VW1-R-3	10000ft	--	--	---	---	--/--	CIRC 21 MI DIA CLSD WALL CLDS 8 MI THICK
25	051533Z	28.1N 122.4E	VW1-R-3	5000ft	--	--	---	---	--/--	CIRC 30 MI DIA APPEARS TO BE WEAKENING WEST SEMI
26	052156Z	28.7N 123.0E	54-R-5	31000ft	--	--	---	---	--/--	CIRC 35 MI DIA
27	052325Z	29.2N 122.6E	56-R-15	689mb	--	--	---	---	--/--	
28	060345Z	29.9N 122.9E	56-R-15	674mb	--	--	---	---	--/--	

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
29	060515Z	29.8N 123.3E	54-R-10	30000ft	--	--	---	---	--/--	EYE DIA 25 MI
30	061000Z	31.8N 123.4E	VW1-R-10	1500ft	--	--	---	---	--/--	CIRC 35 MI DIA OPEN W NO FEEDER BANDS
31	061106Z	31.9N 123.5E	VW1-P-5	1500ft	--	55	995	---	--/--	EYE OPEN W SEMI WALL CLDS 8 MI THICK
32	061535Z	33.5N 124.4E	VW1-R-15	1500ft	--	--	---	---	--/--	NO RADAR EYE

TYPHOON BETTY 02 JUL-06 JUL 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
020600Z	22.0N	132.5E	-----		-----	
021200Z	22.2N	131.0E	-----		-----	
021800Z	22.2N	129.8E	-----		-----	
030000Z	22.5N	128.9E	-----		-----	
030600Z	22.9N	128.1E	316-174		-----	
031200Z	23.3N	127.0E	323-86		-----	
031800Z	23.8N	126.2E	295-170		-----	
040000Z	24.3N	125.5E	287-38		-----	
040600Z	24.7N	125.0E	250-48		294-286	
041200Z	25.2N	124.6E	247-83		291-199	
041800Z	25.8N	124.2E	247-126		306-300	
050000Z	26.4N	123.7E	243-156		280-135	
050600Z	27.0N	123.4E	236-195		241-210	
051200Z	27.8N	123.0E	232-206		236-263	
051800Z	28.6N	122.8E	220-184		236-336	
060000Z	29.3N	122.8E	059-169		235-386	
060600Z	30.5N	123.0E	088-121		233-465	
061200Z	32.4N	123.7E	145-113		231-535	
061800Z	34.1N	125.3E	-----		-----	

AVERAGE 24 HOUR ERROR 134 MI  
 AVERAGE 48 HOUR ERROR 312 MI



TYPHOON CORA - 060600Z to 100000Z JULY

I. DATA

A. Statistics

1. Calendar days of tropical warning - 4
2. Calendar days of typhoon intensity - 3
3. Total distance traveled during tropical warning period - 1026 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 967mb, 062200Z
2. Minimum observed 700mb height - 2844m, 062200Z
3. Maximum surface wind - 140 kts
4. Max radius of surface circulation - 325 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of Polar Trough with easterly wave and subsequent fracture

B. Initial surface vortex

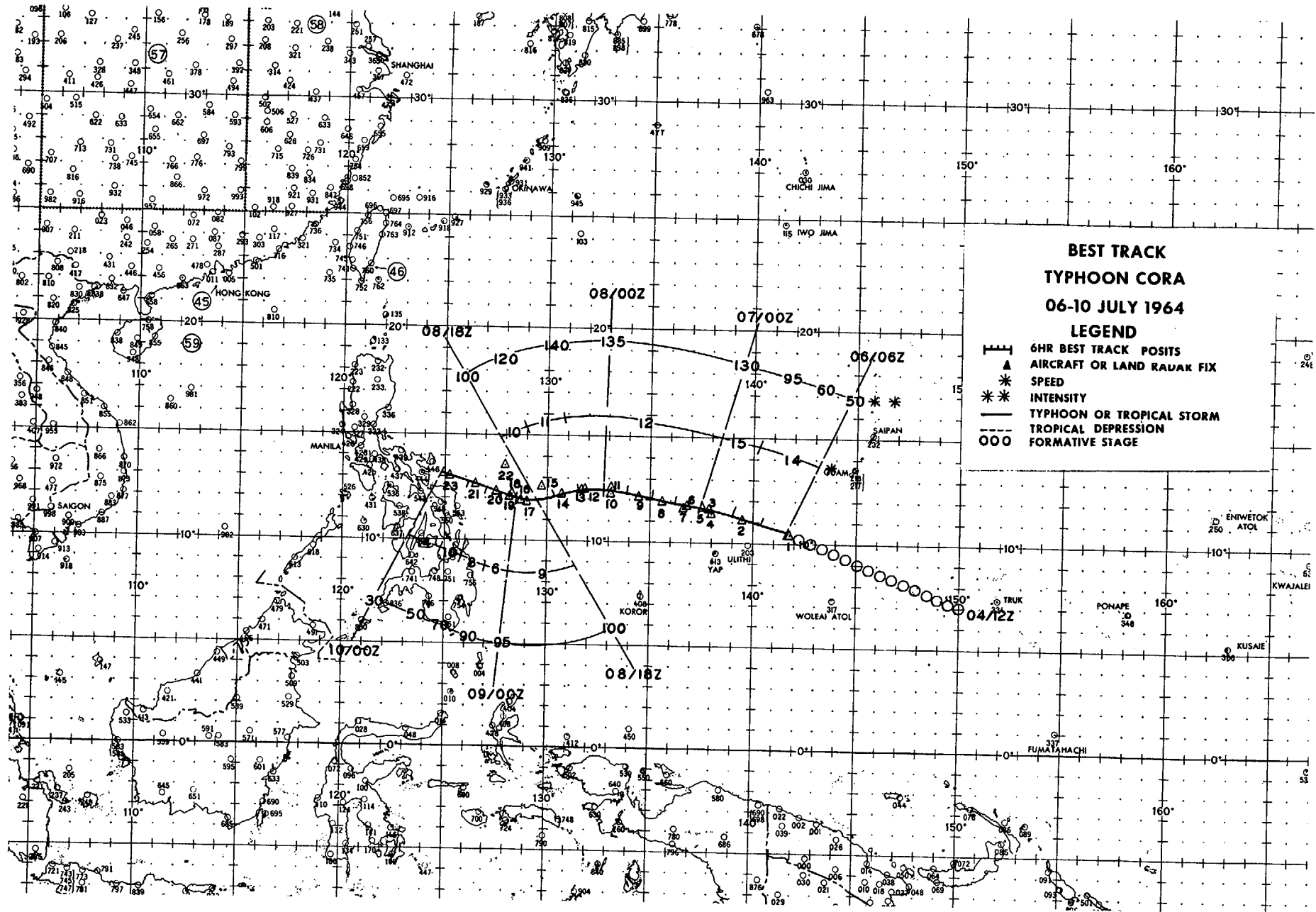
1. Junction vortex at 041200Z
2. Surface pressure less than 1010mb

C. 200mb flow above surface vortex

1. Initial - SW quad of anticyclone
2. Upon reaching typhoon intensity - SE quad of anticyclone

III. FINAL DISPOSITION

- A. Dissipated over water



## EYE FIXES TYPHOON CORA

FLX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	060540Z	10.4N 141.8E	VW1-P-5	900ft	--	--	992	---	25/--	CIRC 12 MI DIA WALL CLDS 3 TO 5 MI THICK
2	061600Z	11.2N 139.4E	VW1-P-5	10500ft	--	--	---	3002	13/--	CIRC 10 MI DIA WALL CLDS 4 MI THICK
3	062200Z	11.7N 137.9E	56-P-2	714mb	70	175	967	2844	18/9	CIRC 8 MI DIA CLSD
4	062229Z	11.5N 138.0E	54-R-5	30000ft	--	150	---	---	--/--	
5	062330Z	11.8N 137.6E	54-R-5	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA
6	070400Z	11.9N 136.8E	56-P-1	678mb	70	175	970	2853	16/13	CIRC 5 MI DIA CLSD UNABLE TO STAY IN EYE
7	070418Z	11.8N 136.6E	54-R-5	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA CLSD
8	070942Z	12.1N 135.5E	VW1-R-10	1500ft	--	--	---	---	--/--	CIRC 10 MI DIA CLASSIC EYE
9	071552Z	12.2N 134.5E	VW1-R-8	1500ft	--	--	---	---	--/--	ELLIP 22 MI NNE/SSW 17 MI WNW/ESE OPEN ESE WALL CLDS 7 MI THICK
10	072200Z	12.3N 133.2E	54-R-3	30000ft	L/V	100	---	---	-32/--	OVAL 10 MI DIA VERY STRONG WALL CLDS SW & W QUADS GREEN SEA VSBL
11	072200Z	12.5N 133.2E	56-P-8	685mb	50	130	985	3015	15/13	CIRC 8 MI DIA DIFFICULT TO STAY IN EYE
12	080400Z	12.4N 131.8E	54-R-5	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA

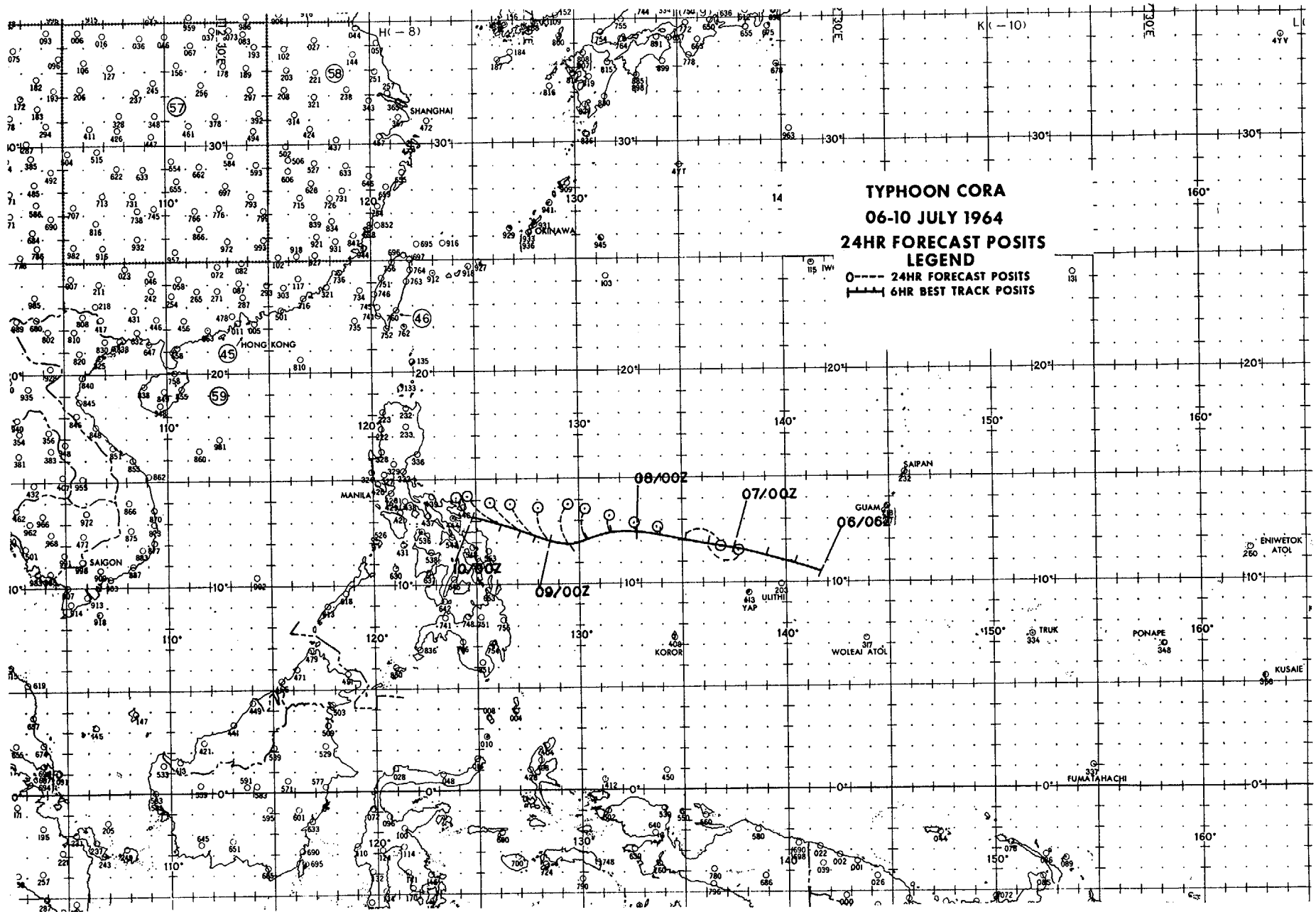


FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
13	080400Z	12.4N 131.7E	56-P-5	700mb	60	140	985	2984	13/13	CIRC 10 MI DIA OPEN NE
14	080930Z	12.2N 130.8E	VW1-P-5	10000ft	--	70	---	3087	16/12	CIRC 25 MI DIA OPEN NE WALL CLDS DIFFUSED 5 MI THICK
15	081610Z	12.1N 129.1E	VW1-P-10	1200ft	--	--	990	---	26/23	EYE 23 MI DIA OPEN E
16	082200Z	12.0N 128.8E	56-P-9	694mb	35	75	993	3109	16/10	OVAL 30 MI ENE/WSW 15 MI SSE/NNW WALL CLDS W QUAD ONLY 5 MI THICK
17	082305Z	11.9N 129.0E	54-R-2	30000ft	--	50	---	---	--/--	CIRC 50 MI DIA CLSD
18	090400Z	12.4N 128.2E	56-P-9	681mb	30	90	1005	3115	14/7	ELLIP 25 MI NE/SW 15 MI NW/SE HVY WALL CLD SW QUAD
19	090400Z	12.2N 128.1E	54-R-3	31000ft	--	95	---	---	--/--	OVAL 30 MI E/W 20 MI N/S CLSD
20	090950Z	12.4N 127.6E	VW1-P-5	1200ft	--	40	1001	---	26/22	CIRC 25 MI DIA OPEN E SEMI RIM CLD 3 MI THICK TOPS 3000FT NEG WALL CLDS
21	091530Z	12.7N 126.5E	VW1-R-5	9000ft	--	--	---	---	--/--	CIRC 30 MI DIA NEG WALL CLDS
22	092115Z	13.2N 128.0E	RAF 6922	---	--	--	---	---	--/--	
23	092200Z	13.1N 125.3E	56-P-1	688mb	31	40	1004	3133	14/6	NO EYE

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TYPHOON CORA 06 JUL-10 JUL 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
060600Z	10.5N	141.6E	-----		-----	
161200Z	10.9N	140.3E	-----		-----	
161800Z	11.3N	139.0E	-----		-----	
070000Z	11.7N	137.5E	-----		-----	
070600Z	11.9N	136.3E	107-90		-----	
071200Z	12.1N	135.1E	100-107		-----	
071800Z	12.3N	133.9E	355-20		-----	
080000Z	12.4N	132.7E	002-34		-----	
080600Z	12.4N	131.5E	001-56		085-143	
081200Z	12.1N	130.3E	358-87		075-158	
081800Z	11.9N	129.4E	003-117		355-120	
090000Z	12.1N	128.5E	344-102		338-141	
090600Z	12.3N	127.9E	321-116		335-155	
091200Z	12.6N	127.2E	314-125		328-170	
091800Z	12.8N	126.2E	311-125		329-176	
100000Z	13.2N	124.8E	-----		-----	
AVERAGE 24 HOUR ERROR			89 MI			
AVERAGE 48 HOUR ERROR			152 MI			



TYPHOON DORIS - 111200Z to 151200Z JULY

I. DATA

A. Statistics

1. Calendar days of tropical warning - 4½
2. Calendar days of typhoon intensity - 1½
3. Total distance traveled during tropical warning period - 1416 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 974mb, 132229Z
2. Minimum observed 700mb height - 2880m, 132229Z
3. Maximum surface wind - 80 kts
4. Max radius of surface circulation - 350 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of MPT with increased divergence at 200mb

B. Initial surface vortex

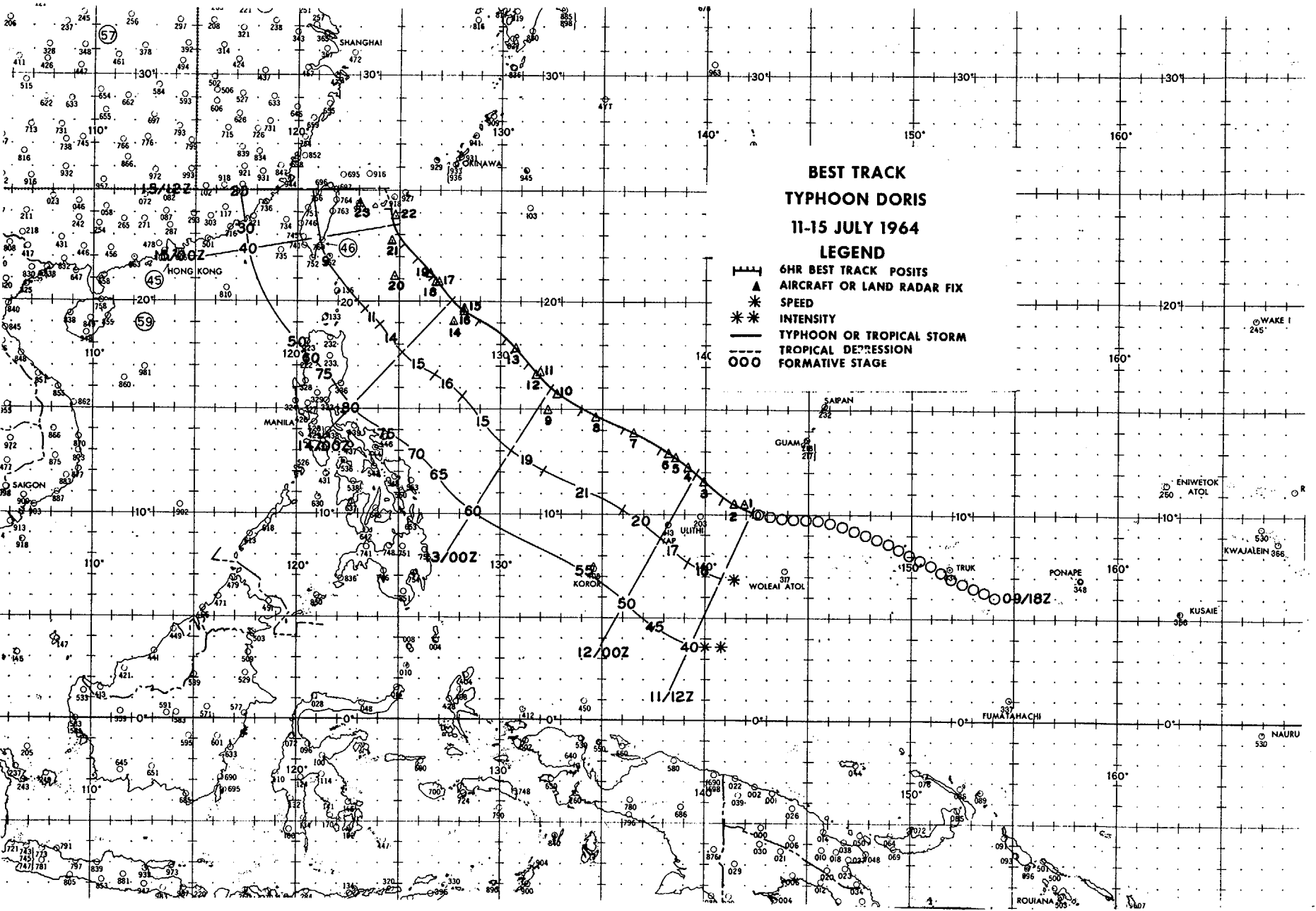
1. Junction vortex at 091800Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - SE quad of anticyclone
2. Upon reaching typhoon intensity - SE quad of anticyclone

III. FINAL DISPOSITION

A. Dissipated over water



## EYE FIXES TYPHOON DORIS

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	110945Z	10.4N 141.9E	VW1-R-U	----	--	--	---	---	--/--	CIRC 40 MI DIA SLD
2	111512Z	10.4N 141.5E	VW1-R-5	1500ft	--	--	---	---	--/--	CIRC 30 MI DIA WALL CLD 8 MI THICK S 4 MI THICK N
3	112225Z	11.5N 139.9E	54-R-5	30000ft	--	45	---	---	--/--	NO RADAR WALL CLDS
4	120200Z	12.3N 139.1E	56-P-3	700mb	40	45	1008	3109	12/9	CIRC 15 MI DIA OPEN E SEMI
5	120400Z	12.6N 138.6E	56-P-2	700mb	40	50	1004	3103	10/10	CIRC 10 MI DIA OPEN E SEMI
6	120400Z	12.9N 138.3E	54-R-0	30000ft	--	40	---	---	--/--	CIRC 20 MI DIA OPEN NE SEMI
7	120955Z	13.9N 136.5E	VW1-P-3	1500ft	--	50	1003	---	26/22	CIRC 30 MI DIA OPEN N SEMI WALL CLD 8 MI THICK TOPS 40000+
8	121538Z	14.7N 134.7E	VW1-R-10	1500ft	--	--	---	---	--/--	CNTR ILL DEFINED WEAK WALL CLD SW QUAD ONLY
9	122200Z	15.0N 132.3E	56-P-2	688mb	40	50	1009	3109	7/7	CIRC 15 MI DIA OPEN S
10	122206Z	15.8N 132.7E	54-R-10	33000ft	--	--	---	---	--/--	CIRC 23 MI DIA CLD
11	130330Z	16.6N 132.0E	56-P-3	687mb	45	65	998	3097	15/12	CIRC 30 MI DIA OPEN N
12	130350Z	16.5N 131.7E	54-R-10	30000ft	--	60	---	---	--/--	15 MI DIA OPEN N & E
13	131010Z	17.9N 130.7E	VW1-P-10	1500ft	--	50	995	---	--/--	NO DEFINABLE EYE
14	131543Z	19.2N 127.6E	VW1-P-5	10600ft	60	--	---	3121	7/5	NO EYE MOD TO OCNLY SVR TURB

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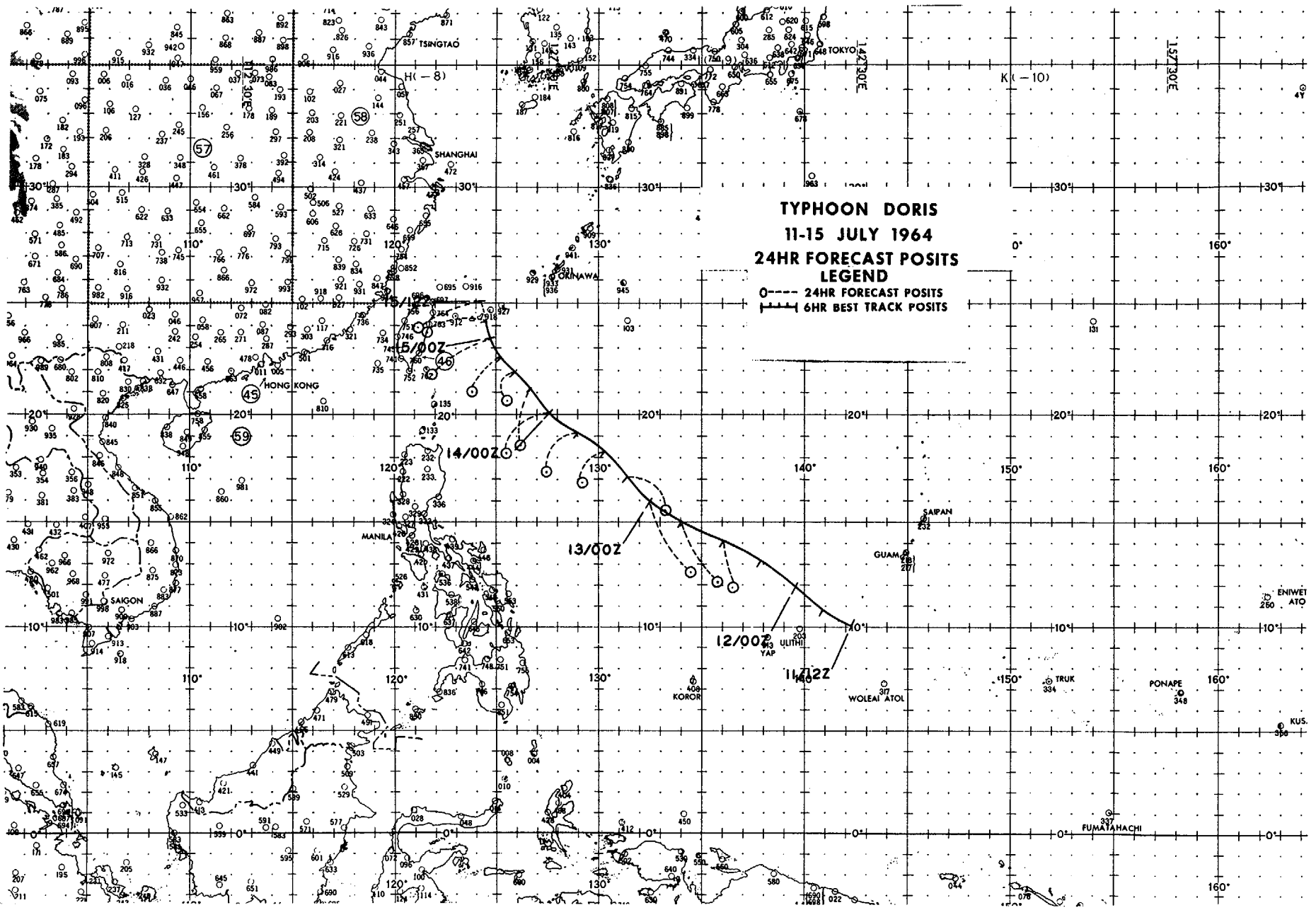
FLX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
15	132200Z	19.8N 127.9E	54-V-3	30000ft	--	100+	----	----	--/--	ELLIP 10 MI DIA OPEN N EYE SHAPE CHANGING RAPIDLY
16	132229Z	19.7N 127.9E	56-P-3	700mb	40	65	974	2880	16/10	CIRC ILL DEFINED
17	140345Z	20.8N 126.9E	56-P-3	700mb	30	75	995	3072	17/11	CIRC 10 MI DIA OPEN N THRU E
18	140400Z	20.8N 126.8E	54-V-5	30000ft	--	85	----	----	--/--	OVAL 40 MI NW/SE 30 MI NE/SW OPEN NE SEMI
19	140930Z	21.2N 126.5E	VW1-P-10	1000ft	--	40	996	----	--/--	NO RADAR PRESENTATION
20	141513Z	21.2N 124.8E	VW1-P-2	10400ft	60	--	----	3121	11/--	OVAL 10 MI DIA MOD TO STRONG WALL CLDS
21	142228Z	22.8N 124.6E	56-P-2	693mb	22	25	1011	3191	13/12	ILL DEFINED OPEN N THRU E
22	150400Z	23.9N 124.8E	56-P-2	683mb	30	30	999	3121	18/14	CIRC 50 MI DIA OPEN NE SEMI
23	151000Z	24.4N 123.0E	VW1-R-10	1500ft	--	--	----	----	--/--	CNTR BRKN STRONG RADAR ECHOES E & W

TYPHOON DORIS 11 JUL-15 JUL 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
111200Z	10.1N	142.3E	-----		-----	
111800Z	10.8N	140.8E	-----		-----	
120000Z	11.9N	139.4E	-----		-----	
120600Z	13.2N	137.9E	-----		-----	
121200Z	14.2N	136.0E		169-137	-----	
121800Z	15.0N	134.1E		149-203	-----	
130000Z	15.9N	132.4E		148-230	-----	
130600Z	17.0N	131.3E		127-150	-----	
131200Z	18.3N	130.3E		217-97		169-304
131800Z	19.2N	129.0E		219-137		164-361
140000Z	20.0N	127.6E		228-162		164-375
140600Z	21.1N	126.6E		189-156		158-242
141200Z	21.9N	125.8E		194-84		219-230
141800Z	22.6N	125.2E		217-121		228-268
150000Z	23.4N	124.7E		240-180		230-308
150600Z	24.2N	124.4E	-----		-----	
151200Z	25.1N	124.1E	-----		-----	

AVERAGE 24 HOUR ERROR 151 MI  
 AVERAGE 48 HOUR ERROR 298 MI





**TYPHOON ELSIE - 131800Z to 181800Z JULY**

**I. DATA**

**A. Statistics**

1. Calendar days of tropical warning -  $5\frac{1}{2}$
2. Calendar days of typhoon intensity -  $1\frac{1}{2}$
3. Total distance traveled during tropical warning period - 1632 mi

**B. Characteristics as a typhoon**

1. Minimum observed SLP - 992mb, 171000Z
2. Minimum observed 700mb height - 3097m, 170400Z
3. Maximum surface wind - 100 kts
4. Max radius of surface circulation - 350 mi

**II. DEVELOPMENT**

**A. Initial impetus - Fracture of Polar Trough**

**B. Initial surface vortex**

1. Embedded vortex at 130000Z
2. Surface pressure less than 1012mb

**C. 200mb flow above surface vortex**








1. Initial - SE quad of anticyclone
2. Upon reaching typhoon intensity - SE quad of anticyclone

**III. FINAL DISPOSITION**

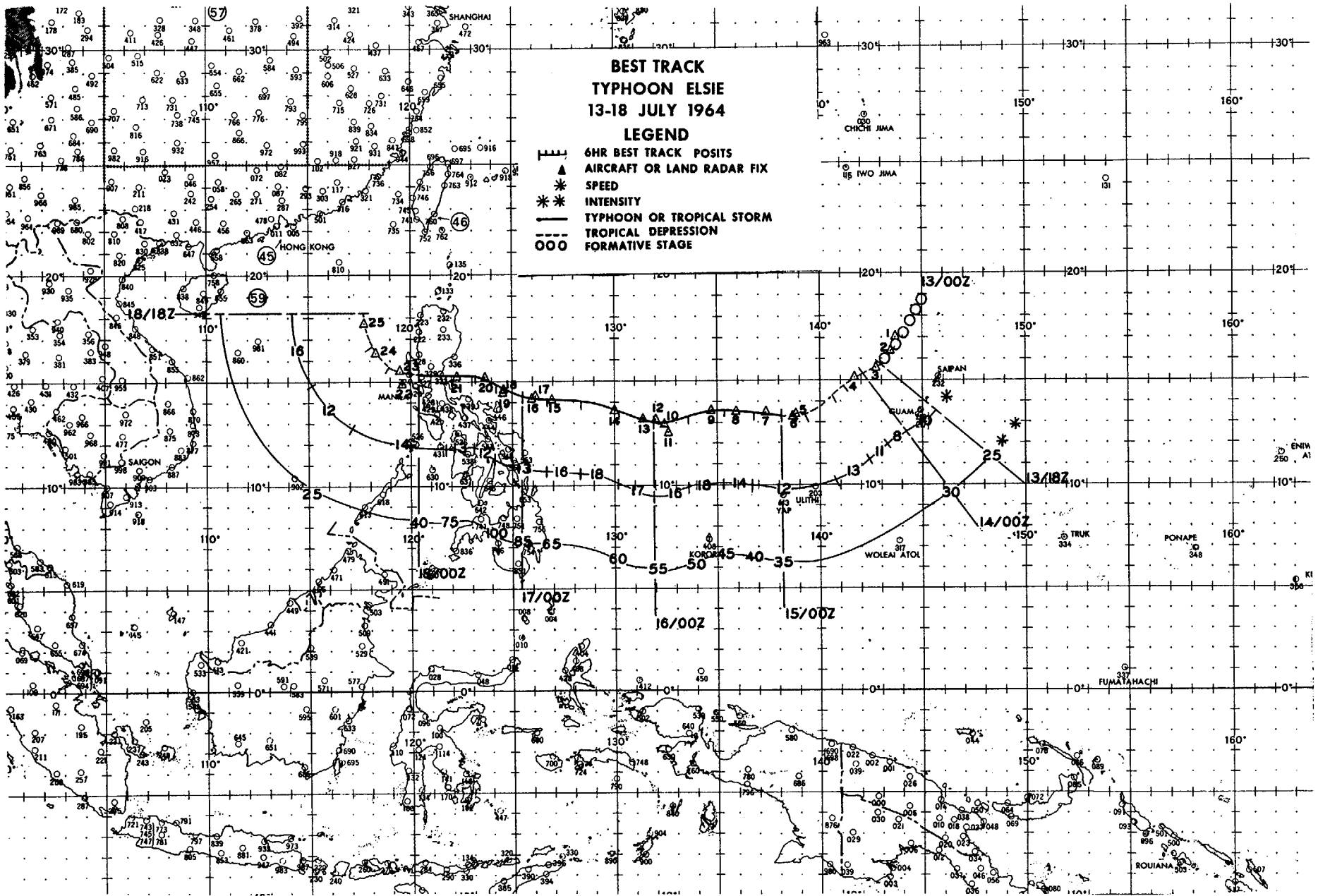
**A. Dissipated over water**

**BEST TRACK  
TYPHOON ELSIE  
13-18 JULY 1964**

**LEGEND**

-  6HR BEST TRACK POSITS
-  AIRCRAFT OR LAND RADAR FIX
-  SPEED
-  INTENSITY
-  TYPHOON OR TROPICAL STORM
-  TROPICAL DEPRESSION
-  FORMATIVE STAGE

916



## EYE FIXES TYPHOON ELSIE

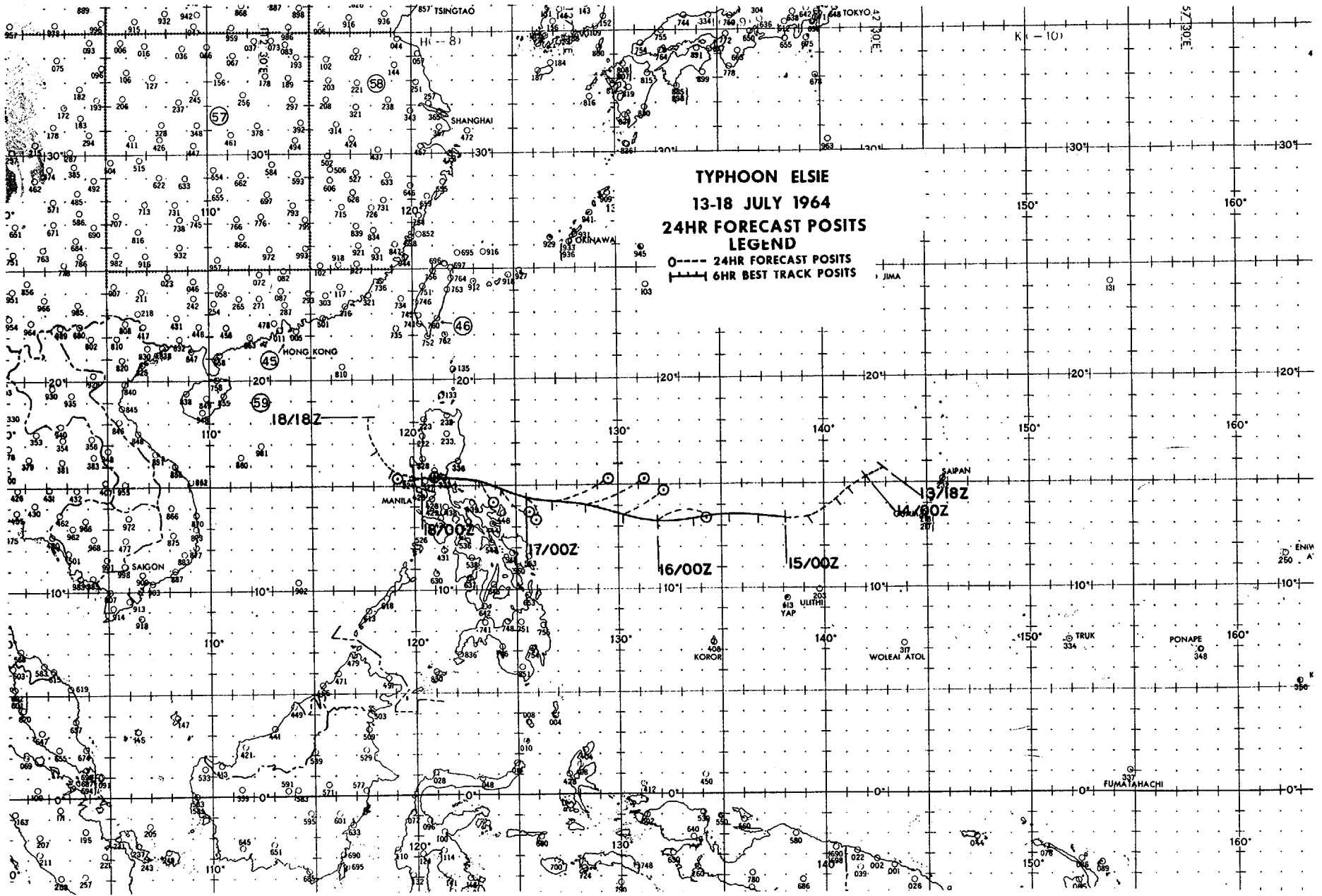
FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	131030Z	17.0N 143.8E	C-97	---	--	--	---	---	--/--	FEEDER BANDS FORMING
2	131350Z	16.4N 143.6E	VW1-P-5	1700ft	--	--	1007	---	27/22	EYE DIA 34 MI CHANGING RAPIDLY
3	131835Z	15.6N 142.8E	56-P-U	10466ft	45	--	---	3161	11/10	OVAL 20 MI E/W 15 MI N/S CLSD
4	140343Z	15.2N 141.8E	VW1-P-3	800ft	--	30	1005	---	25/--	NO FEEDER BANDS OR WALL CLDS
5	141912Z	13.4N 138.8E	54-R-10	30000ft	--	--	---	---	--/--	
6	142215Z	13.4N 138.8E	56-P-5	685mb	20	35	1013	3164	10/6	CIRC 18 MI DIA OPEN SE
7	150350Z	13.6N 137.4E	56-P-2	682mb	30	40	1004	3133	11/7	CIRC 20 MI DIA OPEN E & SE
8	150945Z	13.6N 136.0E	VW1-P-10	1500ft	--	22	1006	---	28/24	ILL DEFINED
9	151426Z	13.6N 134.8E	VW1-P-5	5000ft	--	--	---	---	19/--	CIRC CLSD TOPS 40000FT
10	152200Z	13.0N 132.4E	54-R-3	30000ft	--	50	---	---	--/--	CIRC 15 MI DIA BRKN NW
11	152220Z	12.7N 132.6E	56-P-10	700mb	--	55	1006	3118	10/8	CIRC 10 MI DIA CLSD WEAK N
12	160400Z	13.2N 132.1E	54-R-5	30000ft	--	50	---	---	--/--	CIRC 40 MI DIA OPEN NE SEMI
13	160345Z	13.1N 131.5E	56-P-5	700mb	26	50	1005	3115	12/1	CIRC 10 MI DIA OPEN N THRU E
14	161000Z	13.6N 130.1E	VW1-P-3	1500ft	--	80	991	---	26/21	CIRC 30 MI DIA WALL CLD SW QUAD ONLY 8 MI THICK TOPS 41000+
15	161645Z	14.1N 127.0E	VW1-P-10	1500ft	--	--	1005	---	26/21	CIRC 37 MI DIA WALL CLDS 12 MI THICK S QUAD

FLX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL	OBS SFC	OBS MIN SLP	MIN 700MB HGT	FLT LVL	TT/TD	REMARKS
16	162200Z	14.2N 126.0E	54-R-5	31000ft	--	65	---	---	--/--		CIRC 20 MI DIA
17	162214Z	14.2N 126.2E	56-P-3	683mb	40	85	994	3115	16/7		CIRC 20 MI DIA OPEN N
18	170400Z	14.6N 124.7E	54-R-5	30000ft	--	100	---	---	--/--		WALL CLDS SE ONLY
19	170400Z	14.6N 124.7E	56-P-3	682mb	45	100	998	3097	15/10		CIRC 20 MI DIA OPEN N QUAD
20	171000Z	15.2N 123.8E	VW1-P-5	1500ft	--	60	992	---	27/26		CIRC 22 MI DIA OPEN NE WALL CLD 13 MI THICK TOPS 45000FT+
21	171545Z	15.2N 122.3E	VW1-R-5	5000ft	--	--	---	---	--/--		CIRC 14 MI DIA OPEN N SEMI
22	172200Z	14.9N 119.7E	54-R-3	30000ft	--	--	---	---	--/--		ILL DEFINED
23	180400Z	15.6N 119.5E	54-R-5	30000ft	--	20	---	---	--/--		OVAL 50X40 MI DIFFUSED
24	181115Z	16.3N 118.2E	VW1-P-5	1000ft	--	25	1005	---	25/--		CNTR VERY DIFFUSED
25	181600Z	17.7N 117.9E	VW1-R-5	10000ft	--	--	---	---	--/--		CIRC 42 MI DIA OPEN NW WALL CLD 13 MI THICK SE SEMI

TYPHOON ELSIE 13 JUL-18 JUL 1964  
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
131800Z	15.7N	143.0E	-----		-----	
140000Z	15.3N	142.1E	-----		-----	
140600Z	14.8N	141.3E	-----		-----	
141200Z	14.1N	140.5E	-----		-----	
141800Z	13.5N	139.3E	-----		-----	
150000Z	13.4N	138.1E	-----		-----	
150600Z	13.5N	136.9E	-----		-----	
151200Z	13.6N	135.4E	-----		-----	
151800Z	13.3N	133.7E	-----		-----	
160000Z	13.0N	132.0E	080-134		-----	
160600Z	13.5N	130.3E	051-133		-----	
161200Z	14.0N	128.5E	066-170		-----	
161800Z	14.1N	126.8E	067-166		-----	
170000Z	14.2N	125.5E	150-62		085-276	
170600Z	14.8N	124.3E	133-112		055-236	
171200Z	15.2N	123.2E	148-80		059-255	
171800Z	15.2N	121.8E	283-48		052-255	
180000Z	15.3N	120.4E	266-70		015-43	
180600Z	15.7N	119.0E	-----		-----	
181200Z	16.5N	118.2E	-----		-----	
181800Z	18.2N	117.8E	-----		-----	

AVERAGE 24 HOUR ERROR 108 MI  
AVERAGE 48 HOUR ERROR 213 MI



TYPHOON FLOSSIE - 260000Z to 291200Z JULY

I. DATA

A. Statistics

1. Calendar days of tropical warning - 4 3/4
2. Calendar days of typhoon intensity - 3
3. Total distance traveled during tropical warning period - 984 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 974mb, 282200Z
2. Minimum observed 700mb height - 2944m, 262145Z
3. Maximum surface wind - 80 kts
4. Max radius of surface circulation - 300 mi

II. DEVELOPMENT

A. Initial impetus - Increased 200mb divergence

B. Initial surface vortex

1. Embedded vortex at 240000Z
2. Surface pressure less than 1006mb

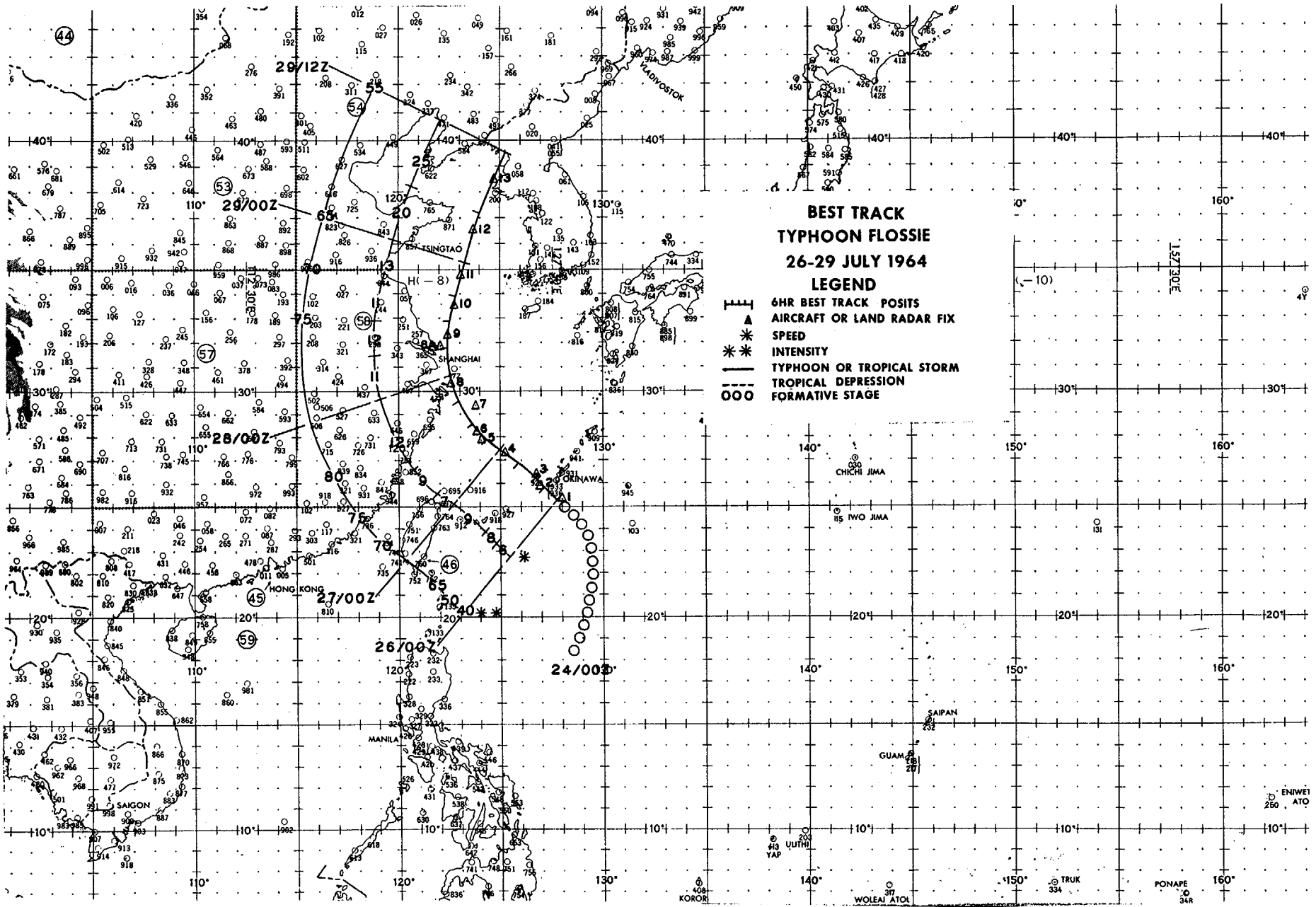
C. 200mb flow above surface vortex

1. Initial - Divergent asymptote
2. Upon reaching typhoon intensity - NW quad of anticyclone

III. FINAL DISPOSITION

A. Dissipated over land





ENIWEI  
250  
ATO

PONAPE  
34R

TRUK  
33A

WOLEAI ATO

YAP  
413

KOROR  
408

GUAM  
281

SAIPAN  
252

CHICHI JIMA  
550

IWO JIMA  
15

MANILA  
229

SAIGON  
998

HONG KONG  
810

SHANGHAI  
368

SINGTAO  
111

LINCOLN  
257

## EYE FIXES TYPHOON FLOSSIE

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	252235Z	25.3N 128.0E	54-R-5	31000ft	--	40	---	---	--/--	CIRC 20 MI DIA OPEN N & NW QUADS
2	260800Z	25.7N 127.0E	56-P-5	700mb	40	60	987	2984	15/15	CIRC 5 MI DIA WALL CLDS 4 MI THICK
3	261315Z	26.4N 126.6E	VW1-R-5	5000ft	--	--	---	---	--/--	CIRC 15 MI DIA CLSD WALL CLDS 10 MI THICK
4	262145Z	27.3N 125.3E	56-P-1	700mb	35	55	983	2944	16/13	CIRC 10 MI DIA WALL CLDS N THRU E ONLY
5	270701Z	27.8N 124.1E	56-R-U	700mb	--	--	---	---	--/--	
6	271005Z	28.2N 124.0E	VW1-R-5	6000ft	--	--	---	---	--/--	CIRC 25 MI DIA WALL CLDS 10 MI THICK
7	271545Z	29.4N 123.8E	VW1-R-5	10600ft	--	--	---	---	--/--	CIRC 35 MI DIA OPEN S WALL CLDS 8 MI THICK
8	272200Z	30.3N 122.6E	56-R-5	689mb	--	--	---	---	--/--	CIRC 20 MI DIA
8A	280328Z	31.8N 122.1E	54-R-U	30000ft	--	--	---	---	--/--	
9	280945Z	32.4N 122.4E	VW1-R-5	6160ft	--	--	---	---	--/--	CIRC 18 MI DIA CLSD WALL CLDS 11 MI THICK
10	281530Z	33.6N 122.8E	VW1-R-5	6000ft	--	--	---	---	--/--	CIRC 29 MI DIA OPEN SW WALL CLD 9 MI THICK
11	282200Z	34.8N 123.1E	56-P-2	698mb	60	65	974	2969	15/8	CIRC 20 MI DIA OPEN S THRU NW

123

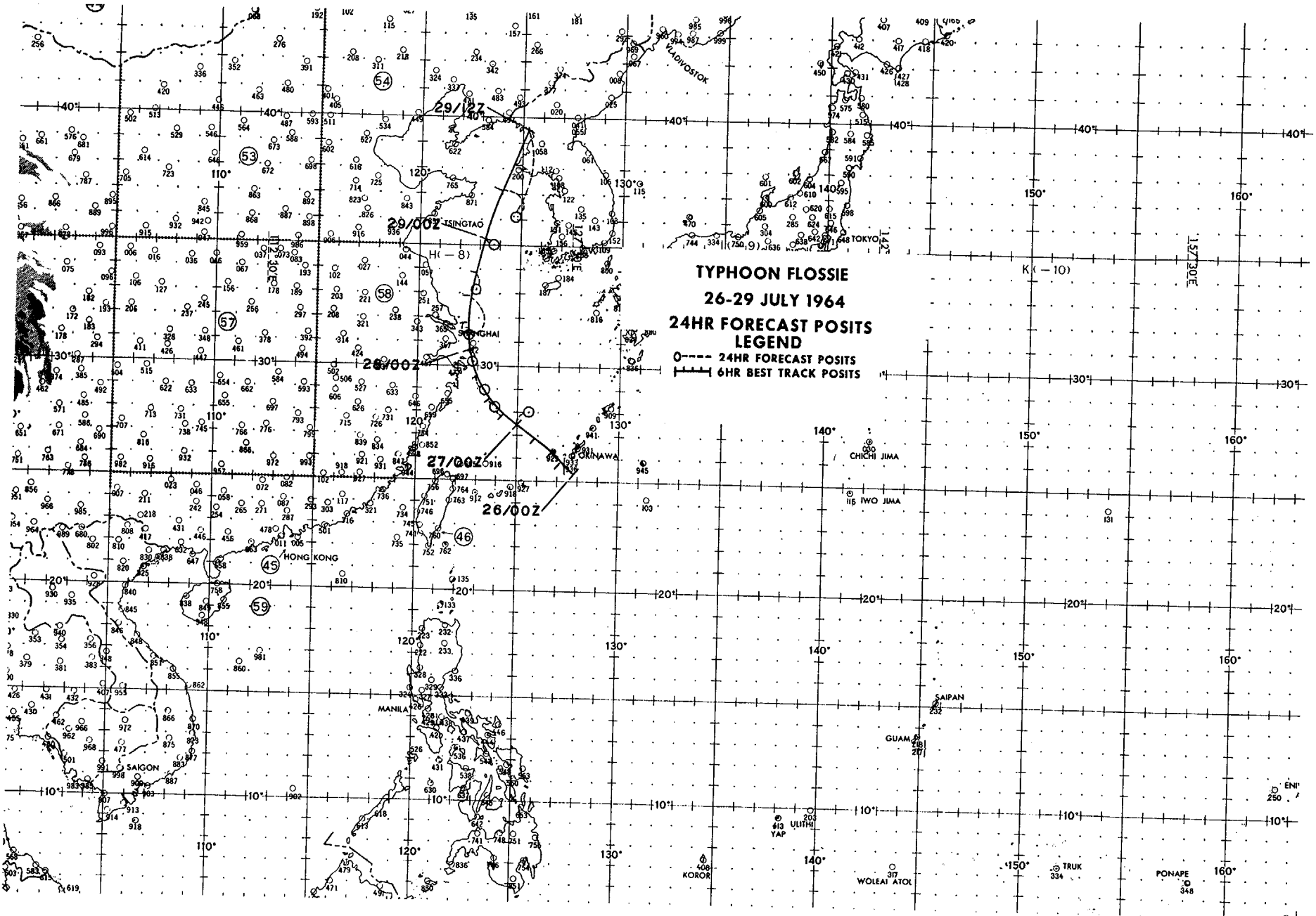
FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
12	290400Z	36.6N 123.6E	56-P-2	700mb	65	50	985	2972	16/9	CIRC 30 MI DIA OPEN S THRU W
13	290930Z	38.5N 124.7E	VW1-R-10	10000ft	--	--	---	---	--/--	CIRC 40 MI DIA OPEN N & SE WALL CLDS 6 MI THICK

TYPHOON FLOSSIE 26 JUL-29 JUL 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
260000Z	25.3N	127.8E	-----		-----	
260600Z	25.7N	127.2E	-----		-----	
261200Z	26.3N	126.6E	-----		-----	
261800Z	26.9N	125.8E	-----		-----	
270000Z	27.3N	124.9E	041-45		-----	
270600Z	27.8N	124.3E	317-25		-----	
271200Z	28.5N	123.7E	150-21		-----	
271800Z	29.5N	122.9E	150-43		-----	
280000Z	30.7N	122.5E	148-30		080-90	
280600Z	31.8N	122.3E	159-28		157-36	
281200Z	32.9N	122.5E	182-90		179-110	
281800Z	34.0N	122.9E	180-47		189-127	
290000Z	35.3N	123.2E	126-24		197-125	
290600Z	37.2N	123.9E	144-77		159-87	
291200Z	39.5N	125.2E	192-210		195-270	

AVERAGE 24 HOUR ERROR 58 MI

AVERAGE 48 HOUR ERROR 121 MI



TYPHOON HELEN - 271800Z to 031200Z JULY-AUGUST

I. DATA

A. Statistics

1. Calendar days of tropical warning - 7
2. Calendar days of typhoon intensity - 4 3/4
3. Total distance traveled during tropical warning period - 1920 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 93lmb, 300315Z
2. Minimum observed 700mb height - 252lm, 300315Z
3. Maximum surface wind - 130 kts
4. Max radius of surface circulation - 450 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of MPT

B. Initial surface vortex

1. Junction vortex at 270000Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - W quad of anticyclone
2. Upon reaching typhoon intensity - Center of outdraft

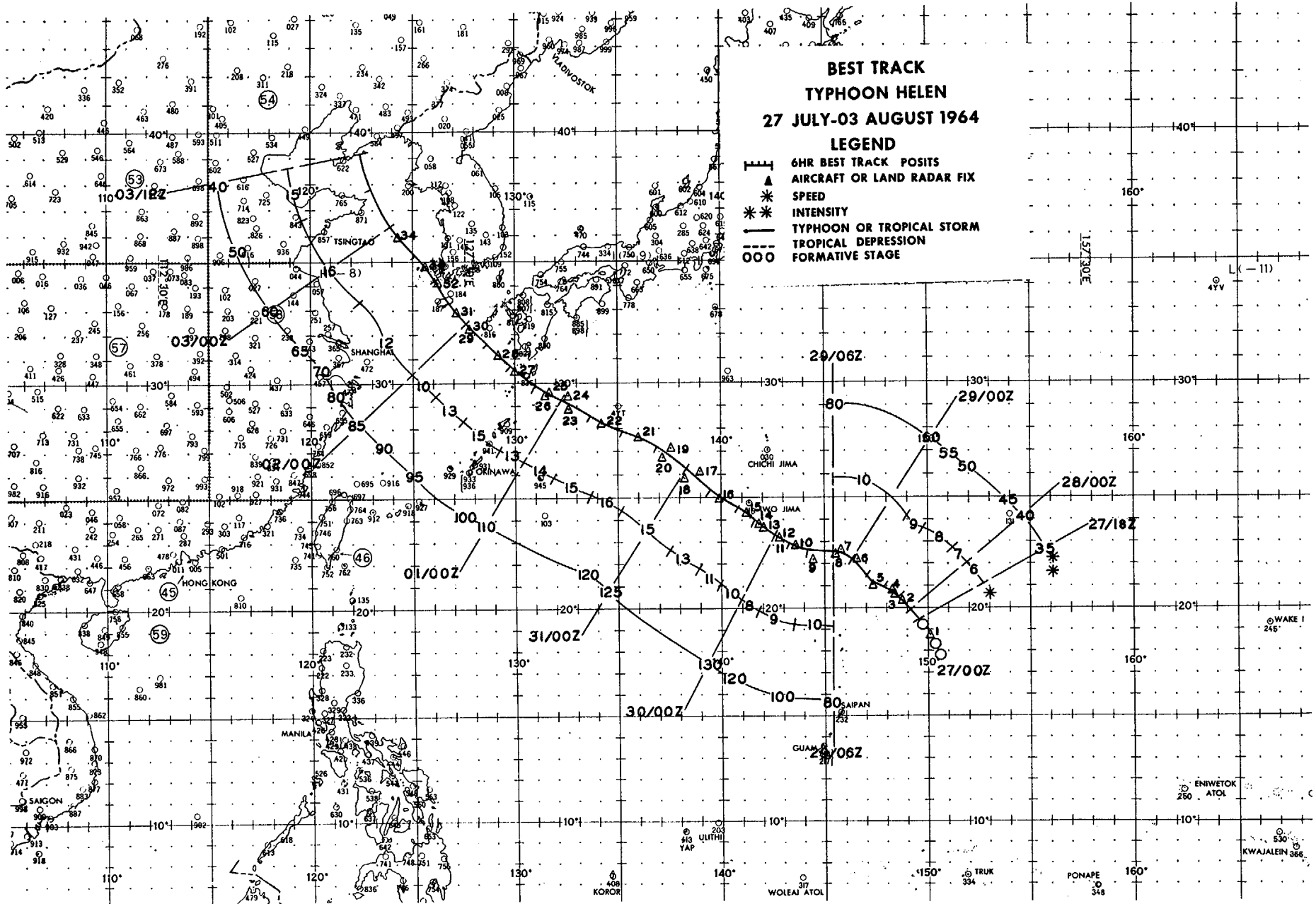
III. FINAL DISPOSITION

A. Dissipated over land

**BEST TRACK  
TYPHOON HELEN  
27 JULY-03 AUGUST 1964**

- LEGEND**
- 6HR BEST TRACK POSITS
  - ▲ AIRCRAFT OR LAND RADAR FIX
  - \* SPEED
  - \* INTENSITY
  - TYPHOON OR TROPICAL STORM
  - - - TROPICAL DEPRESSION
  - OOO FORMATIVE STAGE

128



EYE FIXES TYPHOON HELEN

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	270911Z	18.8N 150.1E	VW1-P-5	1500ft	--	20	1000	---	22/--	OVAL 27 MI DIA WALL CLDS FORMING
2	280303Z	20.3N 148.8E	54-R-15	30000ft	--	--	---	---	--/--	
3	280700Z	20.5N 148.5E	56-P-3	700mb	20	40	994	3057	9/9	CIRC 12 MI DIA
4	280947Z	20.7N 148.4E	VW1-R-3	10000ft	--	--	---	---	--/--	CIRC 11 MI DIA WALL CLDS BROKEN W SEMI
5	281615Z	21.0N 147.3E	VW1-R-5	1500ft	--	--	---	---	--/--	E-W DIA 11 MI OPEN N SEMI WALL CLDS 3-5 MI THICK
6	282230Z	22.1N 146.5E	56-P-2	700mb	45	45	989	2951	17/12	OVAL 7 MI E/W 5 MI N/S
7	290330Z	22.6N 145.8E	56-P-10	700mb	65	85	984	2874	18/12	CIRC 12 MI DIA
8	290600Z	22.4N 145.3E	54-R-5	33000ft	--	--	---	---	--/--	CIRC 20 MI DIA
9	290945Z	22.2N 144.5E	VW1-P-3	500ft	--	65	973	---	25/21	CIRC 15 MI DIA
10	291545Z	22.9N 143.6E	VW1-R-5	7000ft	--	--	---	---	--/--	OVAL 13 MI E/W 10 MI N/S WALL CLDS 3-5 MI THICK
11	292155Z	23.2N 142.8E	54-R-3	30000ft	--	60	---	---	--/--	CIRC 10 MI DIA
12	292200Z	23.2N 142.8E	56-P-1	700mb	70	130	946	2624	15/12	CIRC 7 MI DIA
13	300315Z	23.7N 142.1E	56-P-1	700mb	70	150	931	2521	20/15	CIRC 5 MI DIA STRONG SOLID WALL CLDS ALL QUADS
14	300425Z	23.8N 141.9E	54-R-5	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA
15	300940Z	24.4N 141.2E	VW1-R-3	9000ft	--	--	---	---	--/--	CONCENTRIC EYES 7 MI DIA & 50 MI DIA



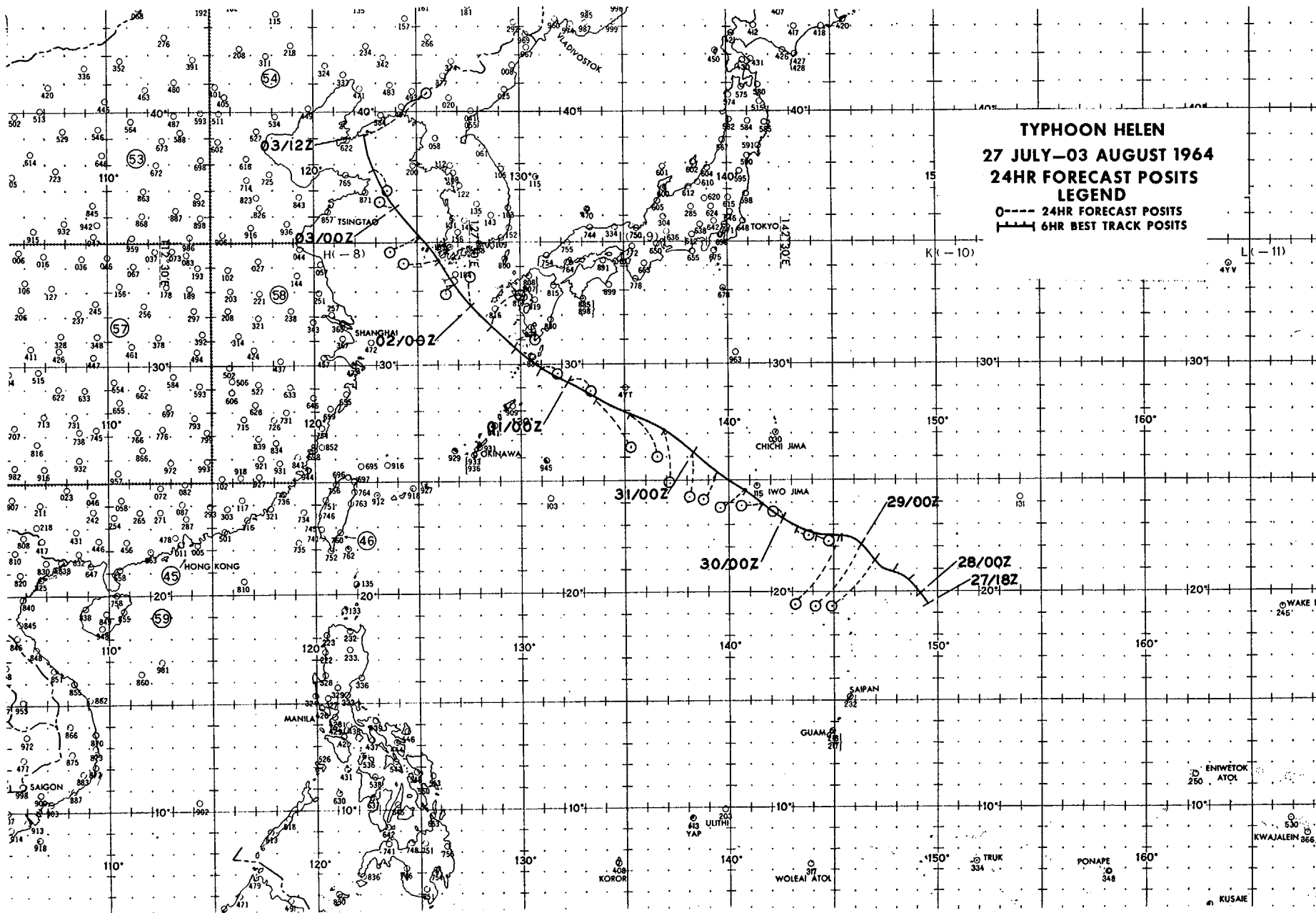
FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
16	301555Z	25.0N 139.9E	VW1-R-3	9500ft	--	--	---	---	--/--	CIRC 12 MI DIA WALL CLDS 8 MI THICK S SEMI & 3 MI THICK N SEMI
17	302200Z	26.1N 139.0E	54-R-5	29000ft	--	90	---	---	--/--	CIRC 10 MI DIA
18	302215Z	25.8N 138.2E	56-P-3	700mb	85	125	956	2740	19/16	CIRC 110 MI DIA OPEN W & SW MULTIPLE CENTERS
19	310400Z	27.2N 137.6E	54-R-10	30000ft	--	--	---	---	--/--	ELLIP 60 X 70 MI
20	310400Z	26.7N 137.2E	56-P-3	700mb	100	125	954	2725	20/16	CIRC 110 MI DIA OPEN SE SEMI
21	310950Z	27.7N 136.0E	VW1-P-3	100ft	--	130	---	---	26/18	CIRC 25 MI DIA CLSD
22	311530Z	28.2N 134.2E	VW1-R-5	1000ft	--	--	---	---	--/--	CIRC 25 MI DIA CLSD
23	312200Z	28.9N 132.7E	56-P-3	700mb	75	120	967	2810	17/14	CIRC 110 MI DIA OPEN NE
24	312200Z	29.3N 132.7E	54-R-5	29000ft	40	---	---	---	-17/--	CIRC 70 MI DIA
25	010400Z	29.6N 131.6E	56-P-2	698mb	90	100	967	2813	17/7	CIRC 30 MI DIA OPEN E
26	010400Z	29.4N 131.4E	54-R-5	31000ft	--	50	---	---	--/--	CIRC 40 MI DIA OPEN E
27	011000Z	30.4N 130.0E	VW1-R-5	1500ft	--	--	---	---	--/--	CIRC 47 MI DIA OPEN SE WALL CLD 10 MI THICK
28	011545Z	31.2N 129.2E	VW1-R-3	3700ft	--	--	---	---	--/--	CIRC 52 MI DIA OPEN NW WALL CLD 13 MI THICK
29	012155Z	32.2N 127.8E	54-R-5	30000ft	--	--	---	---	--/--	OVAL 25 X 35 MI OPEN S & SW QUADS
30	012200Z	32.2N 127.8E	56-P-1	700mb	80	75	968	2822	17/16	CIRC 30 MI DIA OPEN W
31	020330Z	32.8N 127.2E	56-P-2	500mb	60	45	977	2903	1/1	700MB TEMP 15 EYE CIRC 50 MI DIA OPEN S

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
32	021000Z	34.0N 126.3E	VW1-R-1	4000ft	--	--	---	---	--/--	OVAL 30 MI DIA OPEN SW
33	021530Z	34.9N 125.7E	VW1-R-10	4000ft	--	--	---	---	--/--	POORLY DEFINED NE SEMI
34	022145Z	36.0N 124.3E	56-P-2	700mb	55	--	980	2908	15/15	EYE FILLED WITH CLOUDS

TYPHOON HELEN 27 JUL-03 AUG 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
271800Z	19.5N	149.5E	-----		-----	
280000Z	20.0N	149.1E	-----		-----	
280600Z	20.5N	148.6E	-----		-----	
281200Z	20.9N	147.9E	-----		-----	
281800Z	21.3N	147.0E	224-	168	-----	
290000Z	22.1N	146.2E	215-	210	-----	
290600Z	22.4N	145.2E	212-	215	-----	
291200Z	22.5N	144.1E	118-	38	-----	
291800Z	22.9N	143.3E	128-	35	211-	227
300000Z	23.3N	142.6E	307-	30	210-	244
300600Z	23.9N	141.7E	267-	67	208-	276
301200Z	24.7N	140.7E	229-	76	184-	87
301800Z	25.3N	139.5E	207-	80	177-	115
310000Z	26.3N	138.2E	184-	122	187-	115
310600Z	27.2N	136.9E	176-	138	208-	150
311200Z	27.8N	135.3E	149-	127	185-	166
311800Z	28.4N	133.7E	146-	147	169-	189
010000Z	29.3N	132.3E	116-	55	162-	220
010600Z	29.8N	131.0E	104-	45	161-	235
011200Z	30.8N	129.7E	076-	60	149-	233
011800Z	31.6N	128.5E	045-	104	153-	265
020000Z	32.3N	127.7E	003-	75	090-	120
020600Z	33.3N	126.8E	226-	35	093-	160
021200Z	34.3N	126.0E	263-	88	085-	227
021800Z	35.2N	125.1E	247-	77	072-	480
030000Z	36.4N	123.9E	280-	35	073-	420
030600Z	37.7N	123.0E	146-	58	160-	32
031200Z	39.2N	122.3E	061-	175	061-	117

AVERAGE 24 HOUR ERROR 94 MI  
 AVERAGE 48 HOUR ERROR 204 MI



TYPHOON IDA - 020600Z to 090600Z AUGUST

I. DATA

A. Statistics

1. Calendar days of tropical warning -  $7\frac{1}{4}$
2. Calendar days of typhoon intensity -  $4\frac{3}{4}$
3. Total distance traveled during tropical warning period - 2358 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 927mb, 060352Z
2. Minimum observed 700mb height - 2462m, 060352Z
3. Maximum surface wind - 135 kts
4. Max radius of surface circulation - 575 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of Polar Trough with easterly wave and subsequent fracture

B. Initial surface vortex

1. Junction vortex at 010600Z
2. Surface pressure less than 1006mb

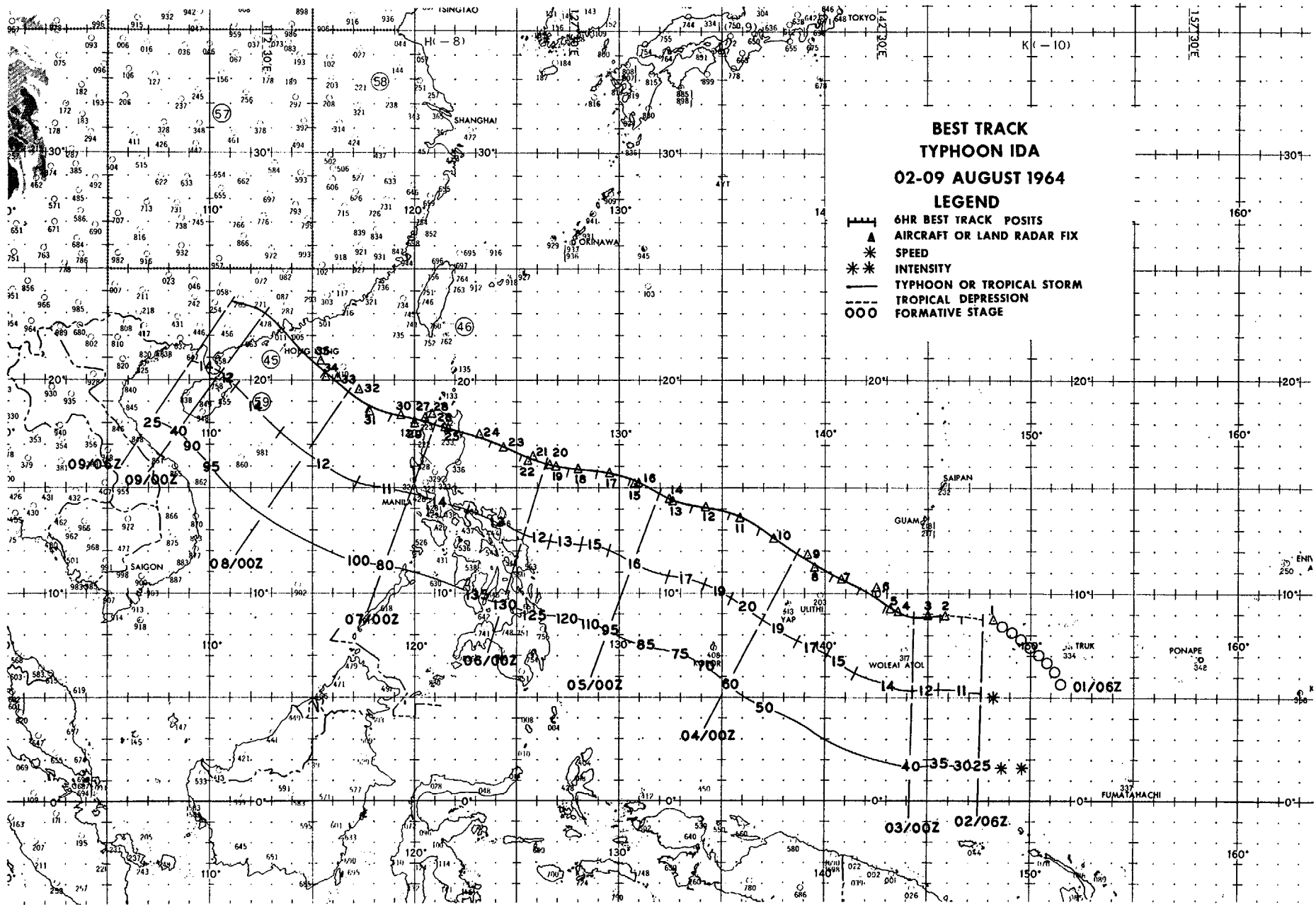
C. 200mb flow above surface vortex

1. Initial - SE quad of anticyclone
2. Upon reaching typhoon intensity - Center

of outdraft

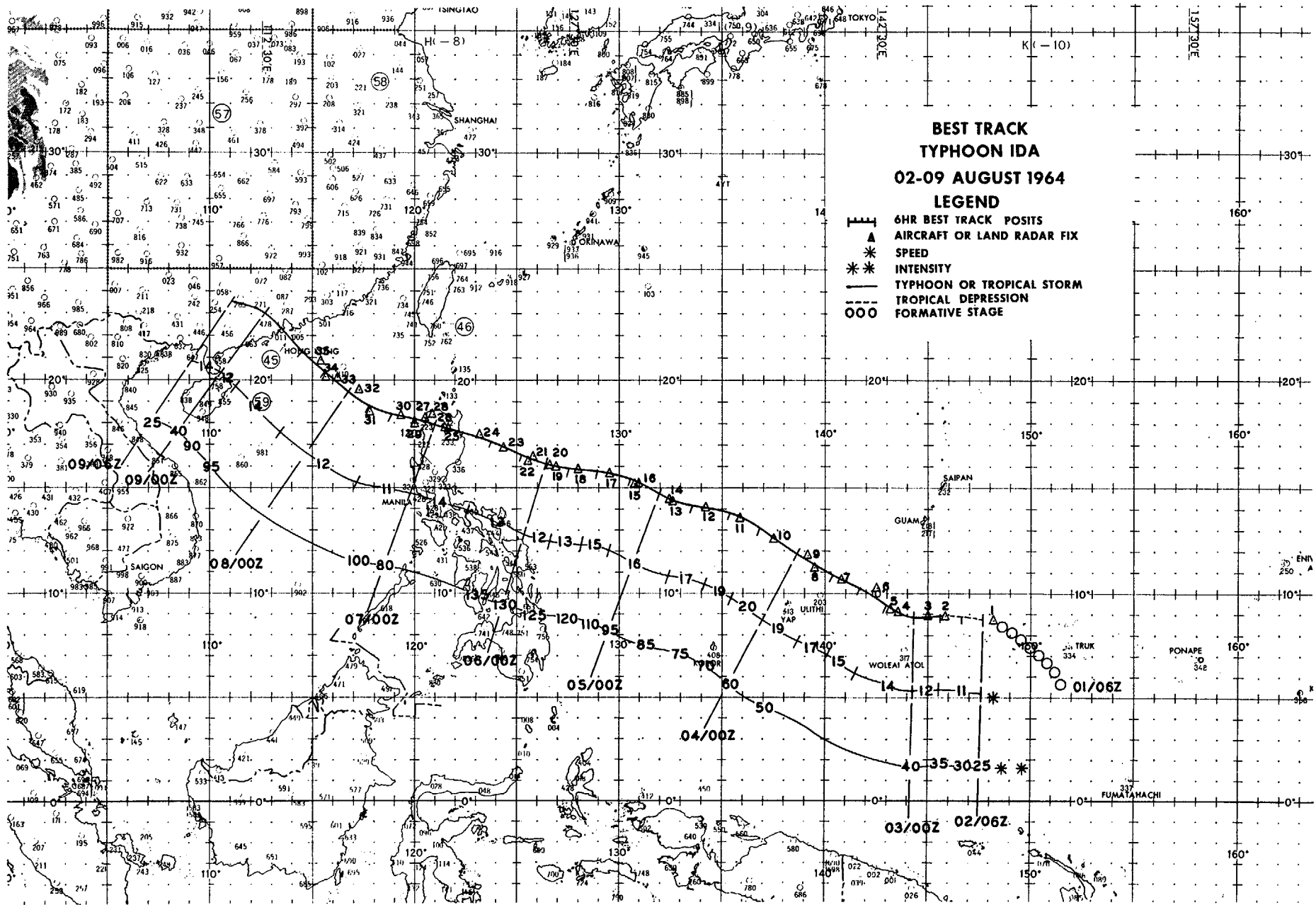
III. FINAL DISPOSITION

A. Dissipated over land



**BEST TRACK  
TYPHOON IDA  
02-09 AUGUST 1964**

- LEGEND**
- 6HR BEST TRACK POSITS
  - ▲ AIRCRAFT OR LAND RADAR FIX
  - \* SPEED
  - \*\* INTENSITY
  - TYPHOON OR TROPICAL STORM
  - - - TROPICAL DEPRESSION
  - OOO FORMATIVE STAGE



## EYE FIXES TYPHOON IDA

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	020300Z	08.7N 148.2E	VW1-P-U	1500ft	--	--	998	---	--/--	
2	021655Z	09.0N 145.8E	VW1-P-5	1500ft	--	--	998	---	25/--	CNTR VERY DIFFUSED
3	022230Z	09.0N 145.0E	56-P-10	691mb	20	30	996	3069	11/11	OVAL 30 MI N/S LGT WALL CLD E
4	030326Z	09.1N 143.4E	56-P-U	1500ft	--	CALM	---	---	--/--	NO CLSD CIRCULATION
5	030405Z	09.2N 143.2E	54-R-10	30000ft	--	--	---	---	--/--	
6	031000Z	10.2N 142.3E	VW1-R-10	1500ft	--	--	---	---	--/--	NO DEFINABLE CNTR
7	031545Z	10.7N 140.7E	VW1-R-15	3000ft	--	--	---	---	--/--	CIRC 15 MI DIA POORLY DEFINED
8	032206Z	11.3N 139.5E	56-P-5	691mb	42	55	1000	3069	9/9	CIRC 50 MI DIA POORLY DEFINED OPEN W
9	032215Z	11.8N 139.1E	54-P-5	30000ft	--	20	---	---	--/--	UNDEFINED CNTR NEG WALL CLDS
10	040400Z	12.7N 137.5E	56-P-2	689mb	55	70	995	3048	12/10	CIRC 20 MI DIA STRONG WALL CLDS ALL QUADS
11	040930Z	13.7N 135.8E	VW1-P-3	1000ft	--	65	983	---	24/18	CIRC 6 MI DIA OPEN SW SEMI WALL CLDS 8 MI THICK
12	041530Z	14.1N 134.2E	VW1-R-2	9000ft	--	--	---	---	--/--	CIRC 6 MI DIA
13	042200Z	14.6N 132.6E	56-P-5	700mb	60	90	972	2853	17/15	CIRC 8 MI DIA OPEN E
14	042200Z	14.7N 132.4E	54-R-10	30000ft	--	--	---	---	--/--	OVAL 75 MI NW-SE CLSD

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
15	050325Z	15.0N 130.8E	54-R-5	30400ft	--	--	---	---	--/--	CIRC 20 MI DIA CLSD
16	050350Z	15.0N 131.0E	56-P-4	699mb	90	140	972	2832	17/12	CIRC 6 MI DIA OPEN TO S & SE
17	050930Z	15.7N 129.5E	VW1-R-10	10000ft	--	--	---	---	--/--	CIRC 17 MI DIA WALL CLD 7 MI THICK DOUBLE WALL CLD W SEMI
18	051530Z	15.9N 128.0E	VW1-R-5	10000ft	--	--	---	---	--/--	ELLIP 24 MI E/W 18 MI N/S CLSD WALL CLD 7 MI THICK
19	052200Z	16.1N 126.9E	56-P-5	700mb	100	150	936	2585	17/15	CIRC 40 MI DIA CLSD
20	052200Z	16.1N 126.6E	54-R-3	31000ft	--	--	---	---	--/--	ELLIP 20 X 15 MI OPEN N-NW
21	060302Z	16.5N 125.6E	54-R-10	30000ft	--	--	---	---	--/--	OVAL 40 MI E/W 30 MI N/S CLSD
22	060352Z	16.4N 125.5E	56-P-2	700mb	115	200+	927	2462	23/18	CIRC 40 MI DIA OPEN N QUAD
23	060955Z	17.0N 124.3E	VW1-R-3	1000ft	--	--	---	---	--/--	CIRC 17 MI DIA CLSD
24	061530Z	17.5N 123.1E	VW1-R-3	10000ft	--	--	---	---	--/--	CIRC 19 MI DIA WALL CLD 12 MI THICK
25	062200Z	17.7N 121.6E	56-P-2	500mb	82	130	---	---	-3/-3	CIRC 15 MI DIA ILL DEFINED EYE FILLED WITH CLOUDS
26	062200Z	17.7N 121.5E	54-R-5	30000ft	--	--	---	---	--/--	CIRC 15 MI DIA OPEN SW QUAD
27	070215Z	18.2N 120.5E	LND RDR	---	--	--	---	---	--/--	
28	070322Z	18.3N 120.9E	54-R-15	30000ft	--	--	---	---	--/--	
29	070400Z	18.0N 120.0E	56-P-1	500mb	70	110	---	---	-3/-3	ELLIP 20 MI N/S 15 MI E/W LGT WALL CLD W QUAD ONLY



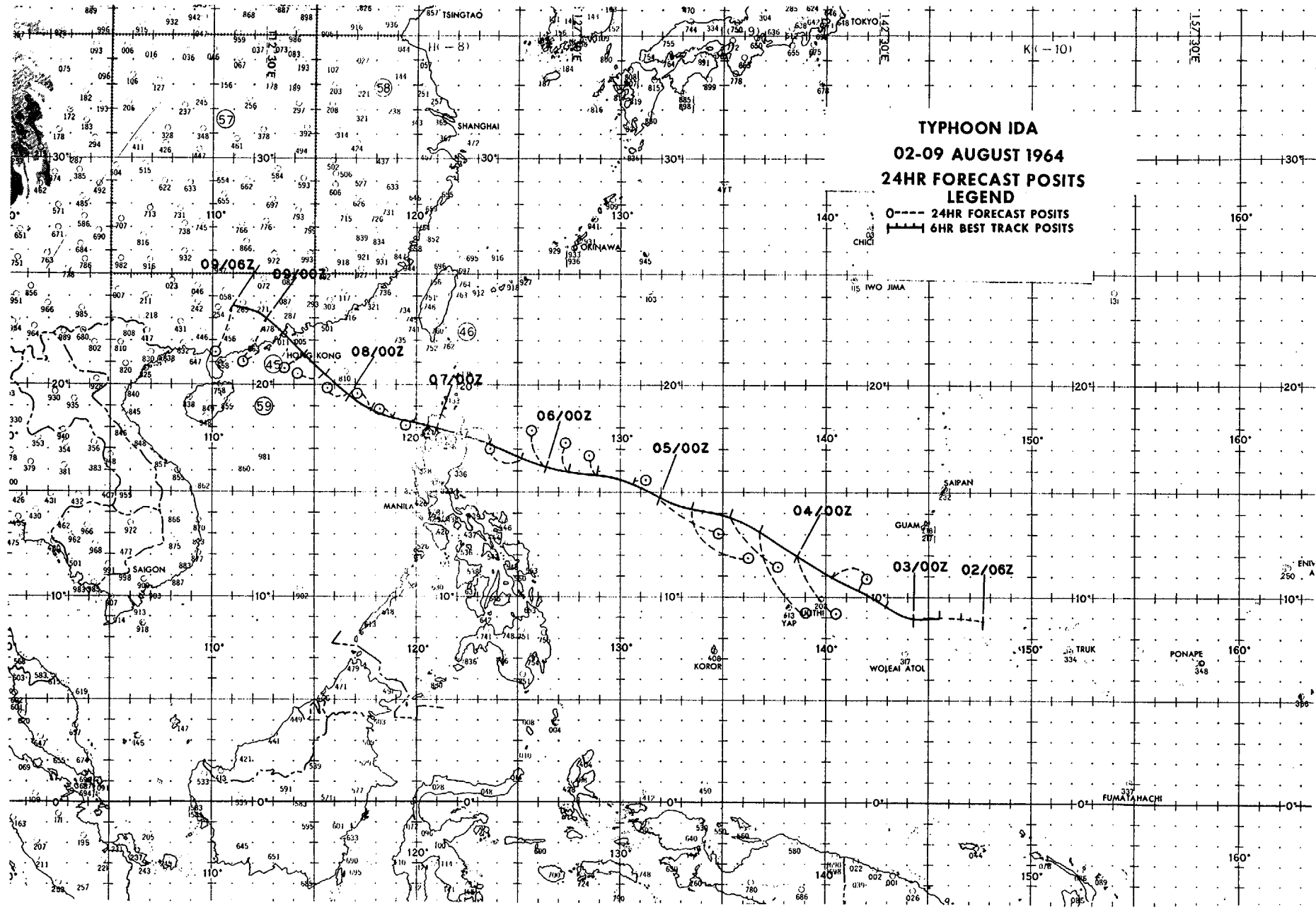
FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
30	071000Z	18.4N 119.3E	VW1-R-5	4000ft	--	--	---	---	--/--	CIRC 18 MI DIA OPEN W SEMI
31	071530Z	18.6N 117.7E	VW1-R-10	9000ft	--	--	---	---	--/--	CIRC 30 MI DIA OPEN SE QUAD
32	072200Z	19.6N 117.3E	56-P-3	700mb	65	75	971	2859	14/12	CIRC 60 MI DIA OPEN NE SEMI
33	080400Z	20.1N 116.2E	56-P-2	700mb	80	100	962	2862	14/13	CIRC 80 MI DIA POORLY DEFINED
34	080409Z	20.1N 115.8E	54-R-10	31000ft	--	--	---	---	--/--	CIRC 30 MI DIA OPEN N
35	080930Z	21.0N 115.3E	VW1-R-10	4000ft	--	--	---	---	--/--	CIRC 60 MI DIA NO DEFINITE WALL CLD

TYPHOON IDA 02 AUG-09 AUG 1964  
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
020600Z	08.8N	147.7E	-----		-----	
021200Z	08.9N	146.6E	-----		-----	
021800Z	09.0N	145.5E	-----		-----	
030000Z	08.9N	144.3E	-----		-----	
030600Z	09.4N	142.9E	-----		-----	
031200Z	10.3N	141.7E	-----		-----	
031800Z	10.9N	140.2E	094-107		-----	
040000Z	11.9N	138.6E	147-204		-----	
040600Z	13.1N	136.9E	151-268		-----	
041200Z	13.9N	135.2E	135-210		-----	
041800Z	14.3N	133.5E	132-220		112-307	
050000Z	14.8N	131.9E	122-200		141-420	
050600Z	15.3N	130.4E	077-55		142-450	
051200Z	15.9N	128.9E	340-60		124-333	
051800Z	15.9N	127.5E	350-82		125-307	
060000Z	16.2N	126.3E	341-105		110-252	
060600Z	16.6N	125.1E	285-87		058-110	
061200Z	17.1N	123.8E	282-120		354-110	
061800Z	17.6N	122.4E	278-115		360-125	
070000Z	17.9N	121.0E	130-20		343-165	
070600Z	18.3N	119.9E	261-34		282-185	
071200Z	18.5N	118.9E	297-44		281-225	
071800Z	18.9N	117.7E	315-48		280-232	
080000Z	19.6N	116.7E	286-60		215-54	
080600Z	20.4N	115.6E	272-82		247-123	
081200Z	21.3N	114.5E	241-67		250-103	
081800Z	22.4N	113.5E	234-140		238-135	
090000Z	23.2N	112.6E	213-132		236-185	
090600Z	23.5N	111.0E	-----		-----	

AVERAGE 24 HOUR ERROR 112 MI  
AVERAGE 48 HOUR ERROR 212 MI

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**TYPHOON IDA**  
**02-09 AUGUST 1964**  
**24HR FORECAST POSITS**  
**LEGEND**  
○--- 24HR FORECAST POSITS  
— 6HR BEST TRACK POSITS

TYPHOON KATHY - 120600Z to 251200Z AUGUST

I. DATA

A. Statistics

1. Calendar days of tropical warning - 13½
2. Calendar days of typhoon intensity - 10
3. Total distance traveled during tropical warning period - 3114 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 945mb, 202225Z
2. Minimum observed 700mb height - 2670m, 180400Z
3. Maximum surface wind - 115 kts
4. Max radius of surface circulation - 850 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of Polar Trough with easterly wave and subsequent fracture

B. Initial surface vortex

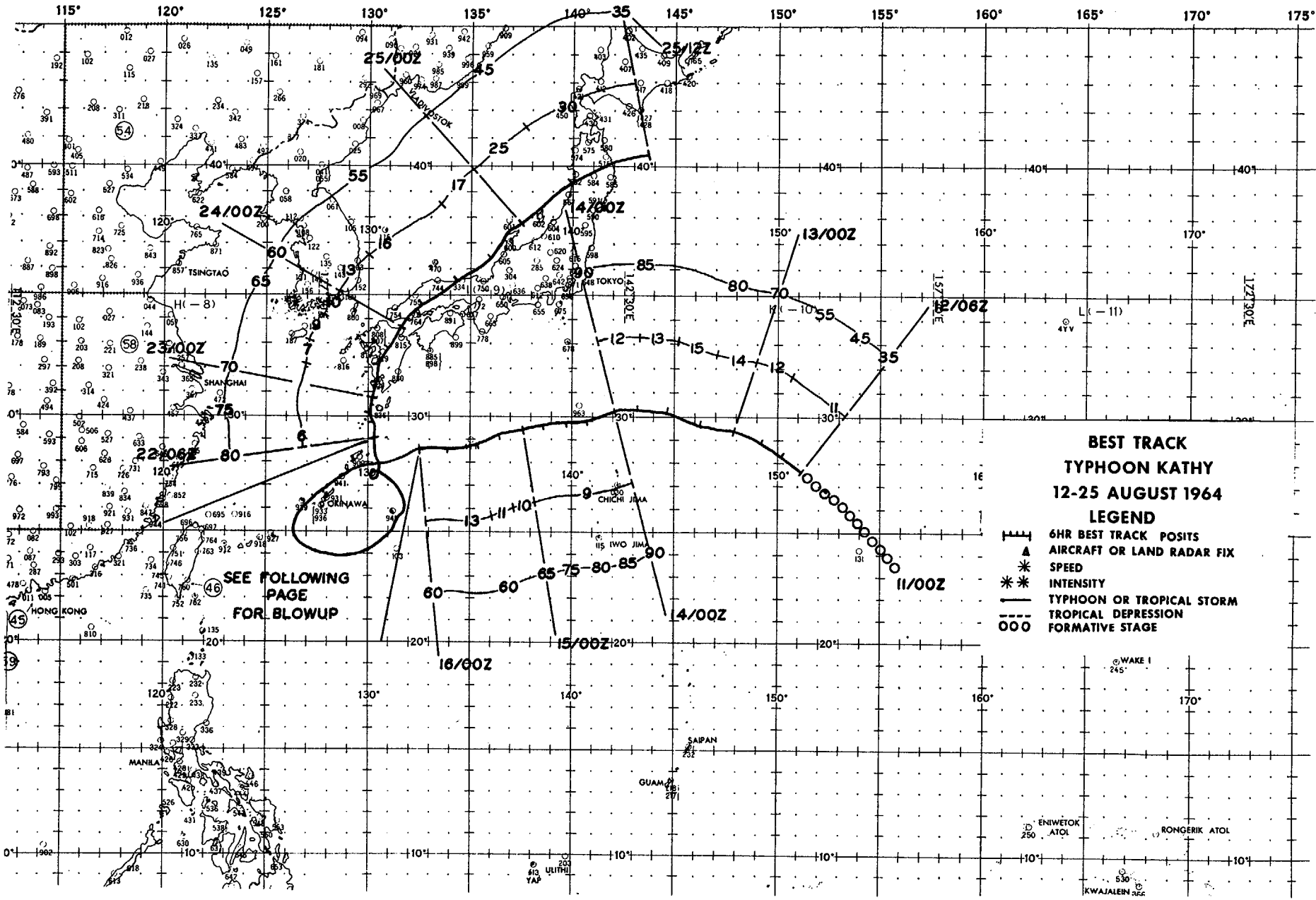
1. Embedded vortex at 110000Z
2. Surface pressure less than 1010mb

C. 200mb flow above surface vortex

1. Initial - East section of Polar Trough
2. Upon reaching typhoon intensity - SE quadrant of anticyclone

III. FINAL DISPOSITION

A. Extratropical



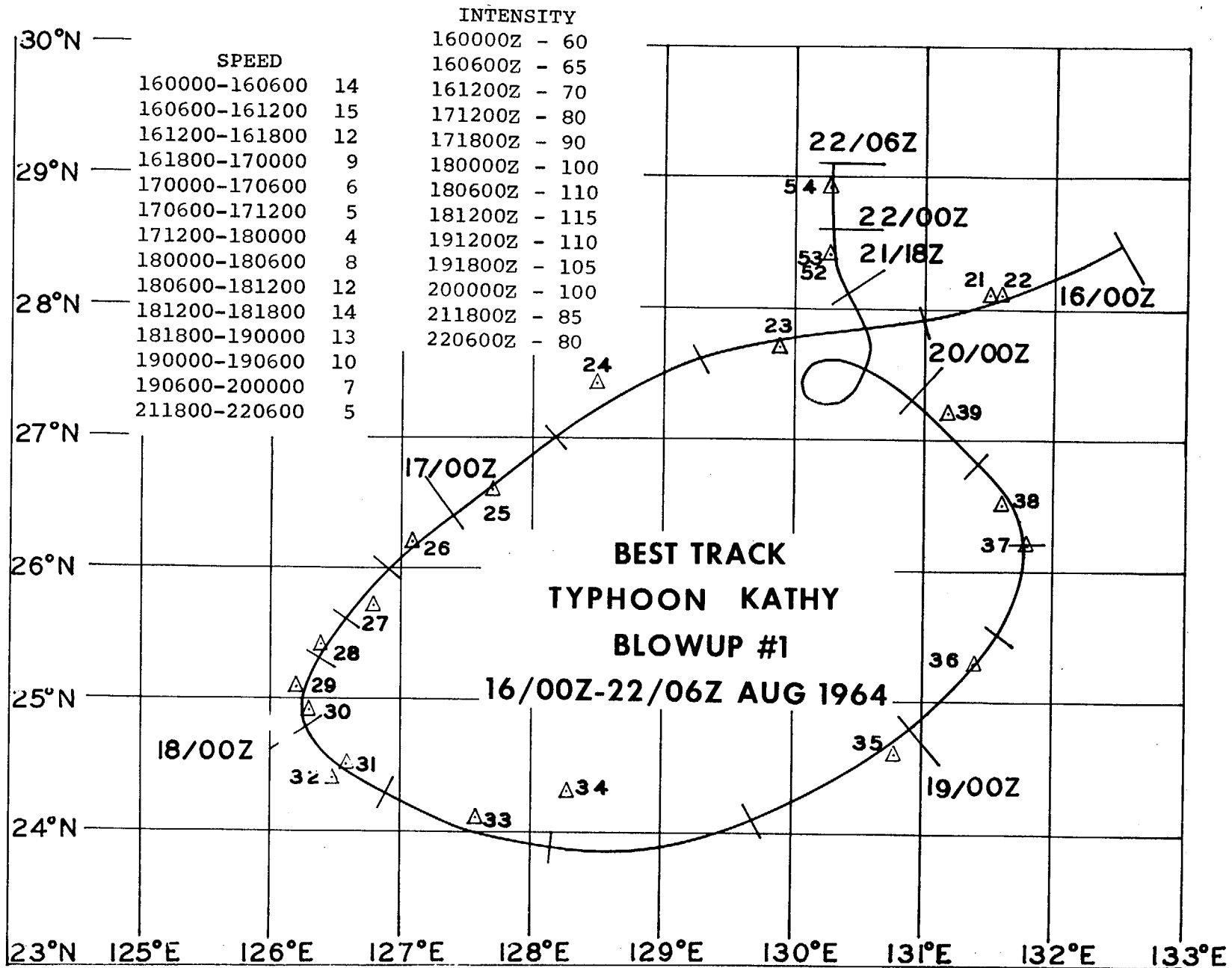
SEE FOLLOWING  
PAGE  
FOR BLOWUP

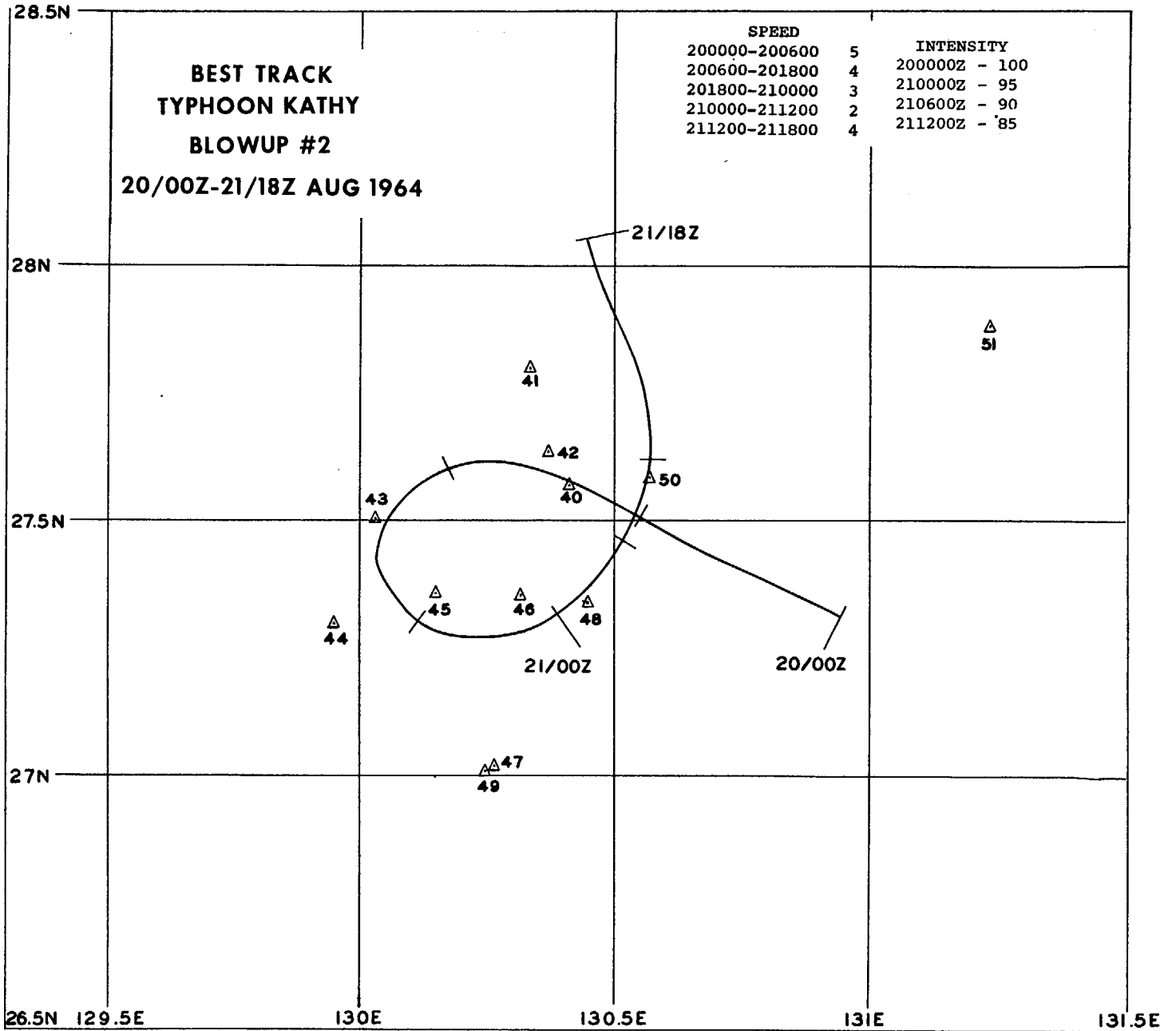
WAKE I  
245°

ENIWEKOK  
ATOL  
250

RONGERIK ATOL

KWAJALEN  
250





## EYE FIXES TYPHOON KATHY

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	121600Z	28.5N 149.5E	MATS ACFT 20959	---	--	--	---	---	--/--	
2	122200Z	29.1N 148.4E	56-P-2	700mb	65	75	981	2923	12/12	CIRC 25 MI DIA WALL CLDS 5 MI THICK
3	130400Z	29.2N 146.8E	56-P-7	700mb	65	110	975	2877	15/13	CIRC 9 MI DIA WALL CLDS 4 MI THICK OPEN N
4	130400Z	29.5N 146.9E	54-R-5	30000ft	--	60	---	---	--/--	
5	130930Z	30.1N 146.1E	VW1-R-5	1500ft	--	--	---	---	--/--	OVAL 12 MI E/W 10 MI N/S WALL CLD THICKNESS 10 MI S 13 MI W 6 MI N 9 MI E
6	131500Z	30.2N 143.9E	VW1-R-5	8000ft	--	--	---	---	--/--	CIRC 12 MI DIA
7	132200Z	30.2N 142.1E	54-R-3	30000ft	--	50	---	---	--/--	CIRC 7 MI DIA CLDS
8	132225Z	30.2N 141.9E	56-P-12	700mb	60	140	977	2917	16/14	CIRC 55 MI DIA CLSD WALL CLDS 7 MI THICK
9	140347Z	30.0N 141.1E	56-P-2	700mb	60	110	977	2935	18/13	CIRC 45 MI DIA OPEN NE WALL CLD 10 MI THICK
10	140400Z	29.9N 141.1E	54-R-5	30000ft	20	80	---	---	--/--	CIRC 15 MI DIA OPEN N AND W QUADS
11	141000Z	29.8N 139.9E	VW1-P-2	700mb	--	80	982	2980	19/--	CIRC 15 MI DIA OPEN NW
12	141345Z	29.6N 139.7E	VW1-R-15	10000ft	--	--	---	---	--/--	EYE DIFFUSED OPEN ALL QUADS XCP SE

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FLX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
13	142200Z	29.5N 138.0E	54-R-5	30000ft	--	70	---	---	--/--	OVAL 20 MI WIDE 25 MI LONG WALL CLD NE QUAD ONLY
14	142200Z	29.5N 137.8E	56-P-2	700mb	45	55	989	2999	20/--	CIRC 40 MI DIA OPEN N SEMI
15	150335Z	29.3N 137.1E	54-V-5	30000ft	--	60	---	---	--/--	CIRC 50 MI DIA OPEN N SEMI MAX TOPS 17000FT
16	150400Z	29.2N 136.7E	56-P-2	688mb	50	55	---	3005	19/--	ELLIP E-W OPEN W THRU ENE
17	151000Z	29.0N 135.8E	VW1-P-5	425ft	--	60	987	---	29/--	ILL DEFINED NO WALL CLDS
18	151530Z	28.6N 134.5E	VW1-P-5	6000ft	--	--	---	---	--/--	ILL DEFINED CLDS FORMING SE SEMI
19	152200Z	28.9N 133.0E	56-P-3	700mb	45	55	989	3027	17/13	OVAL 10 MI N/S 20 MI E/W WALL CLD S QUAD ONLY
20	152230Z	28.4N 132.8E	54-V-15	29000ft	--	70	---	---	--/--	CIRC 35 MI DIA ILL DEFINED
21	160400Z	28.1N 131.5E	56-P-3	683mb	44	80	989	3015	17/9	NO EYE MULTIPLE 700MB CLSD CIRCULATIONS
22	160419Z	28.1N 131.6E	54-R-10	30000ft	--	70	---	---	--/--	CIRC 15 MI DIA
23	161000Z	27.7N 129.9E	VW1-P-2	1000ft	--	80	985	---	24/15	OVAL 10 MI DIA
24	161530Z	27.4N 128.5E	VW1-R-15	10000ft	--	--	---	---	--/--	WALL CLD N QUAD ONLY
25	162200Z	26.6N 127.7E	56-P-2	700mb	42	45	974	2899	16/13	ELLIP 30 MI N/S 20 MI E/W NO DEFINITE WALL CLDS OPEN E-SE
26	170346Z	26.2N 127.1E	56-P-2	700mb	50	70	975	2887	15/14	CIRC 4 MI DIA WALL CLD ALL QUADS WEAK SE AND N

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
27	171040Z	25.7N 126.8E	VW1-R-3	10000ft	--	--	---	---	--/--	CIRC 16 MI DIA CLSD WALL CLDS 7 MI THICK
28	171530Z	25.4N 126.4E	VW1-R-2	10000ft	--	--	---	---	--/--	CIRC 11 MI DIA OPEN E SEMI
29	172144Z	25.1N 126.2E	54-R-5	31000ft	--	--	---	---	--/--	OVAL 30 MI SW/NE 20 MI SE/ NW OPEN NE AND SW
30	172200Z	24.9N 126.3E	56-P-2	700mb	90	100	954	2707	19/17	CIRC 16 MI DIA OPEN NW WALL CLDS 5 MI THICK
31	180323Z	24.5N 126.6E	54-R-10	30000ft	--	60	---	---	--/--	CIRC 20 MI CLSD
32	180400Z	24.4N 126.5E	56-P-2	700mb	80	130	948	2670	17/14	CIRC 6 MI DIA OPEN N
33	180950Z	24.1N 127.6E	VW1-R-5	1500ft	--	--	---	---	--/--	CIRC 8 MI DIA OPEN W SEMI WALL CLD 4 MI THICK MAX TOPS 60000FT
34	181500Z	24.3N 128.3E	VW1-R-5	1500ft	--	--	---	---	--/--	ELLIP 10 MI N/S 16 MI E/W WALL CLD 5 MI THICK MAX TOPS 50000FT
35	182255Z	24.6N 130.8E	56-P-4	698mb	59	130	957	2795	20/12	CIRC 35 MI DIA OPEN N
36	190400Z	25.3N 131.4E	56-P-1	707mb	60	130	---	2781	22/13	ELLIP 30 MI WNW/ESE 25 MI NNE/SSW WEAK WALL CLDS ALL QUADS
37	190957Z	26.2N 131.8E	VW1-R-15	1500ft	--	--	---	---	--/--	CIRC 5 MI DIA
38	191531Z	26.5N 131.6E	VW1-R-10	3645ft	--	--	---	---	--/--	CIRC 8 MI DIA
39	192200Z	27.2N 131.2E	56-P-2	700mb	70	90	955	2707	18/18	CIRC 35 MI DIA CLSD XCP BROKEN NW WALL CLD 8 TO 10 MI THICK

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
40	200330Z	27.6N 130.4E	56-P-3	700mb	70	100	952	2682	17/17	CIRC 20 MI DIA
41	200930Z	27.8N 130.3E	LND RDR	---	--	--	---	---	--/--	
42	200940Z	27.6N 130.4E	VW1-R-5	4000ft	--	--	---	---	--/--	CIRC 16 MI DIA WALL CLD 8 MI THICK
43	201400Z	27.5N 130.0E	LND RDR	---	--	--	---	---	--/--	
44	201530Z	27.3N 130.0E	VW1-R-5	500ft	--	--	---	---	--/--	CIRC 16 MI DIA OPEN E WALL CLD 16 MI THICK
45	201600Z	27.4N 130.2E	LND RDR	---	--	--	---	---	--/--	
46	202225Z	27.4N 130.3E	56-P-2	700mb	65	85	945	2740	17/13	CIRC 12 MI DIA OPEN TO E AND SE WALL CLD 5 MI THICK
47	202200Z	27.0N 130.3E	54-R-2	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA
48	210345Z	27.3N 130.5E	56-P-2	708mb	58	70	---	2822	18/13	CIRC 35 MI DIA OPEN E THRU N
49	210400Z	27.0N 130.3E	54-R-10	30000ft	--	25	---	---	--/--	CIRC 14 MI DIA OPEN E WALL CLD 8 MI THICK
50	211015Z	27.6N 130.6E	VW1-P-5	1500ft	--	70	964	---	24/20	ILL DEFINED OPEN NE
51	211540Z	27.9N 131.2E	VW1-R-1	9000ft	--	--	---	---	--/--	CIRC 24 MI DIA OPEN E WALL CLD 10 MI THICK
52	212200Z	28.4N 130.3E	56-P-2	689mb	50	55	966	2783	18/18	CIRC 20 MI DIA
53	212228Z	28.4N 130.3E	54-R-0	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA
54	220405Z	28.9N 130.3E	56-P-2	700mb	55	65	974	2847	16/16	CIRC 55 MI DIA OPEN S
55	220955Z	29.5N 130.3E	VW1-P-1	1300ft	--	65	967	---	23/22	CIRC 10 MI DIA OPEN E TOPS 3500FT

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
56	221530Z	30.0N 130.1E	VW1-R-1	4800ft	--	--	---	---	--/--	CIRC 15 MI DIA OPEN E TOPS 35000FT
57	222200Z	30.4N 130.0E	54-R-10	30000ft	--	--	---	---	--/--	CIRC 50 MI DIA
58	222218Z	30.6N 130.1E	56-P-1	500mb	60	65	971	2857	3/-1	700MB TEMP 15 CIRC 60 MI DIA
59	230320Z	31.1N 130.3E	54-R-5	30000ft	--	--	---	---	--/--	
60	230330Z	31.1N 130.4E	56-P-1	672mb	65	70	964	2798	16/14	CIRC 40 MI DIA
61	231000Z	31.8N 130.2E	VW1-R-1	8000ft	--	--	---	---	--/--	CIRC 12 MI DIA
62	231530Z	32.5N 130.8E	VW1-R-5	8000ft	--	--	---	---	--/--	CIRC 13 MI DIA WALL CLDS 6 MI THICK
63	232200Z	33.3N 131.4E	56-P-1	500mb	30	--	---	---	2/2	NO EYE
64	240315Z	34.0N 132.0E	56-P-1	500mb	65	60	---	---	2/2	NO EYE
65	241100Z	35.0N 134.1E	LND RDR	---	--	--	---	---	--/--	
66	241300Z	36.3N 135.0E	LND RDR	---	--	--	---	---	--/--	
67	250109Z	37.9N 137.9E	56-P-1	499mb	--	60	982	---	-2/-4	CIRC 10 MI DIA ILL DEFINED
68	250353Z	38.8N 138.5E	56-P-1	500mb	50	65	---	---	-3/-5	CIRC 10 MI DIA ILL DEFINED
69	250305Z	39.0N 140.0E	TIROS	---	--	--	---	---	--/--	ILL DEFINED

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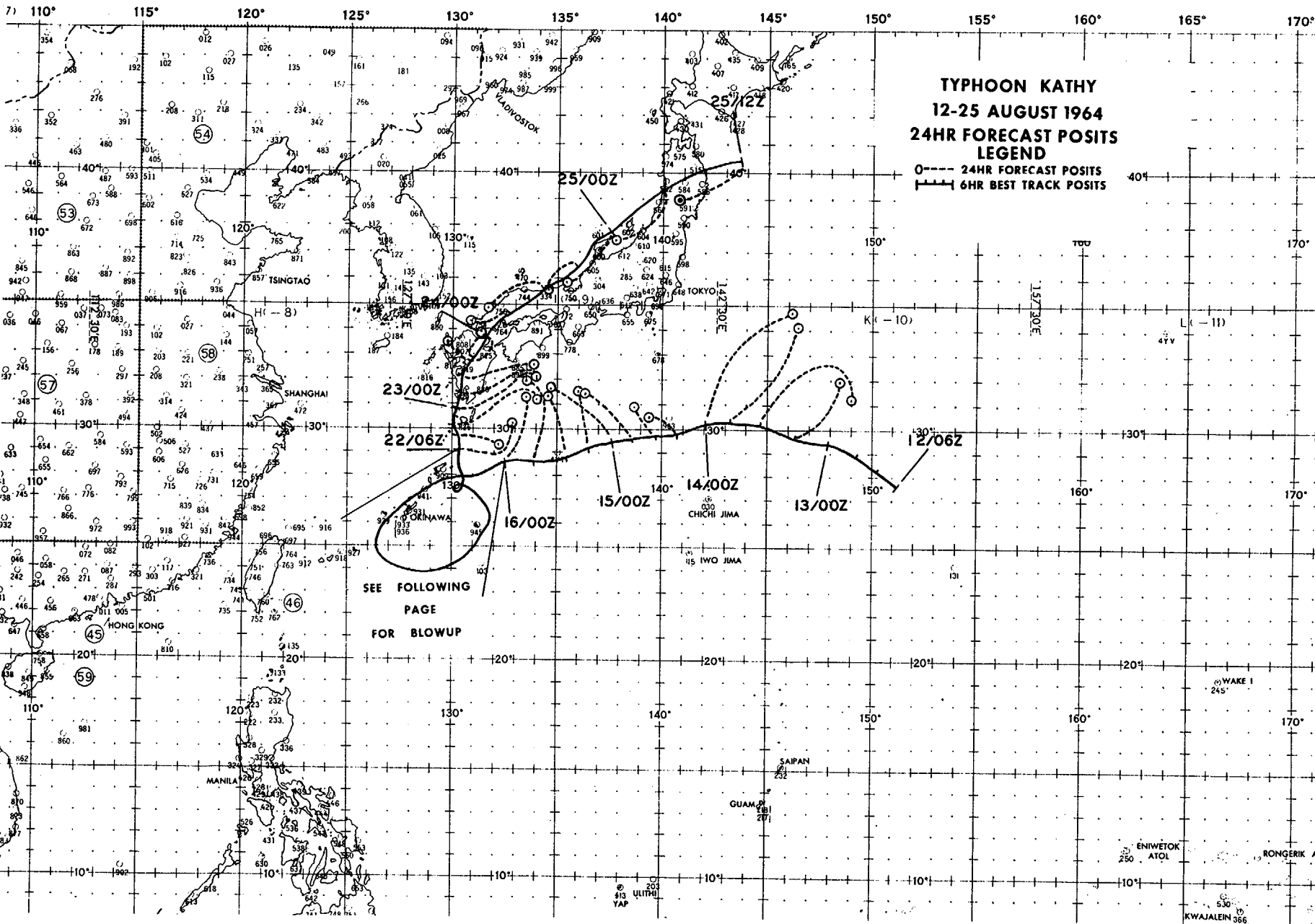
TYPHOON KATHY 12 AUG-25 AUG 1964  
 POSITION AND FORECAST VERIFICATION DATA

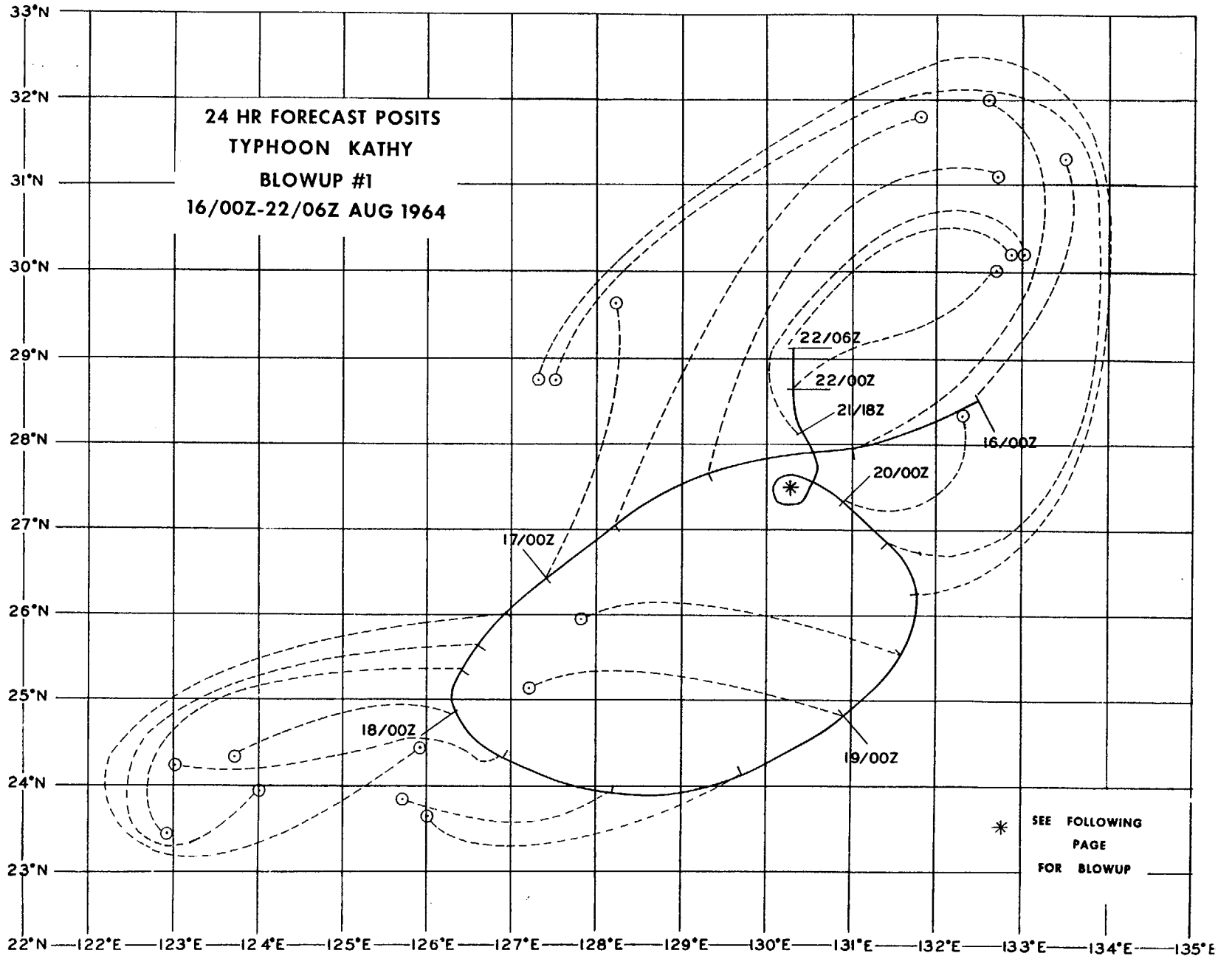
DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
120600Z	27.4N	151.2E	-----		-----	
121200Z	28.1N	150.2E	-----		-----	
121800Z	28.7N	149.2E	-----		-----	
130000Z	29.3N	147.9E	-----		-----	
130600Z	29.5N	146.3E	036-180		-----	
131200Z	30.1N	144.7E	074-227		-----	
131800Z	30.2N	143.2E	036-284		-----	
140000Z	30.2N	142.1E	038-354		-----	
140600Z	29.8N	140.7E	296-77		038-480	
141200Z	29.7N	139.7E	327-83		042-525	
141800Z	29.6N	138.6E	312-160		042-802	
150000Z	29.4N	137.6E	311-199		045-930	
150600Z	29.2N	136.5E	349-139		323-240	
151200Z	28.8N	135.3E	345-148		330-247	
151800Z	28.6N	133.9E	354-202		336-322	
160000Z	28.5N	132.5E	018-177		340-350	
160600Z	27.9N	131.0E	019-256		003-343	
161200Z	27.6N	129.3E	040-275		015-474	
161800Z	27.0N	128.2E	034-343		021-617	
170000Z	26.4N	127.4E	012-193		023-552	
170600Z	26.0N	126.9E	210-112		026-730	
171200Z	25.6N	126.6E	234-175		027-682	
171800Z	25.3N	126.4E	239-217		027-744	
180000Z	24.8N	126.3E	257-149		-----	
180600Z	24.3N	126.9E	267-211		254-345	
181200Z	23.9N	128.2E	267-135		261-567	
181800Z	24.1N	129.7E	263-208		263-696	
190000Z	24.8N	130.9E	276-205		258-627	
190600Z	25.5N	131.6E	277-205		263-693	
191200Z	26.2N	131.8E	303-278		248-314	
191800Z	26.8N	131.4E	298-240		253-276	

TYPHOON KATHY 12 AUG-25 AUG 1964  
 POSITION AND FORECAST VERIFICATION DATA (CONT'D)

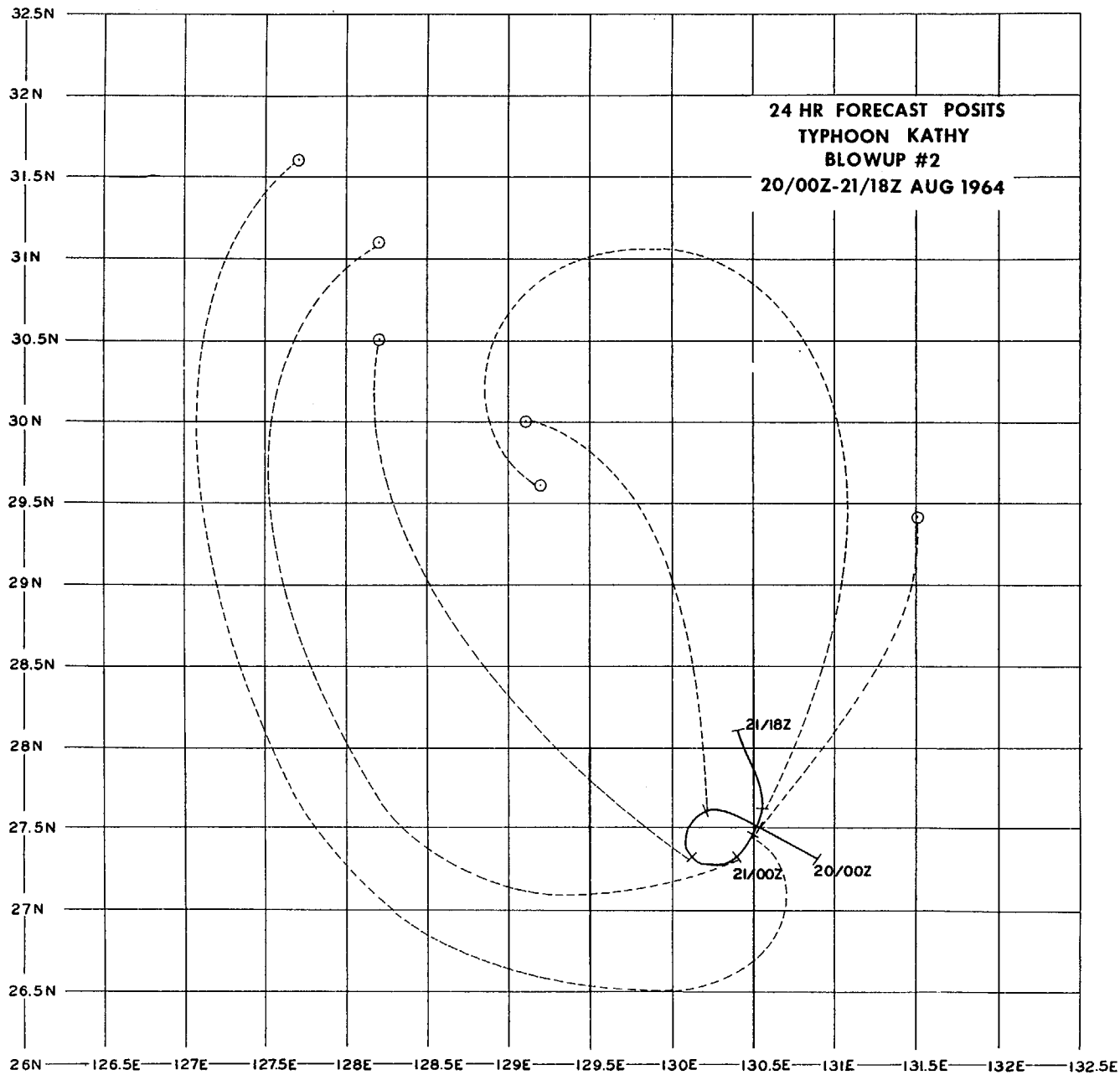
DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
200000Z	27.3N	130.9E	055-94		297-205	
200600Z	27.5N	130.5E	027-126		324-240	
201200Z	27.6N	130.2E	340-157		318-384	
201800Z	27.3N	130.1E	332-215		321-428	
210000Z	27.3N	130.4E	333-257		338-242	
210600Z	27.5N	130.5E	329-287		326-292	
211200Z	27.6N	130.6E	329-139		314-430	
211800Z	28.1N	130.4E	048-182		315-475	
220000Z	28.6N	130.3E	056-151		335-467	
220600Z	29.1N	130.3E	065-150		318-204	
221200Z	29.7N	130.2E	104-106		343-220	
221800Z	30.2N	130.0E	074-216		053-440	
230000Z	30.8N	130.2E	068-210		055-417	
230600Z	31.4N	130.3E	079-193		058-412	
231200Z	32.1N	130.4E	081-178		078-267	
231800Z	32.8N	131.0E	015-65		063-387	
240000Z	33.6N	131.6E	263-90		065-360	
240600Z	34.6N	132.7E	262-92		070-292	
241200Z	35.5N	134.4E	254-133		087-273	
241800Z	36.4N	136.0E	232-90		063-56	
250000Z	37.6N	137.6E	223-147		265-200	
250600Z	39.3N	140.0E	222-150		238-220	
251200Z	40.3N	143.7E	242-148		245-303	

AVERAGE 24 HOUR ERROR 180 MI  
 AVERAGE 48 HOUR ERROR 423 MI









TYPHOON MARIE - 140600Z to 181800Z AUGUST

I. DATA

A. Statistics

1. Calendar days of tropical warning - 4 3/4
2. Calendar days of typhoon intensity - 1
3. Total distance traveled during tropical warning period - 1068 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 976mb, 172200Z
2. Minimum observed 700mb height - 2929m, 172200Z
3. Maximum surface wind - 70 kts
4. Max radius of surface circulation - 325 mi

II. DEVELOPMENT

A. Initial impetus - Moderate inflow at lower levels from outdraft centered S of initial vortex and strong divergent flow at 200mb

B. Initial surface vortex

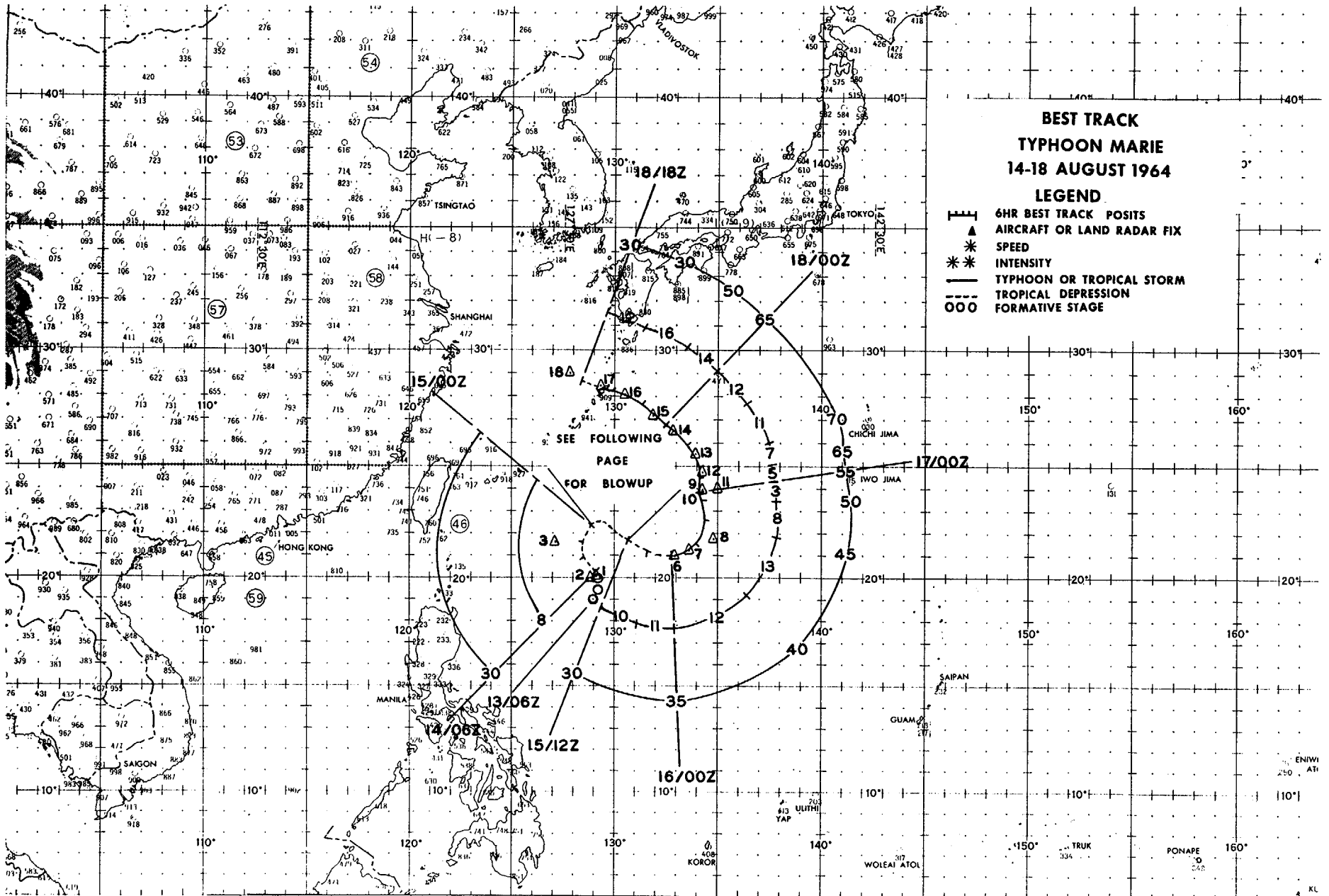
1. Junction vortex at 130600Z
2. Surface pressure less than 1004mb

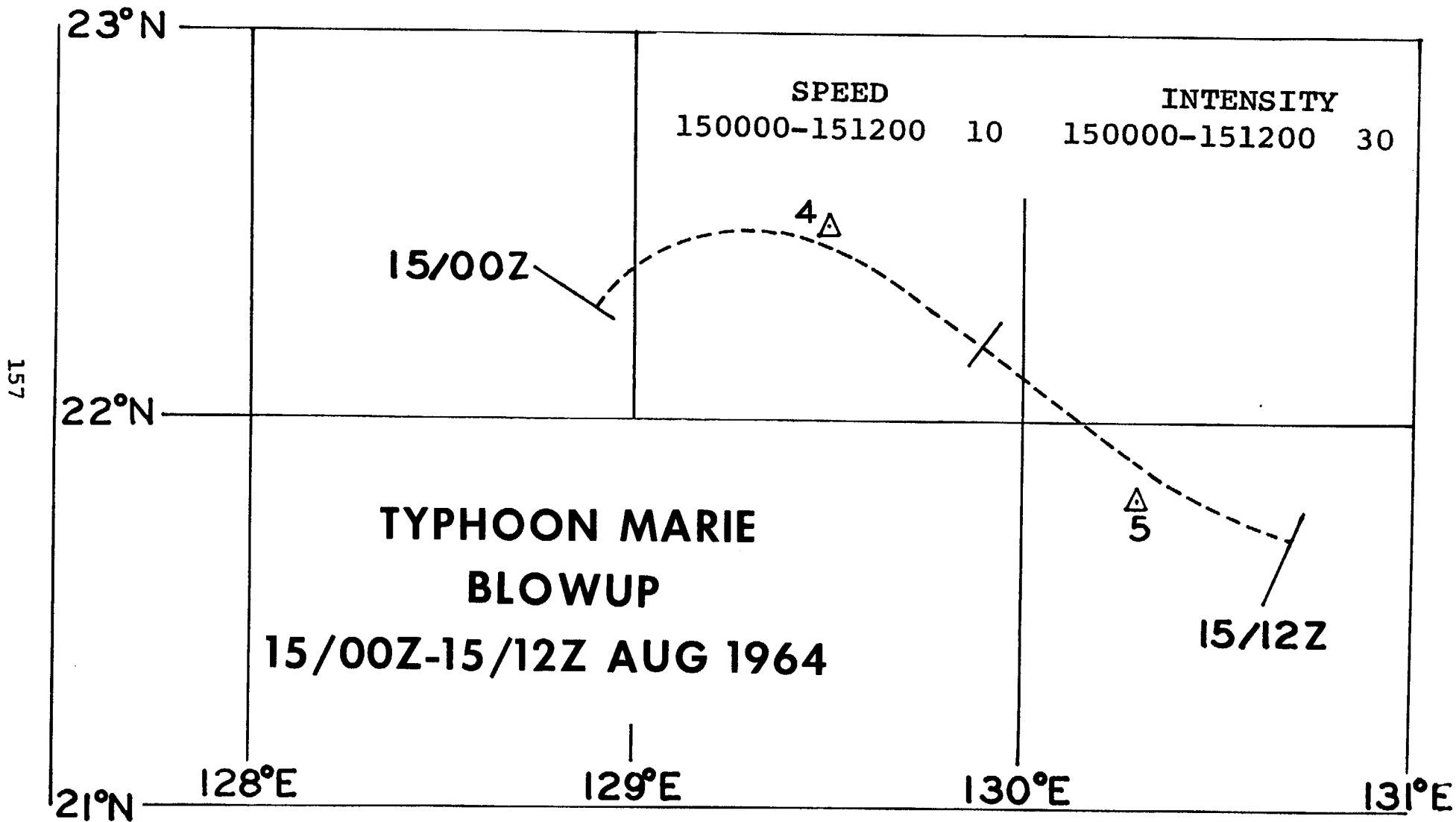
C. 200mb flow above surface vortex

1. Initial - West side of ridge oriented NNE-SSW
2. Upon reaching typhoon intensity - NW quadrant of anticyclone

III. FINAL DISPOSITION

A. Absorbed by circulation of Typhoon Kathy





## EYE FIXES TYPHOON MARIE

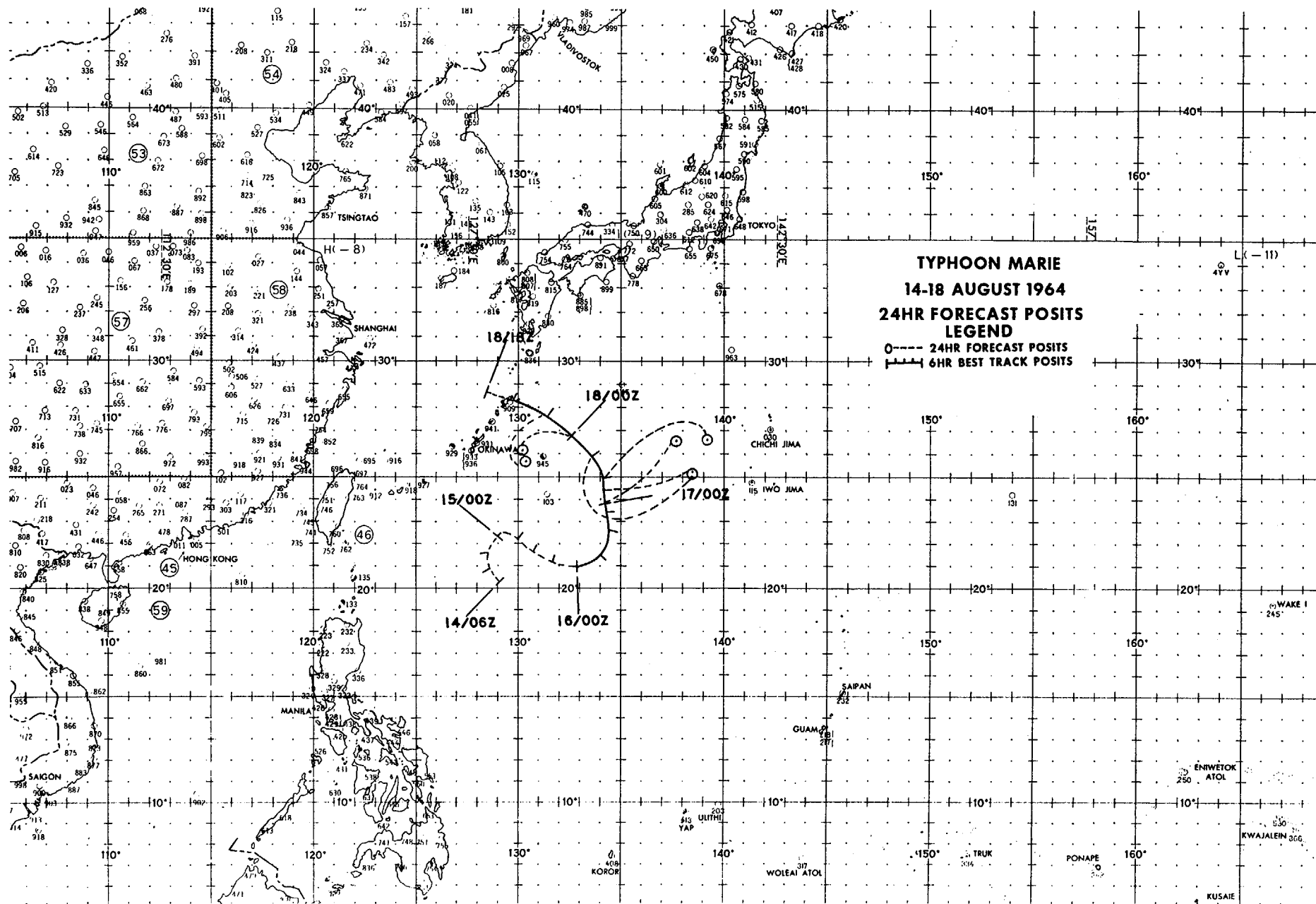
FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	140430Z	20.1N 129.2E	VW1-R-U	1500ft	--	35	---	---	--/--	50 MI DIA E/W 45 MI DIA N/S
2	141700Z	20.0N 128.8E	VW1-R-15	10000ft	--	--	---	---	--/--	CIRC 22 MI DIA OPEN SW THRU NW POORLY DEFINED
3	142200Z	21.6N 127.1E	56-P-2	690mb	50	20	---	3088	12/12	POORLY DEFINED NO WALL CLDS
4	150330Z	22.5N 129.5E	56-P-3	690mb	20	30	---	3069	13/13	ILL DEFINED MULTIPLE CNTRS
5	150830Z	21.8N 130.3E	VW1-P-U	700mb	--	25	---	3158	24/17	CIRC 17 MI DIA NEG WALL CLDS
6	160037Z	21.0N 132.9E	56-P-10	711mb	23	28	998	3036	8/8	NEG WALL CLDS
7	160345Z	21.3N 133.6E	56-P-10	713mb	28	40	995	3021	8/8	NEG WALL CLDS
8	161500Z	21.7N 134.8E	VW1-R-15	1500ft	--	--	---	---	--/--	POORLY DEFINED
9	162200Z	23.9N 134.3E	56-P-3	672mb	35	35	991	3002	23/12	CIRC 20 MI DIA WALL CLDS W & S
10	170300Z	23.8N 134.3E	56-P-3	669mb	40	55	980	2990	15/13	CIRC 45 MI DIA OPEN E WALL CLDS BUILDING RAPIDLY
11	170500Z	24.0N 135.0E	TIROS	---	--	--	---	---	--/--	CRESCENT SHAPED
12	171000Z	24.7N 134.3E	VW1-P-5	650ft	--	70	981	---	29/--	CIRC 31 MI DIA OPEN N WALL CLD 12 MI THICK
13	171530Z	25.5N 133.9E	VW1-R-5	9000ft	--	--	---	---	--/--	ILL DEFINED OPEN NW
14	172200Z	26.5N 132.8E	56-P-2	700mb	50	70	976	2929	17/11	NEG WALL CLDS
15	180348Z	27.2N 131.9E	56-P-2	700mb	60	75	985	2938	17/10	NEG WALL CLDS

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
16	181100Z	28.1N 130.4E	VW1-R-10	1500ft	--	--	---	---	--/--	
17	181400Z	28.4N 129.3E	VW1-R-15	1500ft	--	--	---	---	--/--	ILL DEFINED
18	190040Z	29.0N 127.8E	LND/RDR	---	--	--	---	---	--/--	

TYPHOON MARIE 14 AUG-18 AUG 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
140600Z	20.3N	129.1E	-----	-----
141200Z	20.9N	128.5E	-----	-----
141800Z	21.7N	128.5E	-----	-----
150000Z	22.3N	128.9E	-----	-----
150600Z	22.2N	129.9E	-----	-----
151200Z	21.7N	130.7E	-----	-----
151800Z	21.2N	131.7E	-----	-----
160000Z	21.0N	132.8E	-----	-----
160600Z	21.5N	134.0E	-----	-----
161200Z	22.7N	134.5E	-----	-----
161800Z	23.5N	134.3E	-----	-----
170000Z	23.8N	134.3E	049-260	-----
170600Z	24.3N	134.2E	076-240	-----
171200Z	25.0N	134.2E	070-285	-----
171800Z	25.9N	133.5E	101-270	-----
180000Z	26.7N	132.6E	254-138	045-380
180600Z	27.6N	131.3E	208-126	064-412
181200Z	28.3N	129.7E	-----	-----
181800Z	28.7N	128.4E	-----	-----

AVERAGE 24 HOUR ERROR 220 MI  
 AVERAGE 48 HOUR ERROR 396 MI





TYPHOON RUBY - 010600Z to 051800Z SEPTEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning -  $4\frac{1}{2}$
2. Calendar days of typhoon intensity -  $3\frac{1}{4}$
3. Total distance traveled during tropical warning period - 1254 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 963mb, 041000Z and 042230Z
2. Minimum observed 700mb height - 2804m, 042230Z
3. Maximum surface wind - 120 kts
4. Max radius of surface circulation - 400 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of polar trough with easterly wave and subsequent fracture

B. Initial surface vortex

1. Embedded vortex at 291200Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - SW quadrant of anticyclone
2. Upon reaching typhoon intensity - SE quadrant of anticyclone

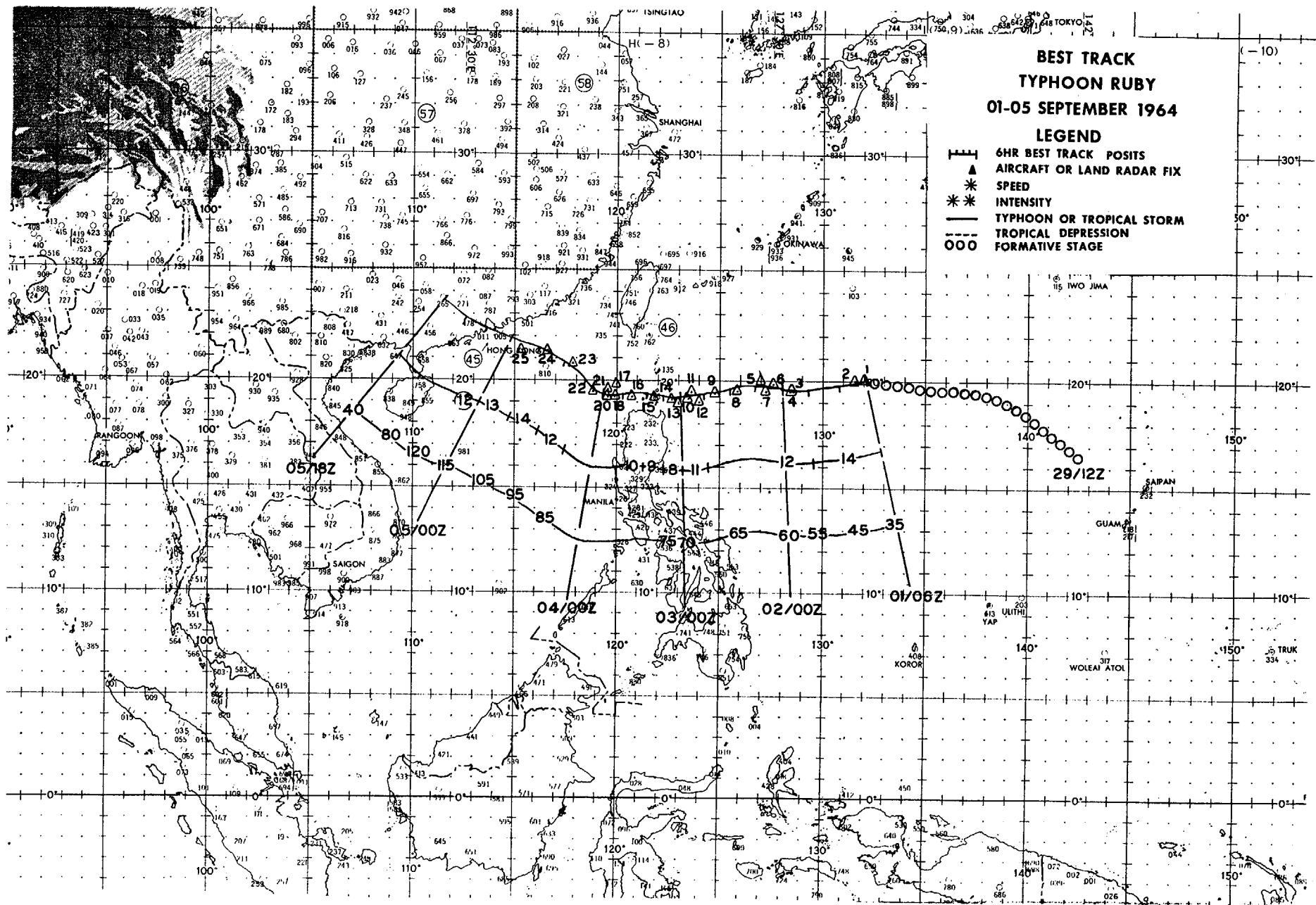
III. FINAL DISPOSITION

- A. Dissipated over land

# BEST TRACK TYPHOON RUBY 01-05 SEPTEMBER 1964

- LEGEND**
- 6HR BEST TRACK POSITS
  - AIRCRAFT OR LAND RADAR FIX
  - SPEED
  - INTENSITY
  - TYPHOON OR TROPICAL STORM
  - TROPICAL DEPRESSION
  - FORMATIVE STAGE

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## EYE FIXES TYPHOON RUBY

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	310013Z	20.0N 137.0E	TIROS	---	--	--	---	---	--/--	BANDING NE & SW QUADS
2	010833Z	20.0N 131.6E	VW1-P-5	1200ft	--	50	998	---	24/19	CIRC 20 MI DIA OPEN N WALL CLDS 6 MI THICK
3	012200Z	19.5N 128.5E	56-P-10	700mb	55	55	991	3038	14/10	CIRC 20 MI DIA
4	012200Z	19.5N 128.3E	54-R-5	30000ft	--	70	---	---	--/--	CIRC 7 MI DIA OPEN NW
5	012319Z	20.0N 127.0E	TIROS	---	--	--	---	---	--/--	STORM ON EDGE OF PICTURE
6	020300Z	19.8N 127.6E	56-P-5	700mb	55	50	991	3008	15/10	CIRC 20 MI DIA OPEN NW
7	020410Z	19.6N 127.2E	54-R-5	30000ft	--	50	---	---	--/--	CIRC 15 MI DIA WALL CLD S QUAD 3-5 MI THICK
8	021000Z	19.6N 125.8E	VW1-P-5	800ft	--	65	986	---	26/21	CIRC 20 MI DIA
9	021600Z	19.4N 124.7E	VW1-R-10	4000ft	--	--	---	---	--/--	CIRC EYE OPEN NW SEMI WALL CLD 7 MI THICK
10	022210Z	19.2N 123.4E	56-P-2	700mb	55	55	980	2935	17/16	ILL DEFINED OPEN NW
11	022130Z	19.5N 123.6E	54-R-10	30000ft	--	50	---	---	--/--	OVAL 30 MI N-S 15 MI E-W OPEN SE
12	022337Z	19.0N 124.0E	TIROS	---	--	--	---	---	--/--	NO EYE VSBL
13	030330Z	18.9N 123.0E	54-R-3	31000ft	--	75	---	---	--/--	OVAL 30 X 20 MI
14	030300Z	19.1N 122.7E	56-P-1	691mb	60	85	981	2911	17/17	NO WELL DEFINED EYE OPEN W SEMI

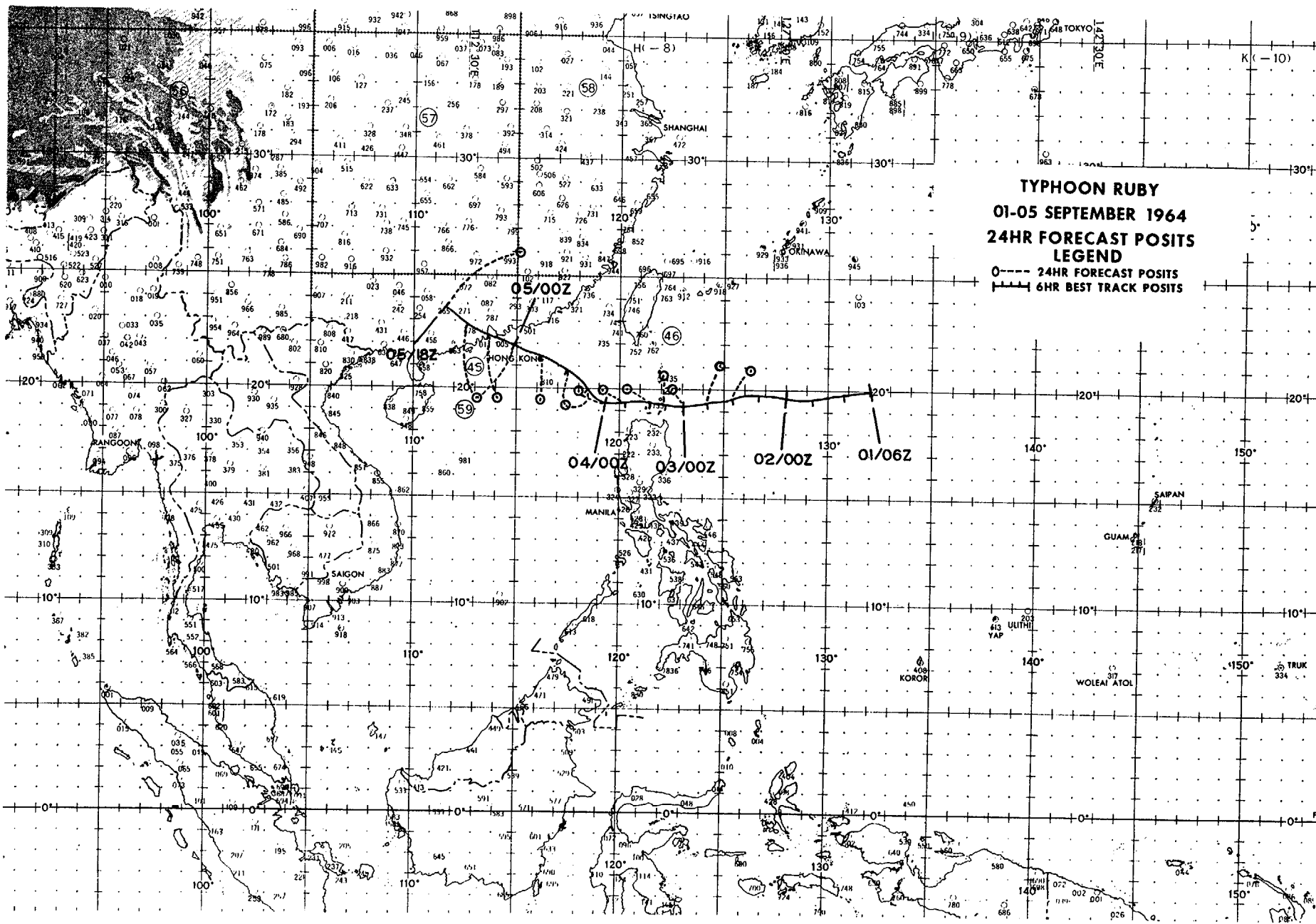
FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
15	030954Z	19.3N 121.8E	VW1-R-1	1100ft	--	--	---	---	--/--	CIRC 10 MI DIA
16	031545Z	19.3N 120.7E	VW1-R-1	11000ft	--	--	---	---	--/--	OVAL 20 MI NE/SW 14 MI NW/SE LGT WALL CLDS ALL QUADS 4 MI THICK
17	031730Z	19.8N 120.0E	SHIP RADAR	---	--	--	---	---	--/--	
18	031750Z	19.3N 119.9E	LAND RADAR	---	--	--	---	---	--/--	
19	032000Z	19.6N 119.5E	SHIP RADAR	---	--	--	---	---	--/--	
20	032205Z	19.3N 119.5E	56-P-3	699mb	60	70	979	2923	14/13	CIRC 40 MI DIA OPEN NW
21	040005Z	19.5N 119.5E	TIROS	---	--	--	---	---	--/--	EYE VSBL
22	040300Z	19.5N 118.8E	56-P-3	700mb	55	65	979	2926	14/13	CIRC 45 MI DIA OPEN W WALL CLD 8 MI THICK
23	041000Z	20.7N 117.8E	VW1-P-3	800ft	--	95	963	---	26/19	OVAL 18 MI N/S 22 MI E/W
24	041600Z	21.3N 116.6E	VW1-R-10	4500ft	--	--	---	---	--/--	CIRC 20 MI DIA THIN BRKN WALL CLDS ALL QUADS
25	042230Z	21.3N 115.3E	56-P-5	700mb	70	65	963	2804	15/13	ELLIP 24 MI E/W 14 MI N/S WALL CLD 5 MI THICK ALL QUADS

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TYPHOON RUBY 01 SEPT-05 SEPT 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
010600Z	19.9N	132.2E	-----		-----	
011200Z	19.8N	130.8E	-----		-----	
011800Z	19.6N	129.3E	-----		-----	
020000Z	19.6N	128.0E	-----		-----	
020600Z	19.7N	126.7E	-----		-----	
021200Z	19.6N	125.4E	033-88		-----	
021800Z	19.4N	124.2E	017-107		-----	
030000Z	19.2N	123.1E	327-62		-----	
030600Z	19.3N	122.3E	354-86		-----	
031200Z	19.4N	121.4E	304-74		348-150	
031800Z	19.4N	120.3E	299-73		342-165	
040000Z	19.4N	119.3E	293-77		309-142	
040600Z	20.0N	118.4E	229-74		332-130	
041200Z	20.8N	117.5E	186-92		274-139	
041800Z	21.4N	116.2E	178-120		266-128	
050000Z	21.9N	114.9E	215-174		258-118	
050600Z	22.3N	113.7E	172-167		205-183	
051200Z	22.8N	112.6E	170-200		184-187	
051800Z	23.6N	111.6E	053-242		186-230	

AVERAGE 24 HOUR ERROR 117 MI  
 AVERAGE 48 HOUR ERROR 157 MI



TYPHOON SALLY - 030000Z to 101800Z SEPTEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning - 8
2. Calendar days of typhoon intensity - 6½
3. Total distance traveled during tropical warning period - 2832 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 894mb, 081030Z
2. Minimum observed 700mb height - 2179m, 072207Z
3. Maximum surface wind - 170 kts
4. Max radius of surface circulation - 425 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of Polar Trough with easterly wave and subsequent fracture

B. Initial surface vortex

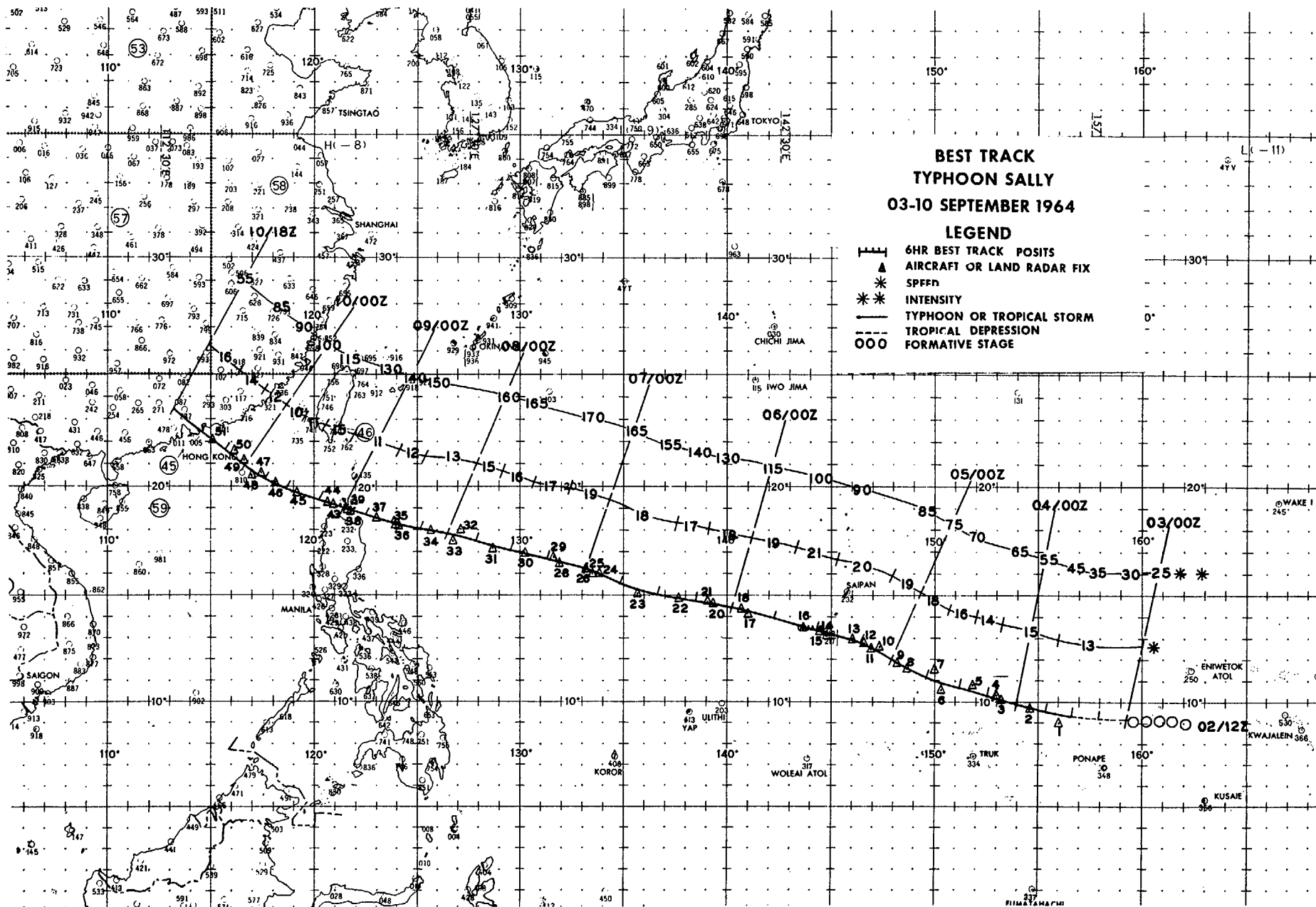
1. Junction vortex at 021200Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - SW quadrant of anticyclone
2. Upon reaching typhoon intensity - SE quadrant of anticyclone

III. FINAL DISPOSITION

A. Dissipated over land





## EYE FIXES TYPHOON SALLY

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	032040Z	09.0N 156.0E	TIROS	---	--	--	---	---	--/--	
2	032133Z	09.9N 154.7E	54-R-10	30000ft	--	40	---	---	--/--	CIRC 10 MI DIA WALL CLD E SIDE ONLY
3	040317Z	10.1N 153.2E	54-R-5	30000ft	--	60	---	---	--/--	CIRC 25 MI DIA OPEN NW
4	040415Z	10.3N 153.0E	VW1-P-5	1000ft	--	55	997	---	24/20	CIRC 35 MI DIA BRKN WALL CLDS 10 MI THICK
5	040956Z	10.8N 151.8E	VW1-P-10	10000ft	--	40	1000	3143	10/4	CIRC 15 MI DIA OPEN SW QUAD
6	041545Z	10.7N 150.3E	VW1-P-2	10000ft	--	70	---	3087	11/4	OVAL 20 MI E/W 10 MI N/S OPEN W WALL CLD 8 MI THICK
7	042103Z	11.5N 150.0E	TIROS	---	--	--	---	---	--/--	EYE NOT VSBL
8	042143Z	11.6N 148.7E	54-R-10	30000ft	--	45	---	---	--/--	CIRC 10 MI DIA OPEN S
9	042210Z	11.8N 148.3E	56-P-5	700mb	40	55	995	3106	9/8	OVAL E-W 12 MI DIA OPEN S
10	050300Z	12.6N 147.3E	54-R-5	30000ft	--	--	---	---	--/--	5 MI DIA OPEN NE QUAD
11	050345Z	12.5N 147.0E	56-P-3	684mb	55	65	993	3033	13/11	CIRC 15 MI DIA OPEN E WALL CLDS 5 MI THICK
12	050500Z	12.7N 146.7E	LAND RADAR	---	--	--	---	---	--/--	ILL DEFINED
13	050700Z	13.0N 146.0E	LAND RADAR	---	--	--	---	---	--/--	CIRC 9 MI WALL CLDS 8 MI THICK
14	050945Z	13.2N 144.9E	VW1-P-2	1500ft	--	100	976	---	--/--	CIRC 5 MI DIA OPEN SE QUAD

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
15	051100Z	13.3N 144.6E	LAND RADAR	---	--	--	---	---	--/--	WALL CLD W SEMI 7 MI THICK
16	051330Z	13.6N 143.6E	VW1-R-2	10000ft	--	--	---	---	--/--	CIRC 4 MI DIA OPEN E
17	052147Z	14.2N 141.0E	54-R-5	290mb	--	75	---	---	--/--	CIRC 5 MI DIA WALL CLDS 3 MI THICK
18	052227Z	14.3N 140.7E	56-P-3	700mb	100	150	---	2762	17/17	CIRC 6 MI DIA SEVERE TURBULENCE
19	051947Z	14.5N 140.5E	TIROS	---	--	--	---	---	--/--	BANDING EVIDENT
20	060326Z	14.6N 139.3E	54-R-3	30000ft	--	--	---	---	--/--	CIRC 18 MI DIA OPEN NW & SE WALL CLDS 7 MI THICK
21	060344Z	14.7N 139.2E	56-P-1	738mb	90	150	---	2758	21/--	CIRC 5 MI DIA OPEN N MODERATE CAT IN EYE
22	060950Z	14.9N 137.5E	VW1-R-5	1400ft	--	--	---	---	--/--	ELLIP 9 MI E-W 12 MI N-S WALL CLDS 9 MI THICK BRKN NE
23	061530Z	15.1N 135.7E	VW1-R-15	1400ft	--	--	---	---	--/--	CIRC 12 MI DIA WALL CLDS 9 MI THICK BRKN NW QUAD
24	062200Z	16.1N 133.8E	56-P-4	700mb	150	200	903	2253	27/17	CIRC 12 MI DIA GREEN SEA N QUAD COVERED BY WHITE SPRAY SHEET
25	062203Z	16.1N 133.7E	54-R-20	33000ft	--	60	---	---	--/--	CIRC 12 TO 18 MI EYE IS PULSATING OCNLY ASSUMING OVAL SHAPE
26	070000Z	16.2N 133.1E	56-P-4	700mb	--	200†	897	2219	29/19	CIRC 7 MI DIA HEAVY SPRAY SHEET AT SFC

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
27	062148Z	16.0N 132.5E	TIROS	---	--	--	---	---	--/--	EYE VSBL
28	070400Z	16.4N 131.9E	54-R-5	30000ft	--	--	---	---	--/--	CIRC 15 MI DIA
29	070430Z	16.7N 131.6E	56-P-10	680mb	140	200	899	2201	25/19	CIRC 12 MI DIA
30	071000Z	17.0N 130.3E	VW1-R-5	1000ft	--	--	---	---	--/--	CIRC 12 MI DIA WALL CLDS 8 MI THICK
31	071545Z	17.2N 128.6E	VW1-R-5	10000ft	--	--	---	---	--/--	CIRC 11 MI DIA WALL CLDS 8 MI THICK
32	072108Z	18.1N 127.1E	54-R-5	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA
33	072207Z	17.7N 126.7E	56-P-6	691mb	150	185	896	2179	27/21	CIRC 10 MI DIA
34	080330Z	18.0N 125.5E	54-V-30	30000ft	--	75	---	---	--/--	CIRC 10 MI DIA
35	081000Z	18.2N 124.0E	VW1-R-5	1300ft	--	--	---	---	--/--	ELLIP 14 MI N/S 9 MI E/W WALL CLD 11 MI THICK E SEMI & 7 MI W SEMI
36	081030Z	18.2N 124.1E	56-P-1	700mb	90	120	894	2201	18/17	CIRC 13 MI DIA
37	081545Z	18.6N 123.0E	VW1-R-1	9300ft	--	--	---	---	--/--	CIRC
38	082105Z	18.8N 121.8E	54-R-0	31000ft	--	--	---	---	--/--	CIRC 15 MI OPEN NW & W
39	082210Z	18.9N 121.6E	56-R-4	500mb	--	--	---	---	--/--	12 MI DIA
40	090100Z	18.8N 121.1E	LAND RADAR	---	--	--	---	---	--/--	
41	090120Z	18.8N 120.8E	LAND RADAR	---	--	--	---	---	--/--	
42	090300Z	18.6N 120.5E	LAND RADAR	---	--	--	---	---	--/--	

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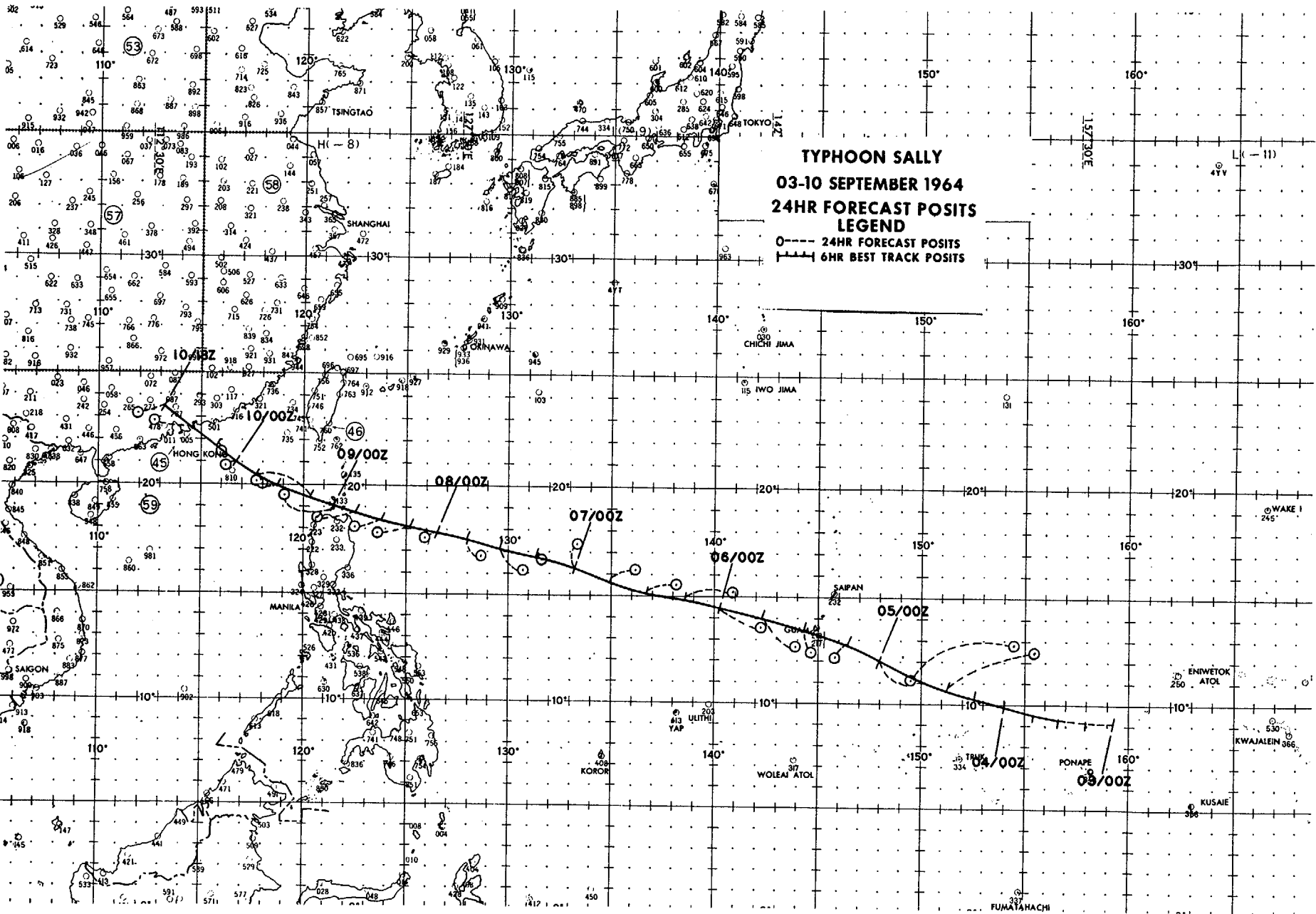
FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
43	090400Z	19.2N 120.8E	56-P-4	690mb	60	130	950	2637	14/14	CONCENTRIC INNER EYE 5 MI DIA OUTER EYE 30 MI DIA WALL CLDS 3 TO 5 MI THICK
44	090356Z	19.3N 120.6E	54-R-5	31000ft	--	--	---	---	--/--	CIRC 12 MI DIA OPEN N QUAD
45	091000Z	19.8N 119.2E	VW1-R-1	4000ft	--	--	---	---	--/--	CONCENTRIC INNER EYE 12 MI DIA OUTER EYE 25 MI DIA WALL CLDS 7 MI THICK
46	091553Z	20.3N 118.0E	VW1-R-1	10000ft	--	--	---	---	--/--	CIRC 10 MI DIA NOT SO WELL DEFINED AS PREVIOUS FIX
47	092159Z	20.7N 117.3E	54-R-10	32000ft	40	--	---	---	--/-30	CIRC 15 MI DIA OPEN W QUAD
48	092200Z	20.6N 117.0E	56-P-1	700mb	--	--	970	2822	17/14	CIRC 30 MI DIA BRKG UP IN SE
49	100300Z	21.1N 116.8E	54-R-20	32000ft	--	--	---	---	--/--	CIRC 15 MI DIA OPEN NW & S QUADS
50	100400Z	21.6N 116.1E	56-P-3	700mb	--	85	973	2859	18/15	CIRC 35-40 MI BCMG DIFFUSED OPEN N
51	100945Z	22.2N 115.0E	VW1-R-3	4000ft	--	--	---	---	--/--	CIRC 12 MI DIA

TYPHOON SALLY 03 SEPT-10 SEPT 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
030000Z	09.2N	159.3E	-----	-----
030600Z	09.3N	158.0E	-----	-----
031200Z	09.5N	156.7E	-----	-----
031800Z	09.7N	155.4E	-----	-----
040000Z	10.0N	154.0E	-----	-----
040600Z	10.3N	152.5E	-----	-----
041200Z	10.7N	151.2E	249-268	-----
041800Z	11.1N	149.6E	251-306	-----
050000Z	12.0N	148.0E	120-102	-----
050600Z	12.8N	146.3E	211-51	-----
051200Z	13.4N	144.3E	157-70	-----
051800Z	14.0N	142.2E	130-134	-----
060000Z	14.4N	140.3E	116-123	114-300
060600Z	14.8N	138.4E	081-142	126-114
061200Z	15.0N	136.7E	073-90	116-163
061800Z	15.6N	134.9E	061-75	113-212
070000Z	16.2N	133.2E	010-70	102-217
070600Z	16.8N	131.3E	095-23	080-252
071200Z	17.1N	129.6E	132-82	079-191
071800Z	17.4N	127.9E	135-56	067-190
080000Z	17.9N	126.4E	244-34	030-170
080600Z	18.0N	125.1E	259-80	028-112
081200Z	18.3N	123.7E	261-78	100-65
081800Z	18.7N	122.6E	264-110	102-10
090000Z	19.0N	121.4E	286-138	270-90
090600Z	19.4N	120.3E	288-156	267-184
091200Z	19.9N	118.7E	278-42	263-150
091800Z	20.4N	117.6E	210-14	270-163
100000Z	20.8N	116.7E	276-34	301-202
100600Z	21.6N	115.6E	137-20	305-211
101200Z	22.5N	114.6E	281-110	295-86
101800Z	23.3N	113.1E	255-67	301-27

TYPHOON SALLY 03 SEPT-10 SEPT 1964  
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

AVERAGE 24 HOUR ERROR 95 MI  
AVERAGE 48 HOUR ERROR 155 MI



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TYPHOON TILDA - 130600Z to 221200Z SEPTEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning -  $9\frac{1}{2}$
2. Calendar days of typhoon intensity -  $5\frac{3}{4}$
3. Total distance traveled during tropical warning period - 1800 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 952mb, 201015Z
2. Minimum observed 700mb height - 2774m, 200300Z
3. Maximum surface wind - 110 kts
4. Max radius of surface circulation - 500 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of Polar Trough with easterly wave and subsequent fracture

B. Initial surface vortex

1. Junction vortex at 120000Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - SE quadrant of huge anticyclone centered over Chinese mainland
2. Upon reaching typhoon intensity - S quadrant of anticyclone

III. FINAL DISPOSITION

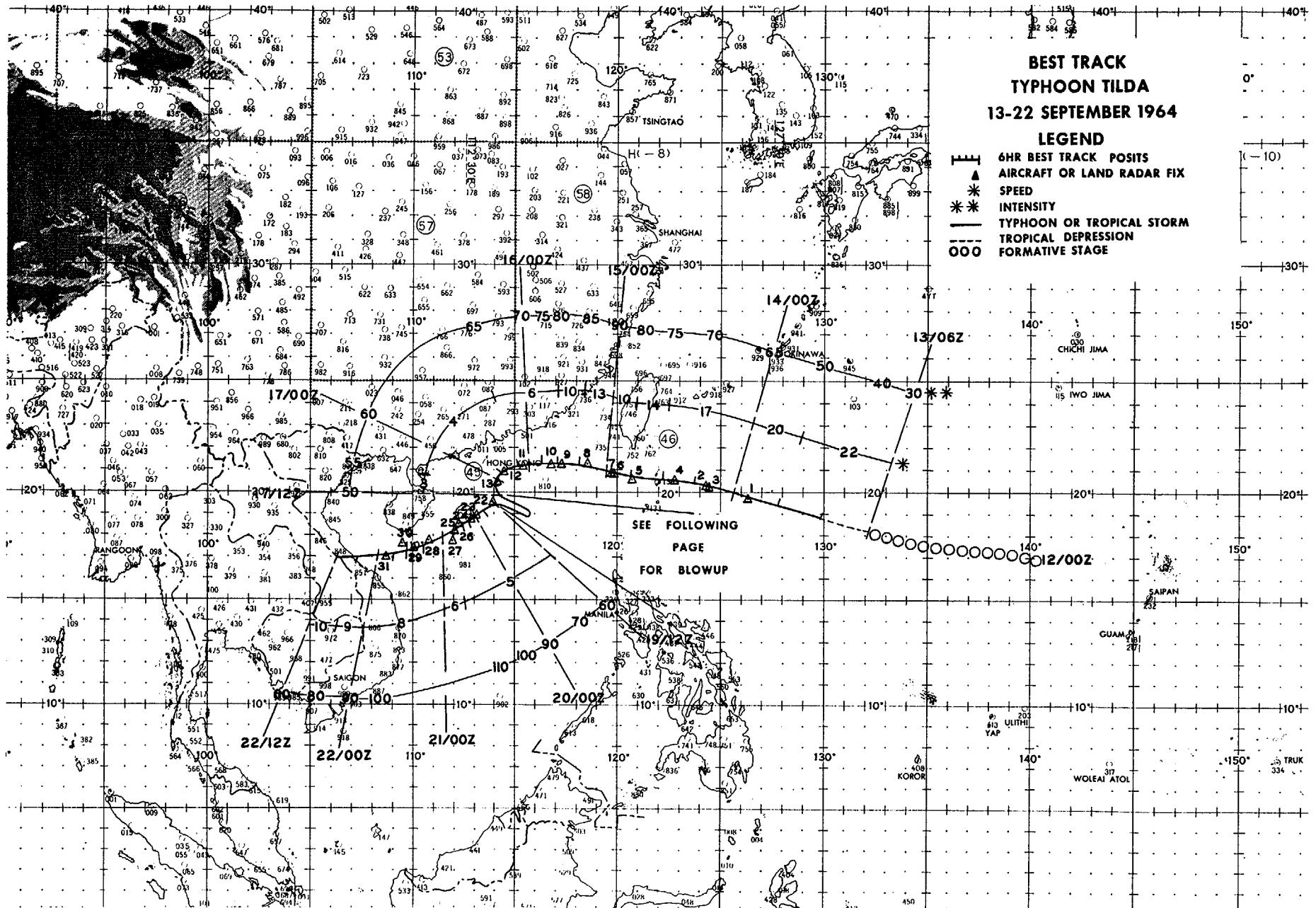
A. Dissipated over land



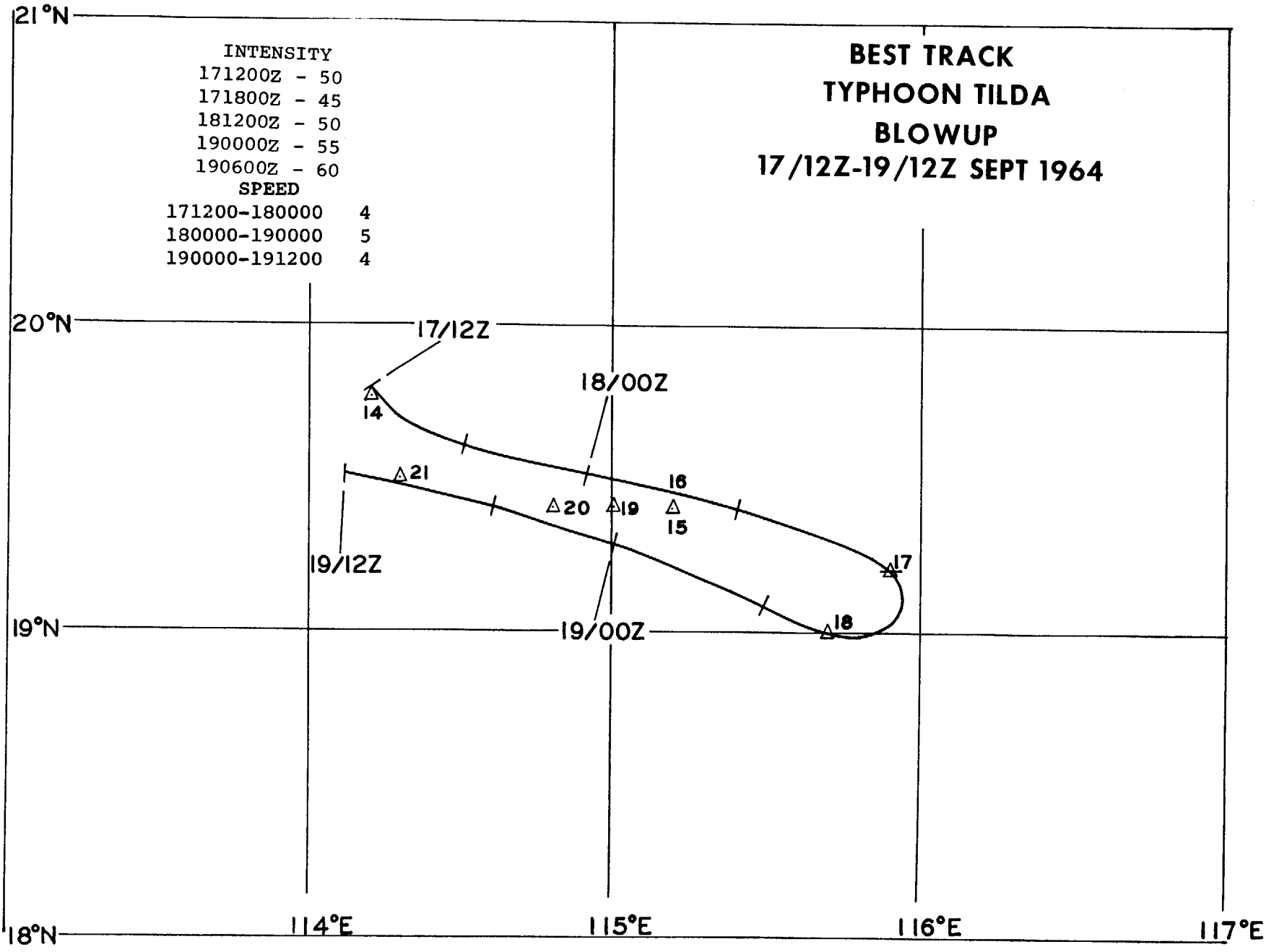
**BEST TRACK  
TYPHOON TILDA  
13-22 SEPTEMBER 1964**

**LEGEND**

- 6HR BEST TRACK POSITS
- ▲ AIRCRAFT OR LAND RADAR FIX
- \* SPEED
- \*\* INTENSITY
- TYPHOON OR TROPICAL STORM
- - - TROPICAL DEPRESSION
- OOO FORMATIVE STAGE



SEE FOLLOWING  
PAGE  
FOR BLOWUP



## EYE FIXES TYPHOON TILDA

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	132206Z	19.9N 126.2E	VW1-P-3	700ft	--	75	989	---	27/20	CIRC 14 MI DIA
2	140330Z	20.3N 124.5E	54-R-5	30000ft	--	80	---	---	--/--	OVAL 25 MI N/S 20 MI E/W
3	140400Z	20.2N 124.5E	56-P-3	704mb	65	70	990	2993	15/12	CIRC 15 MI DIA OPEN NW
4	140950Z	20.7N 122.8E	VW1-R-5	10000ft	--	--	---	---	--/--	CIRC 22 MI DIA WALL CLDS 6 MI THICK ALL QUADS
5	141615Z	20.8N 120.9E	VW1-R-5	10000ft	--	--	---	---	--/--	CIRC 20 MI DIA OPEN N WALL CLDS 5 TO 8 MI THICK
6	142138Z	20.9N 119.9E	54-R-2	30000ft	--	--	---	---	--/--	CIRC 8 MI DIA OPEN NW & SW
7	142200Z	20.9N 120.0E	56-P-6	700mb	90	150	980	2944	16/15	CIRC 15 MI DIA OPEN NE RAGGED WALL CLDS
8	150300Z	21.3N 118.6E	56-P-3	683mb	85	130	990	3033	17/14	CIRC 25 MI DIA BRKN TO NE
9	151110Z	21.3N 117.2E	VW1-R-5	11000ft	--	--	---	---	--/--	CIRC 23 MI DIA WALL CLD 7 MI THICK IN SW QUAD ONLY
10	151545Z	21.2N 116.9E	VW1-R-5	5000ft	--	--	---	---	--/--	NO RADAR EYE STORM APPEARS TO BE WEAKENING
11	160311Z	21.1N 115.5E	56-P-5	700mb	69	65	955	2990	15/13	CIRC 20 MI DIA OPEN SW WALL CLDS 6 MI THICK
12	161500Z	21.1N 114.6E	VW1-R-10	3000ft	--	--	---	---	--/--	ELLIP 51 MI NW/SE 33 MI NE/SW OPEN NW WALL CLD 12 MI THICK
13	170115Z	20.6N 114.3E	56-P-U	691mb	45	50	994	3075	15/8	NO EYE SHAPE NO WALL CLDS

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FLX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
14	171503Z	19.8N 114.2E	VW1-R-5	3000ft	--	--	---	---	--/--	ELLIP 15 MI N/S 25 MI E/W POORLY DEFINED OPEN SE
15	172210Z	19.4N 115.2E	56-P-5	708mb	40	30	993	3042	15/11	CIRC 20 MI DIA OPEN SW
16	180345Z	19.4N 115.2E	56-P-2	700mb	30	45	993	3045	16/9	CIRC 30 MI DIA WEAK WALL CLDS ALL QUADS
17	180945Z	19.2N 115.9E	VW1-P-5	1000ft	--	50	992	3018	24/17	700MB TEMP 14 EYE CIRC 15 MI DIA OPEN E
18	181521Z	19.0N 115.7E	VW1-P-5	1000ft	--	60	990	---	27/20	CIRC 34 MI DIA OPEN E WALL CLD 7 MI THICK
19	182230Z	19.4N 115.0E	56-P-5	704mb	40	35	986	3021	17/12	CIRC 5 MI DIA WALL CLD SE ONLY
20	190300Z	19.4N 114.8E	56-P-5	704mb	45	45	984	2966	15/10	CIRC
21	190930Z	19.5N 114.3E	VW1-R-5	1500ft	--	--	---	---	--/--	CIRC 5 MI DIA OPEN NE
22	191545Z	19.6N 114.0E	VW1-P-5	10000ft	--	--	---	2957	14/10	ELLIP 12 MI NW/SE 9 MI NE/ SW SOLID WALL CLD W SEMI BRKN ELSW
23	192315Z	18.8N 113.3E	56-P-5	692mb	70	45	966	2807	16/13	CIRC 12 MI DIA
24	200300Z	18.7N 113.1E	56-P-3	682mb	60	65	964	2774	17/12	CIRC 14 MI DIA
25	201015Z	18.6N 112.4E	VW1-P-5	800ft	--	130	952	---	25/18	CIRC 12 MI DIA WALL CLD 5 MI THICK
26	201530Z	18.2N 112.2E	VW1-R-5	1500ft	--	--	---	---	--/--	CIRC 12 MI DIA SMALL BREAK N WALL CLD 5 MI THICK

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
27	210305Z	17.7N 112.0E	56-R-5	700mb	--	--	---	---	--/--	CIRC 15 MI SFC WND 70 KTS 50 MI E OF CNTR
28	210625Z	17.9N 110.9E	COMMERCIAL JET-RADAR	UNK	--	--	---	---	--/--	
29	211015Z	17.5N 110.1E	VW1-R-5	1200ft	--	--	---	---	--/--	CIRC 9 MI DIA SFC WND 95 KTS 50 MI E OF CNTR
30	211530Z	17.7N 109.5E	VW1-R-3	1500ft	--	--	---	---	--/--	ELLIP 9 MI NW/SE
31	212230Z	17.1N 108.7E	56-R-10	700mb	--	--	---	---	--/--	CIRC 40 MI DIA STRONG WALL CLDS S & SE QUADS

TYPHOON TILDA 13 SEPT-22 SEPT 1964  
POSITION AND FORECAST VERIFICATION DATA

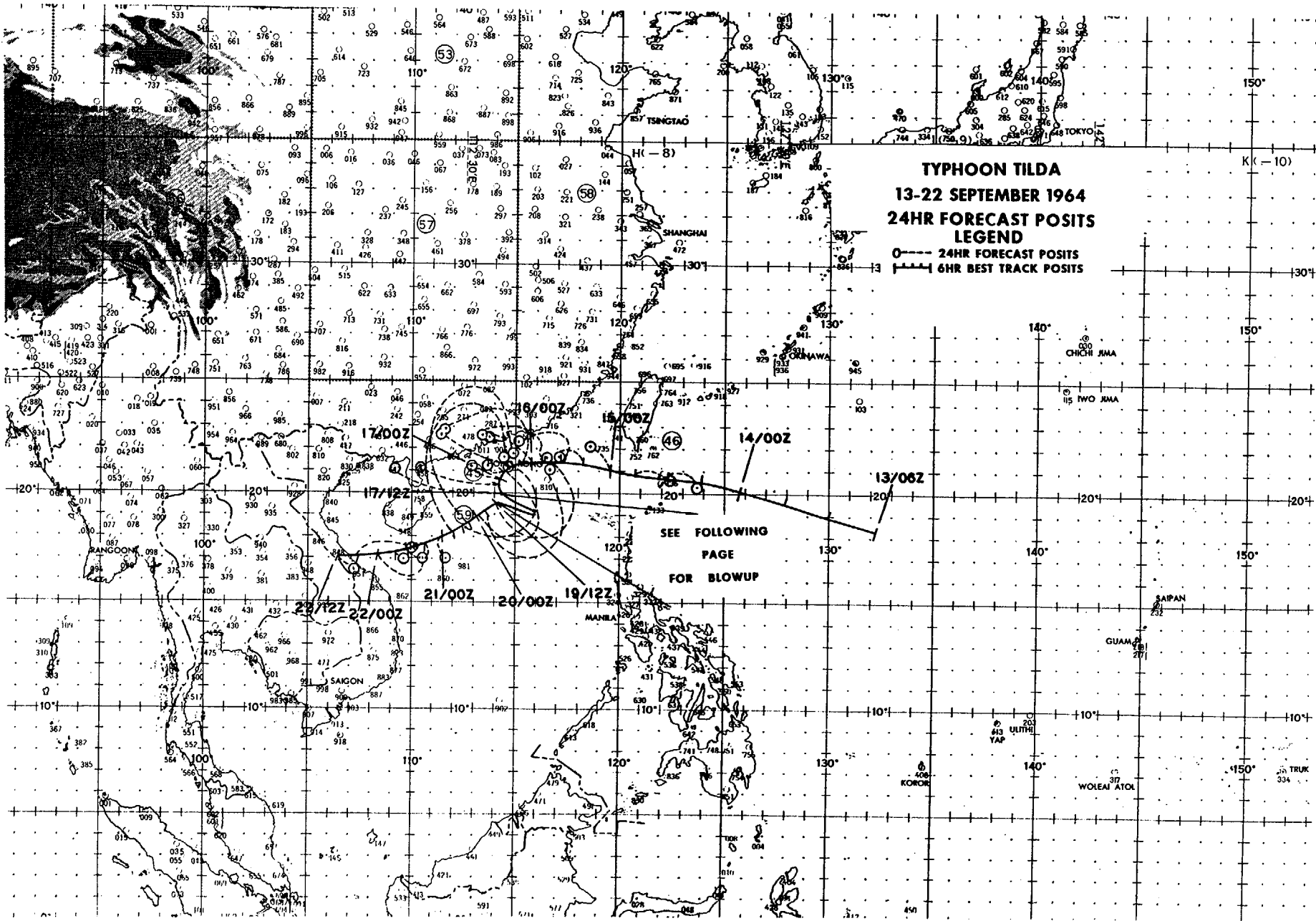
DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
130600Z	18.2N	132.3E	-----	-----
131200Z	18.4N	129.9E	-----	-----
131800Z	19.4N	127.7E	-----	-----
140000Z	20.0N	125.6E	-----	-----
140600Z	20.3N	123.8E	-----	-----
141200Z	20.7N	122.1E	106-93	-----
141800Z	20.8N	120.6E	98-102	-----
150000Z	21.0N	119.6E	325-81	-----
150600Z	21.3N	118.2E	290-65	-----
151200Z	21.3N	117.1E	300-129	064-104
151800Z	21.3N	116.5E	295-192	043-118
160000Z	21.2N	115.8E	303-136	312-237
160600Z	21.1N	115.3E	298-229	301-266
161200Z	21.1N	114.7E	297-212	308-369
161800Z	21.0N	114.4E	288-45	312-520
170000Z	20.6N	114.3E	292-88	-----
170600Z	20.3N	114.2E	283-221	-----
171200Z	19.8N	114.2E	284-297	-----
171800Z	19.6N	114.5E	294-193	299-243
180000Z	19.5N	114.9E	296-200	-----
180600Z	19.4N	115.4E	295-88	280-597
181200Z	19.2N	115.9E	304-120	280-695
181800Z	19.1N	115.5E	303-85	290-441
190000Z	19.3N	115.0E	350-156	290-333
190600Z	19.4N	114.6E	346-112	-----
191200Z	19.5N	114.1E	050-187	-----
191800Z	19.3N	113.6E	057-207	-----
200000Z	18.8N	113.3E	029-171	332-300
200600Z	18.6N	112.8E	033-222	013-394
201200Z	18.4N	112.4E	035-214	028-472
201800Z	18.2N	112.0E	034-251	030-464

TYPHOON TILDA 13 SEPT-22 SEPT 1964  
 POSITION AND FORECAST VERIFICATION DATA

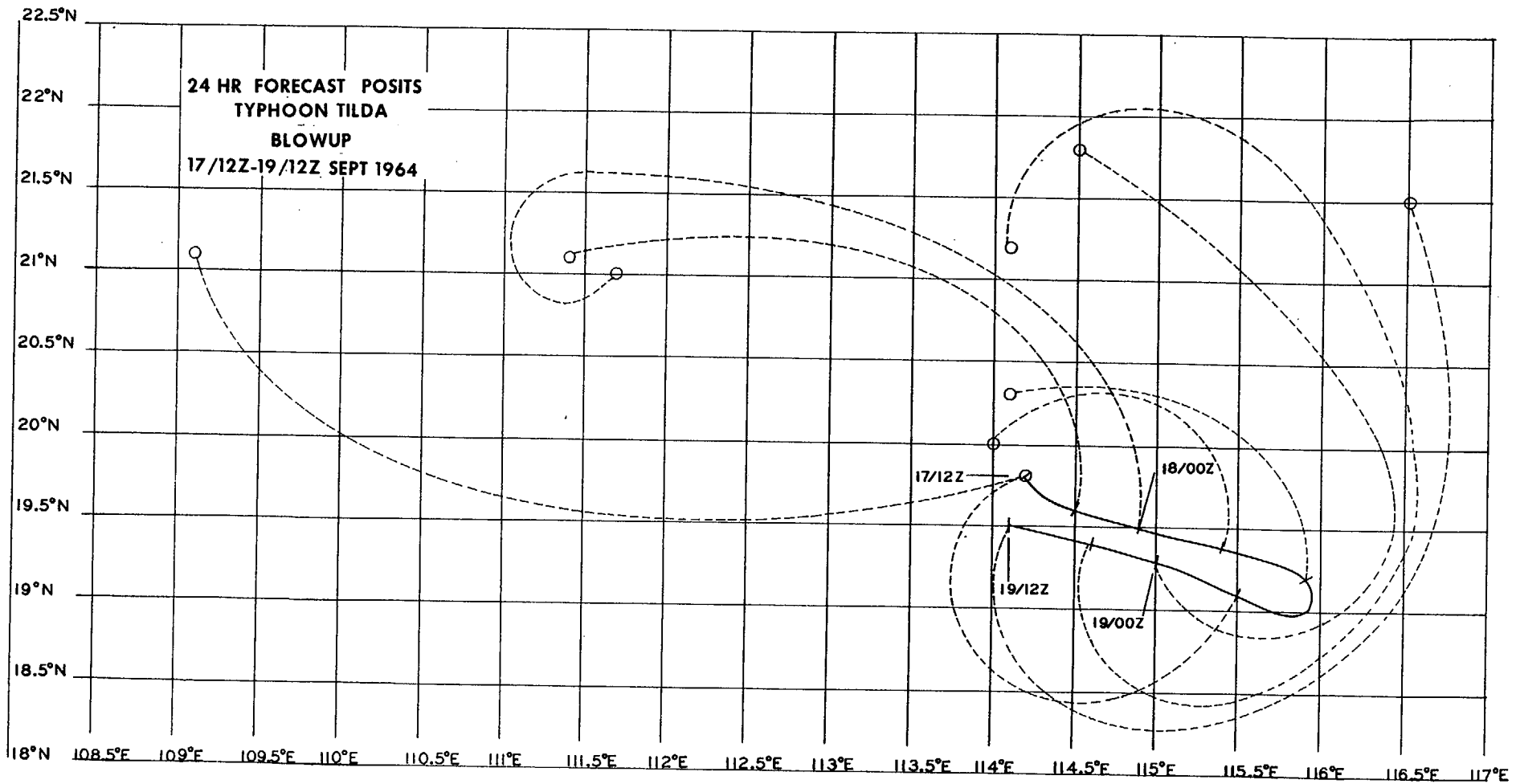
DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
210000Z	17.9N	111.4E	170-55		033-496	
210600Z	17.6N	110.6E	182-40		034-583	
211200Z	17.4N	109.8E	132-41		044-483	
211800Z	17.3N	109.1E	113-37		045-543	
220000Z	17.1N	108.3E	094-117		191-70	
220600Z	17.0N	107.3E	080-155		177-66	
221200Z	17.0N	106.3E	124-54		094-70	

AVERAGE 24 HOUR ERROR - 139MI

AVERAGE 48 HOUR ERROR - 357MI







TYPHOON VIOLET - 140000Z to 151200Z SEPTEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning - 1 3/4
2. Calendar days of typhoon intensity - 1/2
3. Total distance traveled during tropical warning period - 456 mi

B. Characteristics as a typhoon

1. Minimum SLP not observed
2. Minimum 700mb height not observed
3. Maximum surface wind - 75 kts
4. Max radius of surface circulation - 325 mi

II. DEVELOPMENT

A. Initial impetus - Increased inflow at lower levels from out-draft centered S of initial vortex and increased divergent flow at 200mb

B. Initial surface vortex

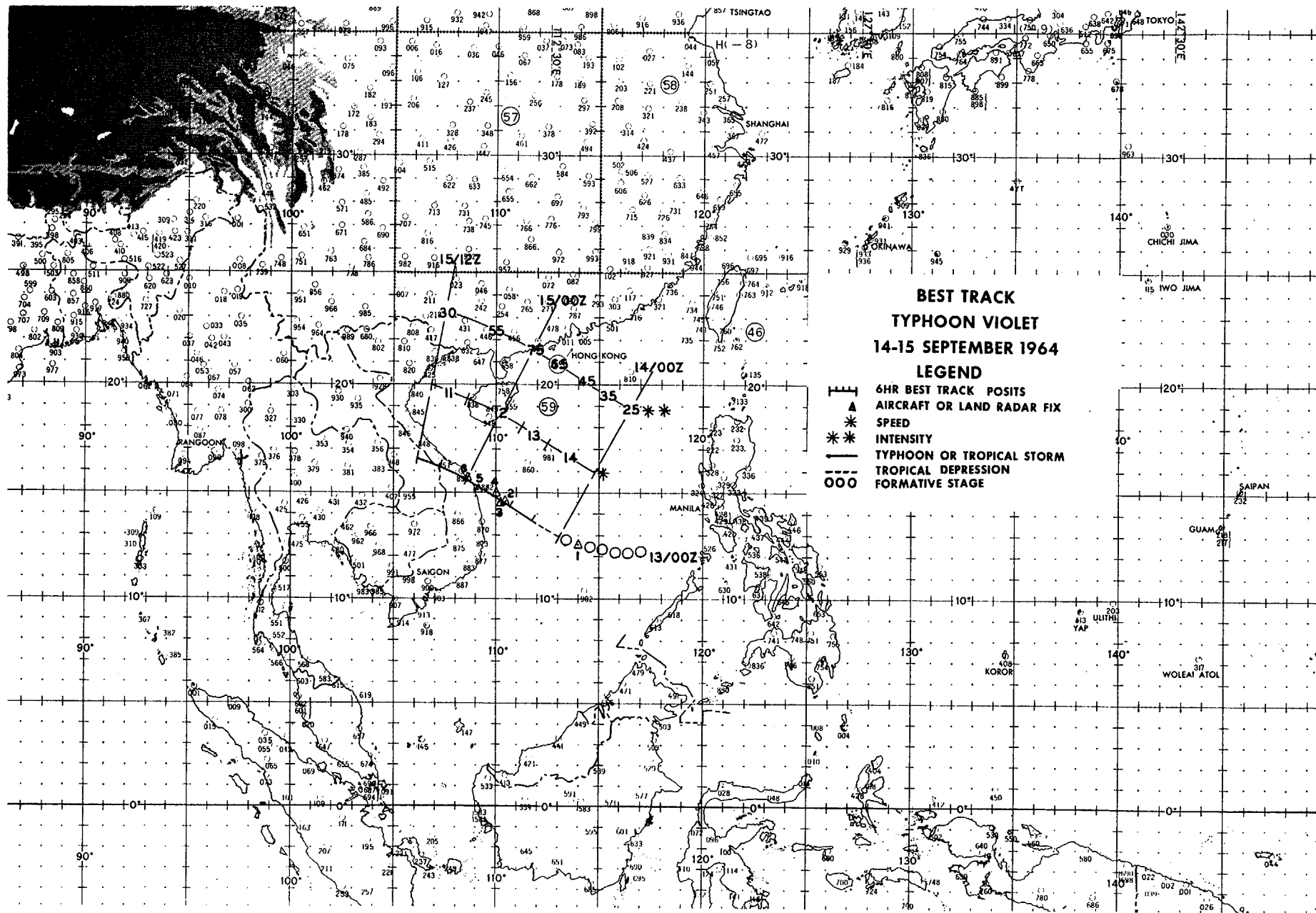
1. Junction vortex at 130000Z
2. Surface pressure less than 1006mb

C. 200mb flow above surface vortex

1. Initial - Ridge extending from anticyclone over East China Sea
2. Upon reaching typhoon intensity - E quadrant of small anticyclone

III. FINAL DISPOSITION

- A. Dissipated over land



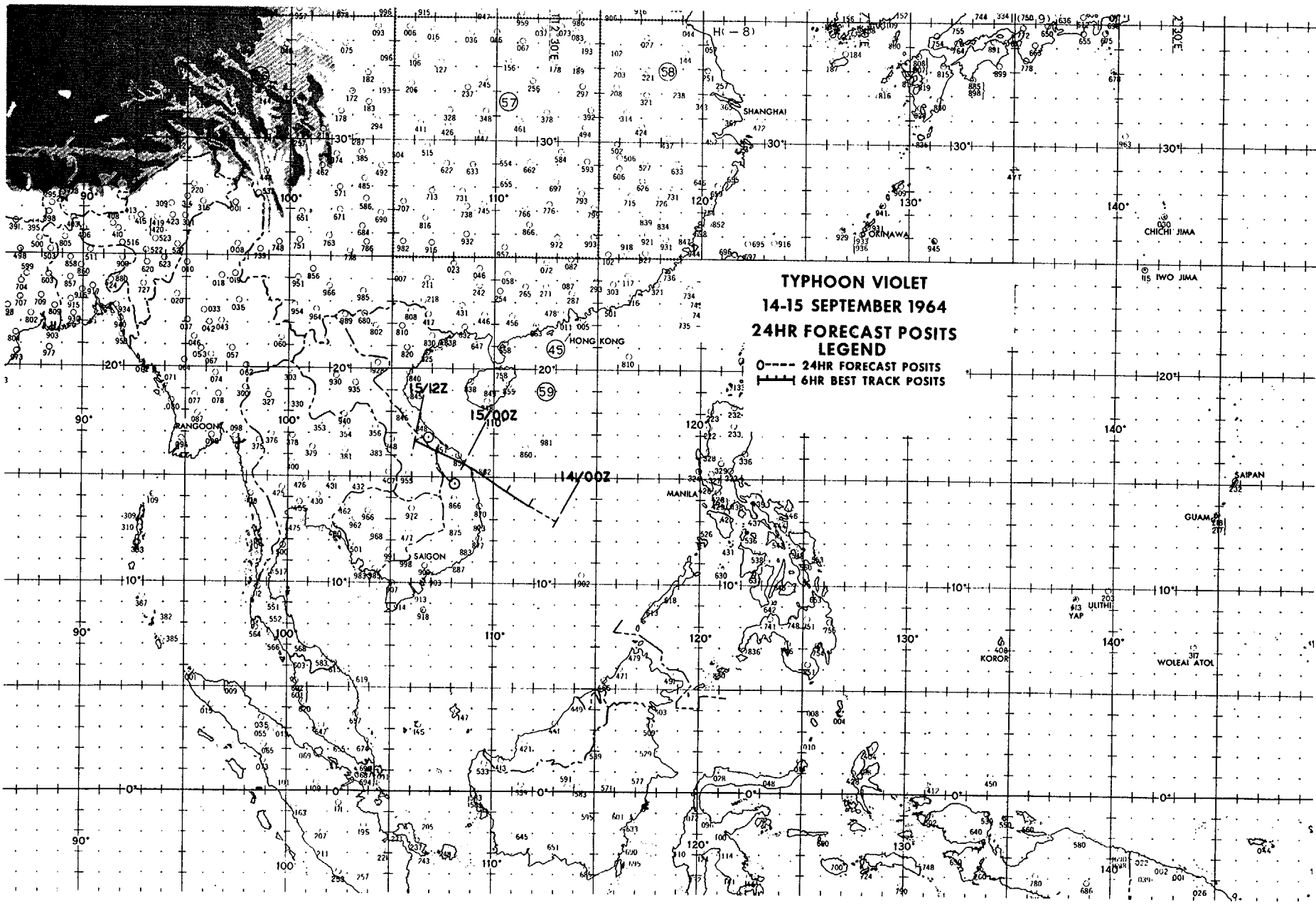
## EYE FIXES TYPHOON VIOLET

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	131930Z	12.5N 114.0E	UNK ACFT	---	---	--	---	---	--/--	EYE DIA 30 MI ILL DEFINED
2	141230Z	14.6N 110.5E	SHIP RADAR	---	---	--	---	---	--/--	HEAVY BANDS 12 & 48 MI FM CNTR EST MAX WND IN CNTR 45 KTS
3	141300Z	14.5N 110.3E	SHIP RADAR	---	---	--	---	---	--/--	SPIRAL BANDS WITH SMALL EYE AT CNTR WND 33 GUSTS TO 40 KTS 72 MI N OF CNTR
4	141730Z	15.0N 110.0E	SHIP RADAR	---	---	--	---	---	--/--	WND 30 MI FM CNTR 35 TO 45 KTS GUSTS TO 52 KTS
5	141940Z	15.2N 109.1E	VW1-R-3	1500ft	---	--	---	---	--/--	CIRC 9 MI DIA WALL CLD 5 MI THICK SFC WND 40+ KTS 70 MI NE OF EYE
6	150000Z	15.7N 108.4E	VW1-R-3	1000ft	---	--	---	---	--/--	CIRC 7 MI DIA WALL CLD 6 MI THICK SFC WND 80 KTS 30 MI NE OF EYE

TYPHOON VIOLET 14 SEPT-15 SEPT 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
140000Z	12.9N	113.0E	-----	-----
140600Z	13.6N	111.8E	-----	-----
141200Z	14.4N	110.5E	-----	-----
141800Z	15.1N	109.4E	-----	-----
150000Z	15.7N	108.3E	-----	-----
150600Z	16.2N	107.2E	145-108	-----
151200Z	16.5N	106.1E	-----	-----

AVERAGE 24 HOUR ERROR 108 MI



TYPHOON WILDA - 190600Z to 250000Z SEPTEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning -  $6\frac{1}{4}$
2. Calendar days of typhoon intensity -  $5\frac{1}{2}$
3. Total distance traveled during tropical warning period - 1578 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 905mb, 202200Z
2. Minimum observed 700mb height - 2246m, 210300Z
3. Maximum surface wind - 150 kts
4. Max radius of surface circulation - 675 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of polar trough with easterly wave and subsequent fracture

B. Initial surface vortex

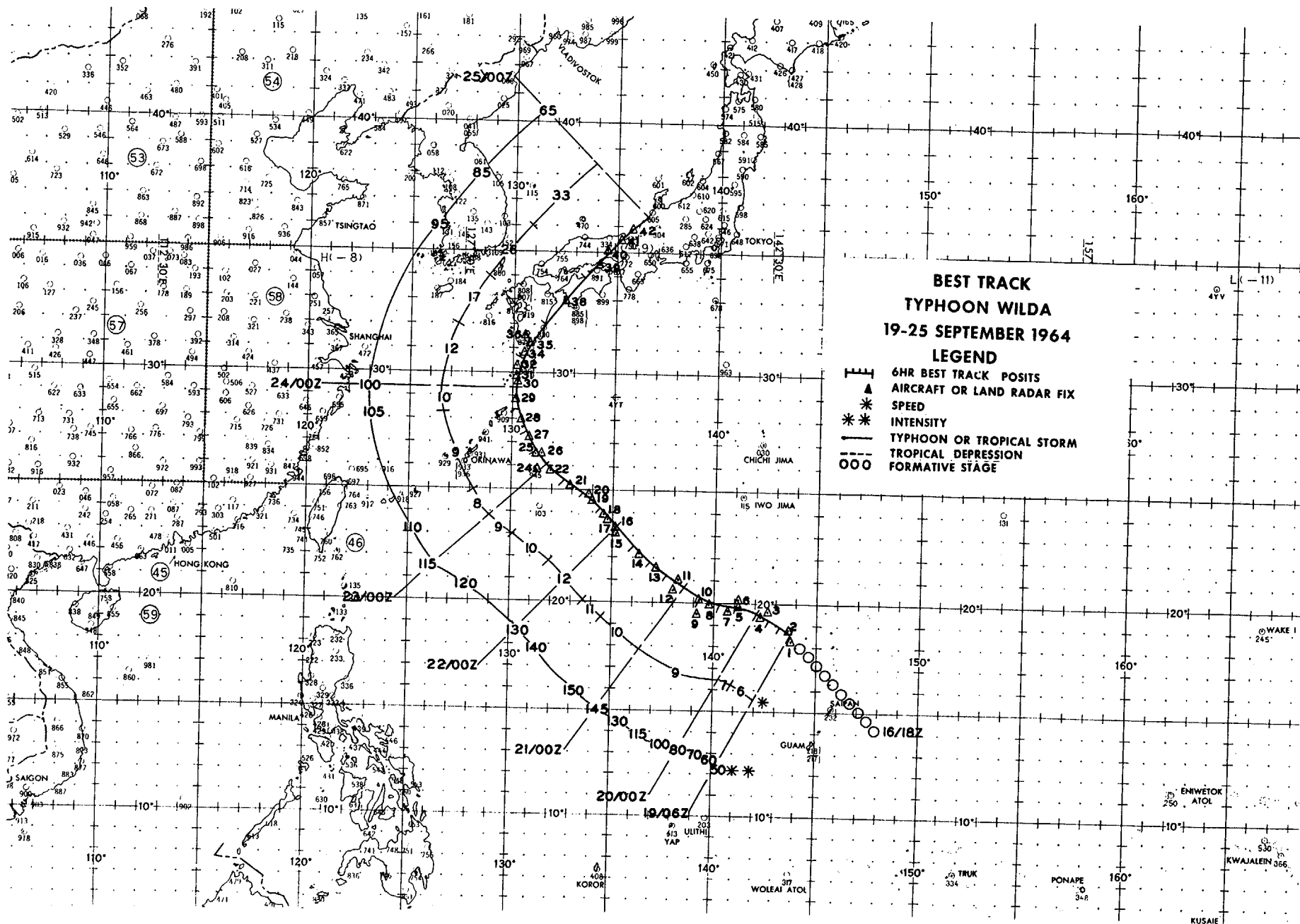
1. Junction vortex at 161800Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - NW quadrant of anticyclone
2. Upon reaching typhoon intensity - Centered under outdraft

III. FINAL DISPOSITION

A. Extratropical





## EYE FIXES TYPHOON WILDA

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	190300Z	18.2N 143.8E	54-R-5	30000ft	--	50+	---	---	----	CIRC 10 MI DIA BRKN S QUAD
2	190947Z	18.7N 143.7E	VW1-R-5	1500ft	--	--	---	---	----	CIRC 10 MI DIA
3	191630Z	19.6N 142.7E	VW1-R-5	9000ft	--	--	---	---	----	ELLIP 50 MI NE/SW 35 MI NW/SE NEG WALL CLD
4	192200Z	19.4N 142.3E	54-R-5	30000ft	--	70	---	---	----	CIRC 25 MI DIA OPEN SW QUAD
5	200400Z	19.8N 141.2E	54-R-10	30000ft	--	--	---	---	----	CIRC 30 MI DIA
6	200605Z	20.1N 141.2E	56-P-10	700mb	70	130	959	2737	16/1	CIRC 25 MI DIA WALL CLD 20 MI THICK XCP 10 MI THICK S QUAD
194 7	200900Z	19.7N 140.6E	VW1-P-5	1000ft	--	85	953	2705	22/16	OVAL 23 MI E/W 17 MI N/S WALL CLD 5-8 MI THICK 700MB TEMP 17
8	201545Z	19.9N 139.7E	VW1-R-5	10700ft	--	--	---	---	----	CIRC 16 MI DIA WALL CLD 6 MI THICK
9	202208Z	19.5N 139.1E	54-R-25	30000ft	--	85	---	---	----	CIRC 18 MI DIA WALL CLD 3 TO 5 MI THICK
10	202200Z	20.2N 139.3E	56-P-3	700mb	115	140	905	2295	24/12	CIRC 20 MI DIA WALL CLD 5 TO 7 MI THICK 3 WALL CLDS TO N
11	210300Z	21.0N 138.2E	56-P-3	700mb	--	140	---	2246	30/19	CIRC 22 MI DIA WALL CLD 5 MI THICK
12	210530Z	20.6N 138.0E	54-R-5	30000ft	--	--	---	---	----	CIRC 18 MI DIA
13	210945Z	21.6N 137.2E	VW1-R-10	1500ft	--	--	---	---	----	CIRC 15 MI DIA WALL CLD 6 MI THICK

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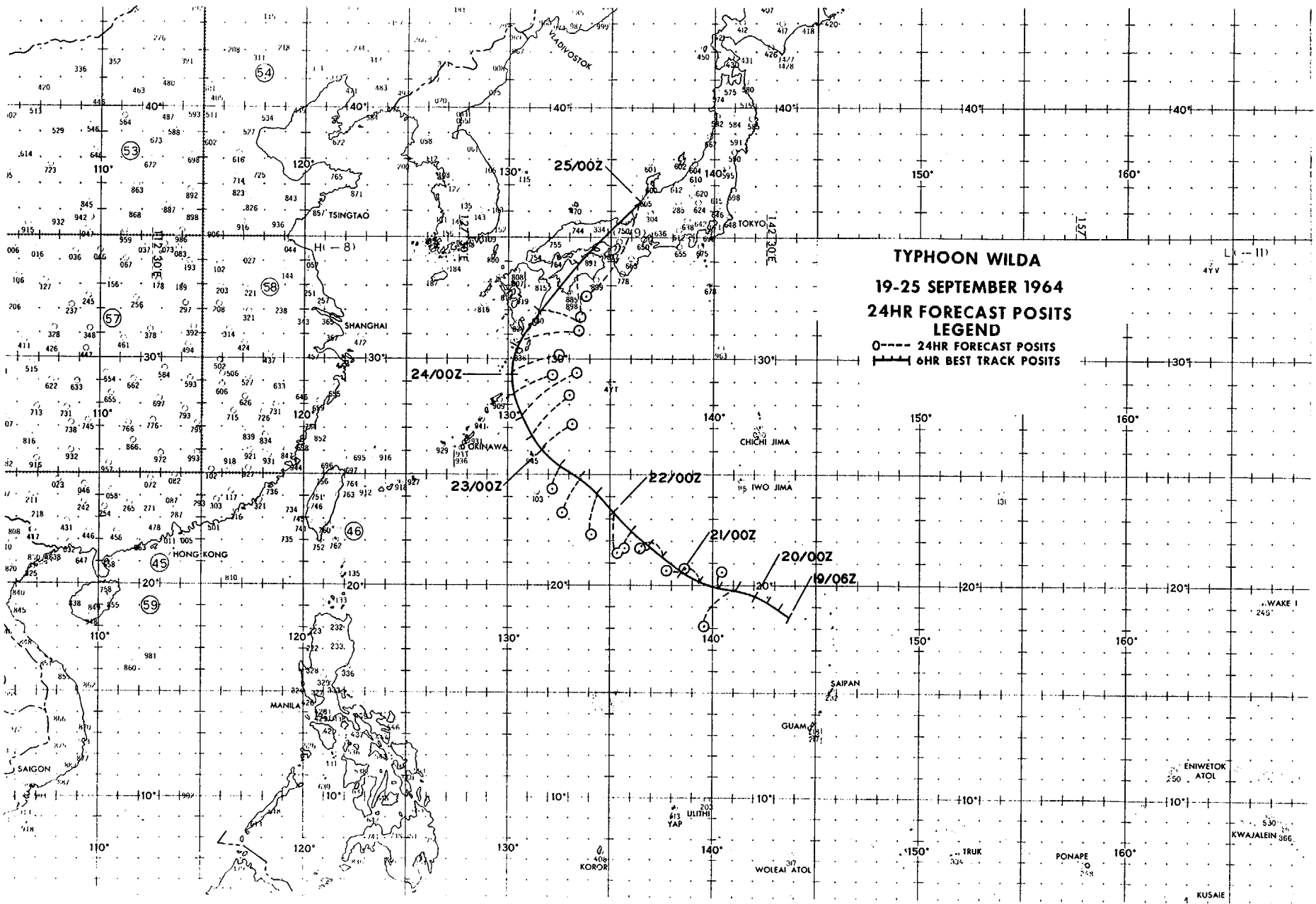
FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
14	211545Z	22.2N 136.3E	VW1-R-5	10000ft	--	--	---	---	----	CIRC 14 MI DIA WALL CLD 5 MI THICK
15	212305Z	23.1N 135.2E	54-R-10	30000ft	--	100	---	---	----	CIRC 15 MI DIA
16	212310Z	23.3N 135.2E	56-P-3	692mb	--	125	923	2405	22/17	CIRC 12 MI DIA WALL CLDS WEAK ALL QUADS
17	220300Z	23.7N 134.7E	56-P-3	700mb	--	125	923	2414	21/17	CIRC 14 MI DIA WALL CLDS WEAK ALL QUADS
18	220400Z	23.9N 134.4E	54-R-5	30000ft	--	--	---	---	----	CIRC 15 MI DIA
19	220751Z	24.5N 134.0E	TIROS	---	--	--	---	---	----	EYE VSBL
20	220945Z	24.8N 133.8E	VW1-R-3	1000ft	--	--	---	---	----	CIRC CONCENTRIC 45 MI DIA & 19 MI DIA WALL CLDS 6 TO 9 MI THICK
21	221545Z	25.2N 132.9E	VW1-R-2	10000ft	--	--	---	---	----	CIRC 38 MI DIA WEAK WALL CLDS ALL QUADS 3 MI THICK
22	222200Z	25.8N 131.9E	54-R-10	30000ft	--	--	---	---	----	OVAL 35 MI N/S 30 MI E/W WALL CLD 6 MI THICK
23	222210Z	25.9N 131.7E	56-P-2	700mb	--	85	933	2506	19/15	CIRC 40 MI DIA WALL CLD 5-7 MI THICK
24	222300Z	25.9N 131.3E	LND/RDR	---	--	--	---	---	----	
25	230355Z	26.5N 131.2E	56-P-1	700mb	--	85	935	2524	17/12	CIRC 39 MI DIA
26	230400Z	26.5N 131.4E	54-R-0	30000ft	--	100	---	---	----	CONCENTRIC, OUTER EYE OVAL 110X 90 MI INNER EYE CIRC 25 MI DIA

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
27	230945Z	27.2N 130.8E	VW1-R-1	1500ft	--	--	---	----	-----	CIRC 25 MI DIA WALL CLD 5 MI THICK SFC WND 75 KTS 100 MI W OF EYE
28	231545Z	28.0N 130.4E	VW1-R-2	3000ft	--	--	---	----	-----	CIRC 26 MI DIA WALL CLD 6 MI THICK
29	232142Z	28.9N 130.2E	54-R-1	30000ft	--	--	---	----	-----	OVAL 30X22 MI WALL CLD 4 MI THICK
30	240100Z	29.7N 130.3E	LND/RDR	---	--	--	---	----	-----	
31	240300Z	29.9N 130.2E	LND/RDR	---	--	--	---	----	-----	
32	240500Z	30.3N 130.2E	LND/RDR	---	--	--	---	----	-----	
33	240535Z	30.5N 130.3E	56-P-1	500mb	110	100	943	2609	4/1	CIRC 55 MI DIA BRKN WALL CLDS 10 MI THICK 700MB TEMP 18
34	240700Z	30.8N 130.5E	LND/RDR	---	--	--	---	----	-----	
35	240800Z	31.1N 130.8E	56-P-1	500mb	110	100	941	2610	3/0	CIRC 30 MI DIA WEAK WALL CLDS
36	240754Z	31.5N 130.5E	TIROS	---	--	--	---	----	-----	EYE VSBL
37	240945Z	31.3N 130.8E	VW1-R-3	1500ft	--	--	---	----	-----	ELLIP 30 MI NW/SE 23 MI NE/SW BCMG DIFFUSED SFC WND 75 KTS 85 MI ESE OF EYE
38	241546Z	33.1N 132.6E	VW1-R-2	11000ft	--	--	---	----	-----	CIRC 11 MI DIA VERY WEAK WALL CLDS
39	242000Z	34.5N 134.2E	LND/RDR	---	--	--	---	----	-----	
40	242100Z	35.1N 134.5E	LND/RDR	---	--	--	---	----	-----	
41	242200Z	35.5N 135.2E	LND/RDR	---	--	--	---	----	-----	
42	242300Z	36.0N 135.8E	LND/RDR	---	--	--	---	----	-----	

TYPHOON WILDA 19 SEPT-25 SEPT 1964  
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
190600Z	18.5N	143.6E	-----		-----	
191200Z	18.8N	143.2E	-----		-----	
191800Z	19.2N	142.7E	-----		-----	
200000Z	19.5N	142.0E	-----		-----	
200600Z	19.7N	141.1E	222	130	-----	
201200Z	19.9N	140.1E	028	54	-----	
201800Z	20.1N	139.4E	315	56	-----	
210000Z	20.7N	138.5E	258	44	-----	
210600Z	21.3N	137.7E	296	72	210	210
211200Z	21.8N	136.9E	239	22	225	47
211800Z	22.5N	135.9E	197	47	238	105
220000Z	23.3N	135.1E	173	116	217	120
220600Z	24.1N	134.2E	182	118	253	120
221200Z	24.9N	133.5E	205	110	218	115
221800Z	25.5N	132.4E	190	65	196	105
230000Z	26.0N	131.7E	052	165	183	180
230600Z	26.7N	131.1E	044	140	199	195
231200Z	27.5N	130.7E	050	184	212	187
231800Z	28.4N	130.3E	060	120	216	184
240000Z	29.4N	130.1E	068	132	068	255
240600Z	30.6N	130.4E	076	158	068	348
241200Z	32.0N	131.4E	101	100	072	386
241800Z	33.9N	133.5E	176	121	092	235
250000Z	36.3N	136.2E	210	253	138	136

AVERAGE 24 HOUR ERROR 110 MI  
AVERAGE 48 HOUR ERROR 183 MI



TYPHOON CLARA - 020000Z to 080600Z OCTOBER

I. DATA

A. Statistics

1. Calendar days of tropical warning - 6½
2. Calendar days of typhoon intensity - 4
3. Total distance traveled during tropical warning period - 2106 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 979mb, 060930Z
2. Minimum observed 700mb height - 2949m, 060930Z
3. Maximum surface wind - 80 kts
4. Max radius of surface circulation - 525 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of MPT

B. Initial surface vortex

1. Junction vortex at 300600Z
2. Surface pressure less than 1006mb

C. 200mb flow above surface vortex

1. Initial - NW quadrant of anticyclone
2. Upon reaching typhoon intensity - W quadrant of anticyclone

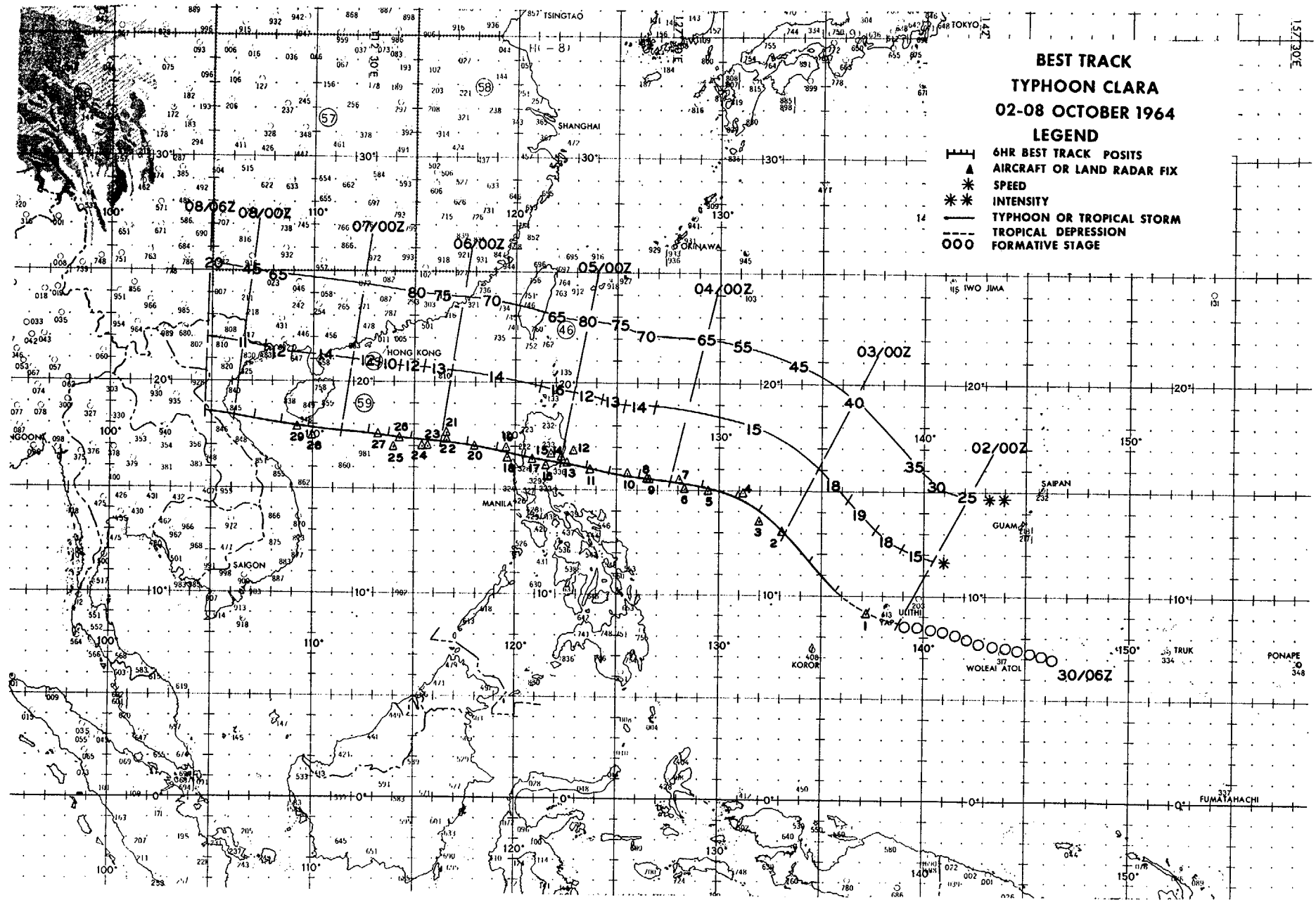
III. FINAL DISPOSITION

A. Dissipated over land

**BEST TRACK  
TYPHOON CLARA  
02-08 OCTOBER 1964  
LEGEND**

- 6HR BEST TRACK POSITS
- ▲ AIRCRAFT OR LAND RADAR FIX
- \* SPEED
- \*\* INTENSITY
- TYPHOON OR TROPICAL STORM
- - - TROPICAL DEPRESSION
- OOO FORMATIVE STAGE

200



## EYE FIXES TYPHOON CLARA

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	020600Z	09.2N 137.3E	VW1-P-U	1500ft	--	30	998	---	26/19	NO RADAR PRESENTATION
2	030030Z	13.1N 133.1E	54-V-U	30000ft	--	--	---	---	--/--	ILL DEFINED. APPROXIMATE CNTR REPORTED
3	030344Z	13.5N 132.0E	TIROS	---	--	--	---	---	--/--	
4	031039Z	14.9N 131.2E	VW1-P-5	900ft	--	--	999	---	27/24	CNTR OPEN S WALL CLD FORMING NW QUAD
5	031500Z	15.0N 129.5E	VW1-R-10	1500ft	--	--	---	---	--/--	OVAL 16 MI E/W 12 MI N/S CLSD
6	032200Z	15.1N 128.3E	56-P-2	703mb	40	65	989	3015	16/7	CIRC 15 MI DIA
7	032200Z	15.5N 128.1E	54-R-10	30000ft	--	--	---	---	--/--	CIRC 18 MI DIA WALL CLD 3 MI THICK
8	040401Z	15.6N 126.5E	54-R-3	30000ft	--	--	---	---	--/--	CIRC 10 MI DIA
9	040417Z	15.5N 126.6E	56-P-5	715mb	58	65	991	3011	15/15	OVAL 20X16 MI
10	041000Z	15.8N 125.5E	VW1-P-5	1000ft	--	60	985	---	25/16	CIRC 16 MI DIA OPEN NE SEMI WALL CLD 4-8 MI THICK
11	041545Z	16.0N 123.8E	VW1-R-5	10000ft	--	--	---	---	--/--	CIRC 17 MI DIA OPEN NE QUAD WALL CLD 7 MI THICK
12	042125Z	16.8N 122.9E	LND/RDR	---	--	--	---	---	--/--	
13	042155Z	16.3N 122.6E	54-R-0	31000ft	--	--	---	---	--/--	OVAL 18X23 MI OPEN SW QUAD WALL CLD 7 TO 10 MI THICK
14	042330Z	16.4N 122.4E	LND/RDR	---	--	--	---	---	--/--	

201

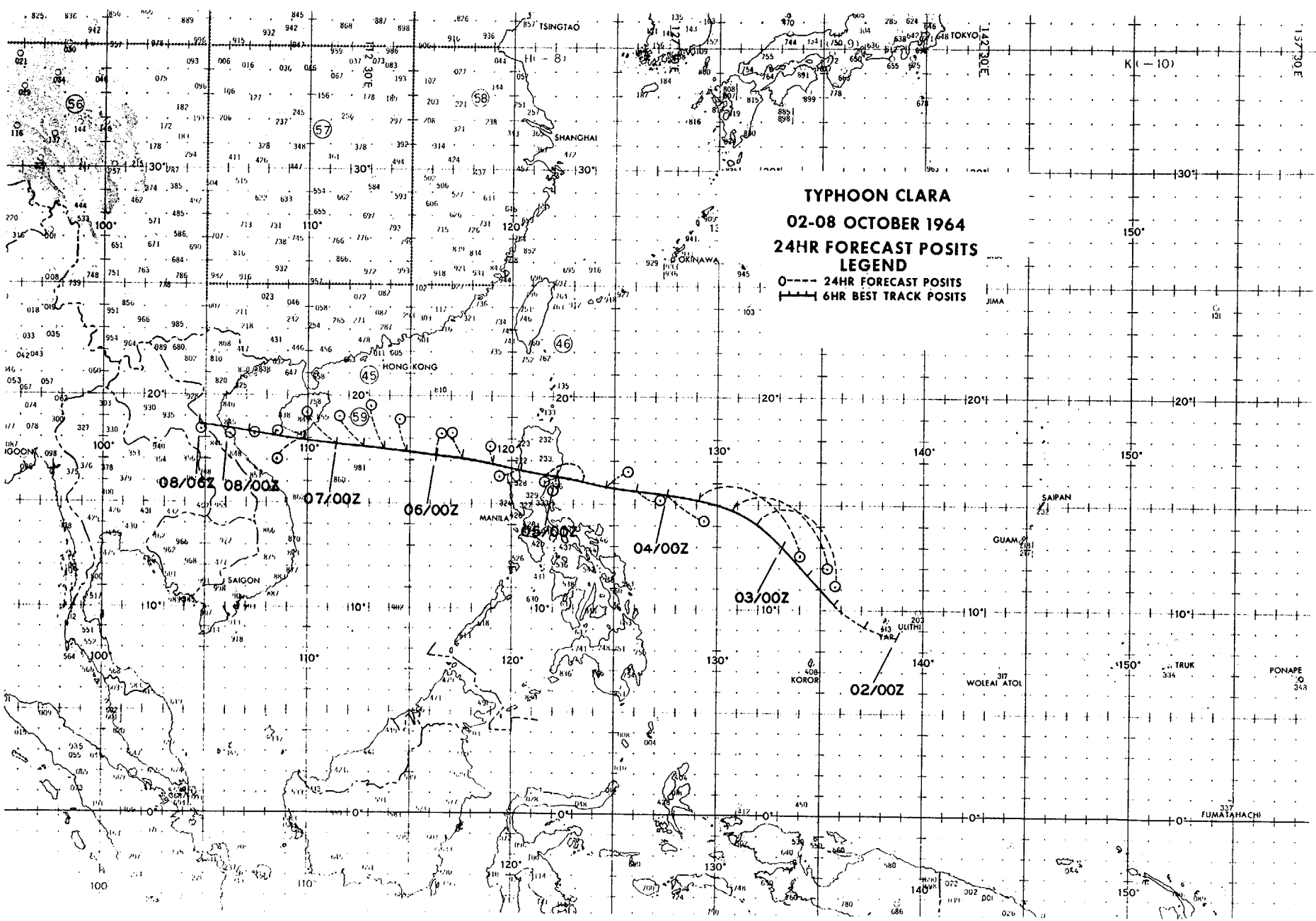


FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
15	050030Z	16.6N 121.8E	LND/RDR	---	--	--	---	---	--/--	
16	050135Z	16.3N 121.5E	LND/RDR	---	--	--	---	---	--/--	
17	050400Z	16.4N 120.9E	56-P-1	500mb	60	--	---	---	-5/-5	NO EYE SHAPE DIA 10 MI BY RDR
18	050950Z	16.5N 119.7E	56-R-2	700mb	--	--	---	---	--/--	EYE DIFFUSE 10 MI DIA
19	050935Z	17.0N 119.5E	VW1-R-2	1400ft	--	--	---	---	--/--	ELLIP 50 MI N/W 25 MI E/W NO WALL CLD
20	051545Z	17.0N 118.0E	VW1-R-3	10000ft	--	--	---	---	--/--	CIRC 35 MI DIA OPEN NW QUAD NO WALL CLD
21	052216Z	17.6N 116.6E	54-R-0	31000ft	--	45	---	---	-31/--	CIRC 40 MI DIA NO WALL CLD
22	052300Z	17.3N 116.6E	56-P-4	700mb	50	85	991	2981	11/9	CIRC 40 MI DIA WALL CLDS ALL QUADS
23	060330Z	17.0N 115.6E	56-P-2	700mb	60	75	985	2969	15/11	EYE INDEFINITE NO WALL CLDS
24	060300Z	17.0N 115.4E	54-R-5	35000ft	--	--	---	---	--/--	OVAL AREA OF NO RDR RETURN 40 MI NE/SW 30 MI NW/SE
25	060438Z	17.0N 114.0E	TIROS	---	--	--	---	---	--/--	
26	060930Z	17.3N 114.3E	VW1-P-5	900ft	--	80	979	2949	25/16	CNTR ELLIP 20 MI E/W 35 MI N/S NO WALL CLD 700MB TEMP 12
27	061530Z	17.5N 113.2E	VW1-R-5	10000ft	--	--	---	---	--/--	CNTR OVAL 27 MI E/W 19 MI N/S
28	070350Z	17.5N 110.0E	TIROS	---	--	--	---	---	--/--	
29	070840Z	17.9N 109.1E	LND/RDR	---	--	--	---	---	--/--	

TYPHOON CLARA 02 OCT-08 OCT 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
020000Z	08.7N	138.8E	-----	-----
020600Z	09.2N	137.3E	-----	-----
021200Z	10.3N	135.8E	-----	-----
021800Z	11.6N	134.4E	-----	-----
030000Z	12.9N	133.2E	-----	-----
030600Z	14.0N	132.1E	-----	-----
031200Z	14.8N	130.8E	122-316	-----
031800Z	15.2N	129.2E	118-317	
040000Z	15.3N	127.7E	119-124	-----
040600Z	15.6N	126.1E	112-68	-----
041200Z	15.8N	124.7E	055-70	112-428
041800Z	16.1N	123.4E	269-102	113-427
050000Z	16.3N	122.2E	193-47	110-154
050600Z	16.5N	120.5E	258-60	114-117
051200Z	16.9N	119.1E	353-51	109-66
051800Z	17.1N	117.7E	337-80	263-110
060000Z	17.2N	116.3E	021-68	154-22
060600Z	17.3N	114.9E	353-100	268-112
061200Z	17.4N	113.8E	345-125	347-143
061800Z	17.5N	112.8E	322-112	336-202
070000Z	17.7N	111.4E	321-122	353-183
070600Z	17.8N	109.9E	240-97	353-247
071200Z	18.0N	108.4E	042-12	328-158
071800Z	18.2N	107.2E	090-13	307-127
080000Z	18.4N	106.1E	148-08	295-144
080600Z	18.5N	104.9E	-----	-----

AVERAGE 24 HOUR ERROR - 100MI  
 AVERAGE 48 HOUR ERROR - 176MI



704

TYPHOON DOT - 060600Z to 131200Z OCTOBER

I. DATA

A. Statistics

1. Calendar days of tropical warning -  $7\frac{1}{2}$
2. Calendar days of typhoon intensity -  $4\frac{1}{4}$
3. Total distance traveled during tropical warning period - 1734 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 976mb, 120300Z
2. Minimum observed 700mb height - 2902m, 120300Z
3. Maximum surface wind - 90 kts
4. Max radius of surface circulation - 400 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of Polar Trough with easterly wave and subsequent fracture

B. Initial surface vortex

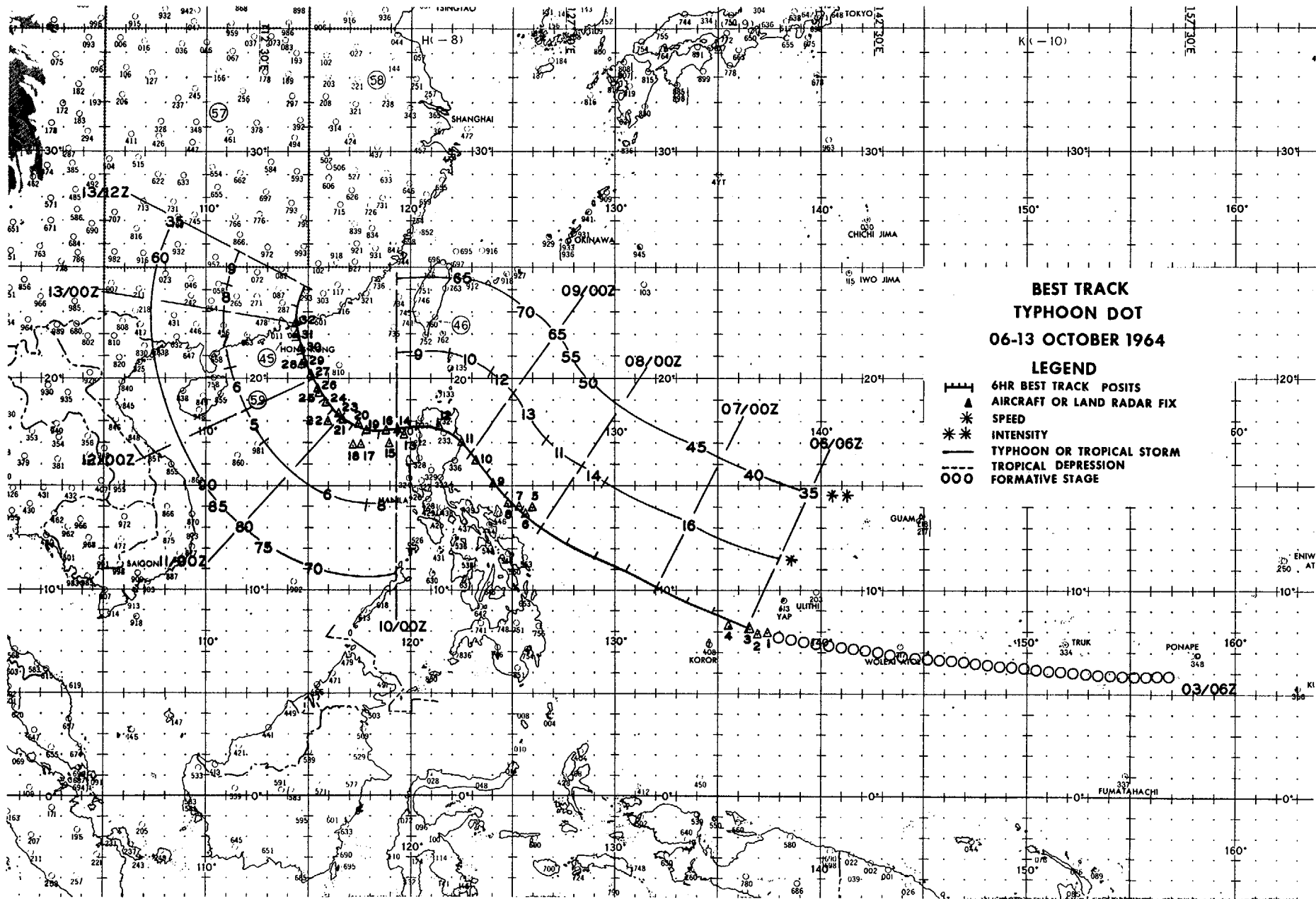
1. Junction vortex at 030600Z
2. Surface pressure less than 1006mb

C. 200mb flow above surface vortex

1. Initial - N of E-W ridge
2. Upon reaching typhoon intensity - E quadrant of anticyclone

III. FINAL DISPOSITION

A. Dissipated over land



**BEST TRACK  
TYPHOON DOT  
06-13 OCTOBER 1964**

**LEGEND**

- 6HR BEST TRACK POSITS
- AIRCRAFT OR LAND RADAR FIX
- SPEED
- INTENSITY
- TYPHOON OR TROPICAL STORM
- TROPICAL DEPRESSION
- FORMATIVE STAGE

## EYE FIXES TYPHOON DOT

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	060230Z	08.0N 137.3E	VW1-P-U	1500ft	--	20	997	---	22/20	WND CIRCULATION COMPLETE NO RDR CENTER
2	061006Z	08.0N 137.0E	VW1-R-10	1500ft	--	--	---	---	----	POOR RDR PRESENTATION
3	061600Z	08.2N 136.7E	VW1-R-25	3000ft	--	--	---	---	----	ESTIMATED CNTR. NO EYE PRESENTATION
4	070400Z	08.3N 135.5E	54-R-U	30000ft	--	--	---	---	----	ESTIMATED CNTR. NO EYE FOUND
5	080258Z	14.0N 126.0E	TIROS	---	--	--	---	---	----	
6	080400Z	13.6N 125.6E	56-P-3	700mb	30	35	995	3097	----	OVAL 10 MI N/S 5 MI E/W
7	080406Z	14.0N 125.4E	54-R-0	33000ft	--	40	---	---	----	NO EYE
8	080930Z	14.1N 124.9E	VW1-P-2	1000ft	--	50	996	---	--/17	OVAL 11 MI NE/SW 7 MI NW/SE
9	081545Z	15.2N 124.1E	VW1-P-3	9000ft	--	--	---	3074	22/--	SECONDARY CNTR 160/30 MI
10	082220Z	16.3N 123.3E	56-P-2	700mb	30	65	990	3005	12/10	CIRC 70 MI DIA OPEN N & NE QUADS
11	090300Z	17.1N 122.6E	56-P-2	700mb	50	80	988	2997	12/11	CIRC 40 MI DIA STRONGEST E QUAD
12	090945Z	17.8N 121.5E	VW1-R-3	10000ft	--	--	---	---	----	CIRC 12 MI DIA OPEN NW DIFFUSE
13	091620Z	17.4N 119.8E	VW1-R-10	10000ft	--	--	---	---	----	CNTR DIFFUSE. NO WALL CLD
14	092320Z	17.7N 119.3E	56-P-1	700mb	30	45	995	3024	11/10	CIRC OPEN SE & NW
15	100259Z	17.0N 119.0E	TIROS	---	--	--	---	---	----	RAGGED EYE VSBL

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
16	100300Z	17.7N 118.8E	56-P-2	700mb	45	65	994	3018	12/11	CIRC 80 MI DIA OPEN W
17	100100Z	17.0N 117.6E	SHIP RDR	---	--	--	---	---	----	
18	100300Z	17.0N 117.3E	SHIP RDR	---	--	--	---	---	----	
19	100940Z	17.6N 117.9E	VW1-P-3	1000ft	--	80	988	---	24/20	CIRC 80 MI DIA
20	101545Z	17.9N 117.5E	VW1-R-10	10000ft	--	--	---	---	----	ELLIP 68 MI NW/SE 48 MI NE/SW
21	102200Z	18.1N 116.7E	56-P-4	700mb	30	--	984	2960	13/10	CIRC 40 MI DIA OPEN NE
22	110208Z	18.0N 116.0E	TIROS	---	--	--	---	---	----	SMALL EYE DISCERNABLE
23	110300Z	18.3N 116.6E	56-P-10	700mb	50	100	984	2960	15/10	CIRC 80 MI DIA OPEN W
24	111000Z	18.8N 115.9E	VW1-R-5	5000ft	--	--	---	---	----	CIRC 46 MI DIA WALL CLD 27 MI THICK. EYE ROTATING RAPIDLY CCW
25	111530Z	19.4N 115.5E	VW1-R-5	10000ft	--	--	---	---	----	CIRC 50 MI DIA
26	112210Z	19.4N 115.5E	56-P-2	675mb	60	--	980	2914	13/11	CIRC 40 MI DIA OPEN W & N QUADS
27	120300Z	20.2N 115.2E	56-P-2	674mb	55	90	976	2902	17/9	CIRC 80 MI DIA WEAK N QUAD
28	120800Z	20.7N 114.8E	SHIP RDR	---	--	--	---	---	----	
29	120945Z	20.9N 114.9E	VW1-R-5	1200ft	--	--	---	---	----	CIRC 58 MI DIA WALL CLD 10 MI THICK
30	121545Z	21.5N 114.7E	VW1-R-2	350ft	--	--	---	---	----	CIRC 55 MI DIA WALL CLD 5 MI THICK
31	122230Z	22.2N 114.5E	56-R-3	700mb	--	--	---	---	----	CIRC 35 MI DIA
32	130211Z	22.5N 114.5E	TIROS	---	--	--	---	---	----	EYE VSBL

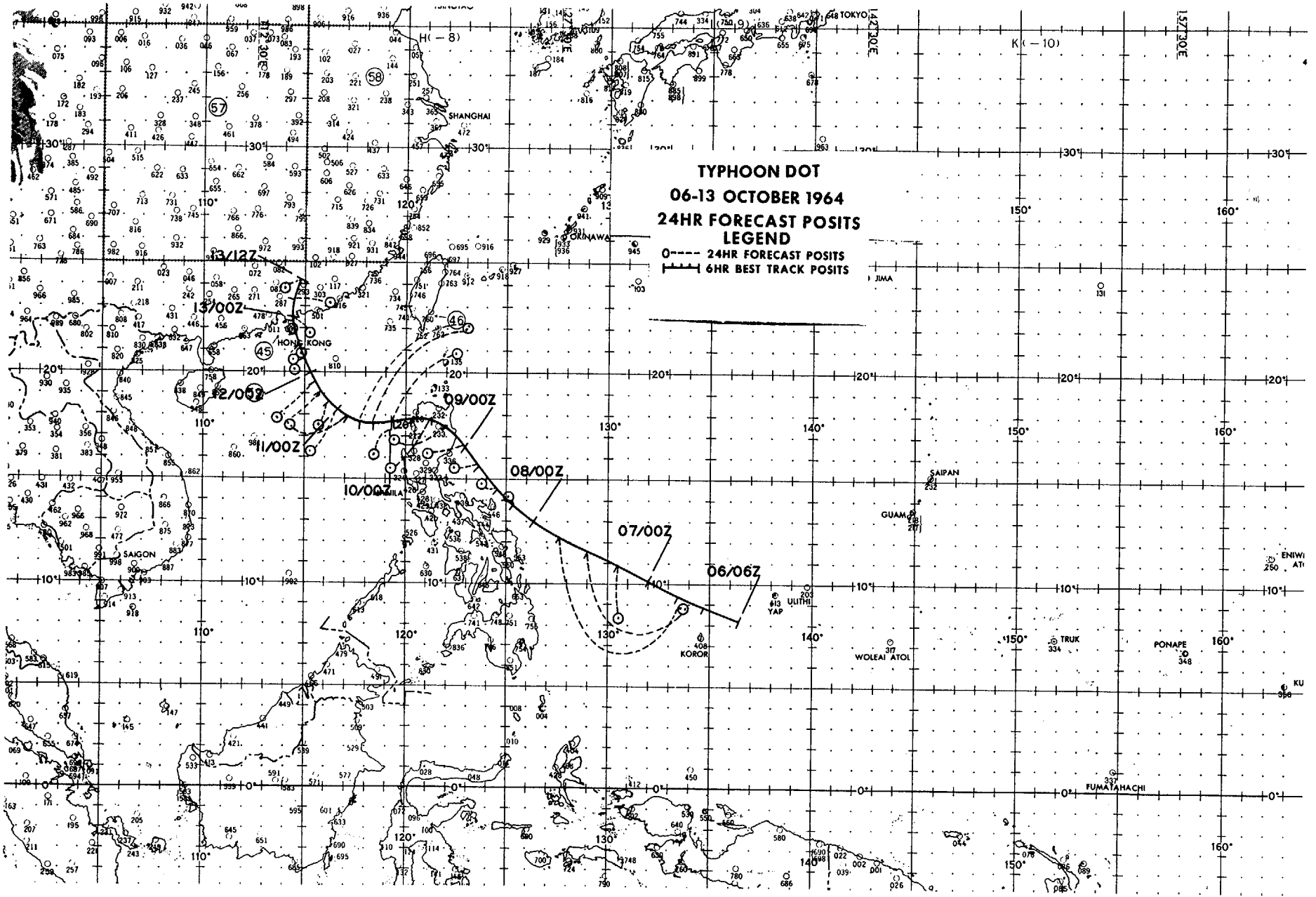
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TYPHOON DOT 06 OCT-13 OCT 1964  
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
060600Z	08.3N	136.4E	-----	-----
161200Z	08.8N	134.9E	-----	-----
061800Z	09.5N	133.4E	-----	-----
070000Z	10.2N	132.0E	-----	-----
070600Z	10.9N	130.5E	181-162	-----
071200Z	11.6N	129.0E	121-327	-----
071800Z	12.4N	127.6E	121-408	-----
080000Z	13.1N	126.3E	-----	-----
080600Z	13.8N	125.4E	318-23	188-231
081200Z	14.5N	124.6E	292-49	134-318
081800Z	15.6N	123.8E	266-82	136-398
090000Z	16.6N	123.0E	257-117	-----
090600Z	17.4N	122.1E	258-162	255-133
091200Z	17.8N	121.2E	217-187	262-164
091800Z	17.7N	120.2E	225-140	275-172
100000Z	17.7N	119.3E	044-268	287-190
100600Z	17.6N	118.4E	045-375	291-235
101200Z	17.7N	117.8E	049-408	243-258
101800Z	17.9N	117.2E	259-158	253-240
110000Z	18.2N	116.7E	214-147	053-772
110600Z	18.6N	116.2E	208-75	055-950
111200Z	19.0N	115.8E	225-130	058-907
111800Z	19.4N	115.5E	227-141	251-374
120000Z	19.9N	115.3E	281-50	233-379
120600Z	20.5N	115.0E	313-27	227-274
121200Z	21.2N	114.8E	203-42	237-400
121800Z	21.8N	114.6E	310-20	235-409
130000Z	22.5N	114.5E	133-57	309-118
130600Z	23.3N	114.6E	093-98	346-87
131200Z	24.2N	114.8E	251-48	282-55

AVERAGE 24 HOUR ERROR 148 MI  
AVERAGE 48 HOUR ERROR 336 MI





**TYPHOON DOT**  
**06-13 OCTOBER 1964**  
**24HR FORECAST POSITS**  
**LEGEND**  
○--- 24HR FORECAST POSITS  
—— 6HR BEST TRACK POSITS

13/12Z

13/00Z

12/00Z

11/00Z

10/00Z

08/00Z

07/00Z

06/06Z

120°E

K(-10)

157°E

30°N

130°

150°

160°

20°N

120°

150°

160°

10°N

120°

150°

160°

0°

160°

H(-8)

SHANGHAI

TOKYO

OSAKA

HONG KONG

SAIGON

SAIPAN

GUAM

ENIWI ATI

ULITHI

WOLEAI ATOL

TRUK

PONAPE

KU

FUMATAHACHI

KOROR

IRIAN JAYA

PHILIPPINES

INDONESIA

VIETNAM

CHINA

JAPAN

SEA OF JAPAN

100°E

110°E

120°E

130°E

140°E

150°E

160°E

170°E

180°E

190°E

200°E

210°E

220°E

230°E

240°E

250°E

260°E

270°E

280°E

30°N

35°N

40°N

45°N

50°N

55°N

60°N

65°N

70°N

75°N

80°N

85°N

90°N

95°N

100°N

105°N

110°N

115°N

120°N

TYPHOON HOPE - 231800Z to 291800Z OCTOBER

I. DATA

A. Statistics

1. Calendar days of tropical warning - 6
2. Calendar days of typhoon intensity - 1 3/4
3. Total distance traveled during tropical warning period - 2088 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 973mb, 280400Z
2. Minimum observed 700mb height - 2883m, 280400Z
3. Maximum surface wind - 130 kts
4. Max radius of surface circulation - 650 mi

II. DEVELOPMENT

A. Initial impetus - Increased inflow at lower levels due to tightening of gradient N and increased divergent flow at 200mb

B. Initial surface vortex

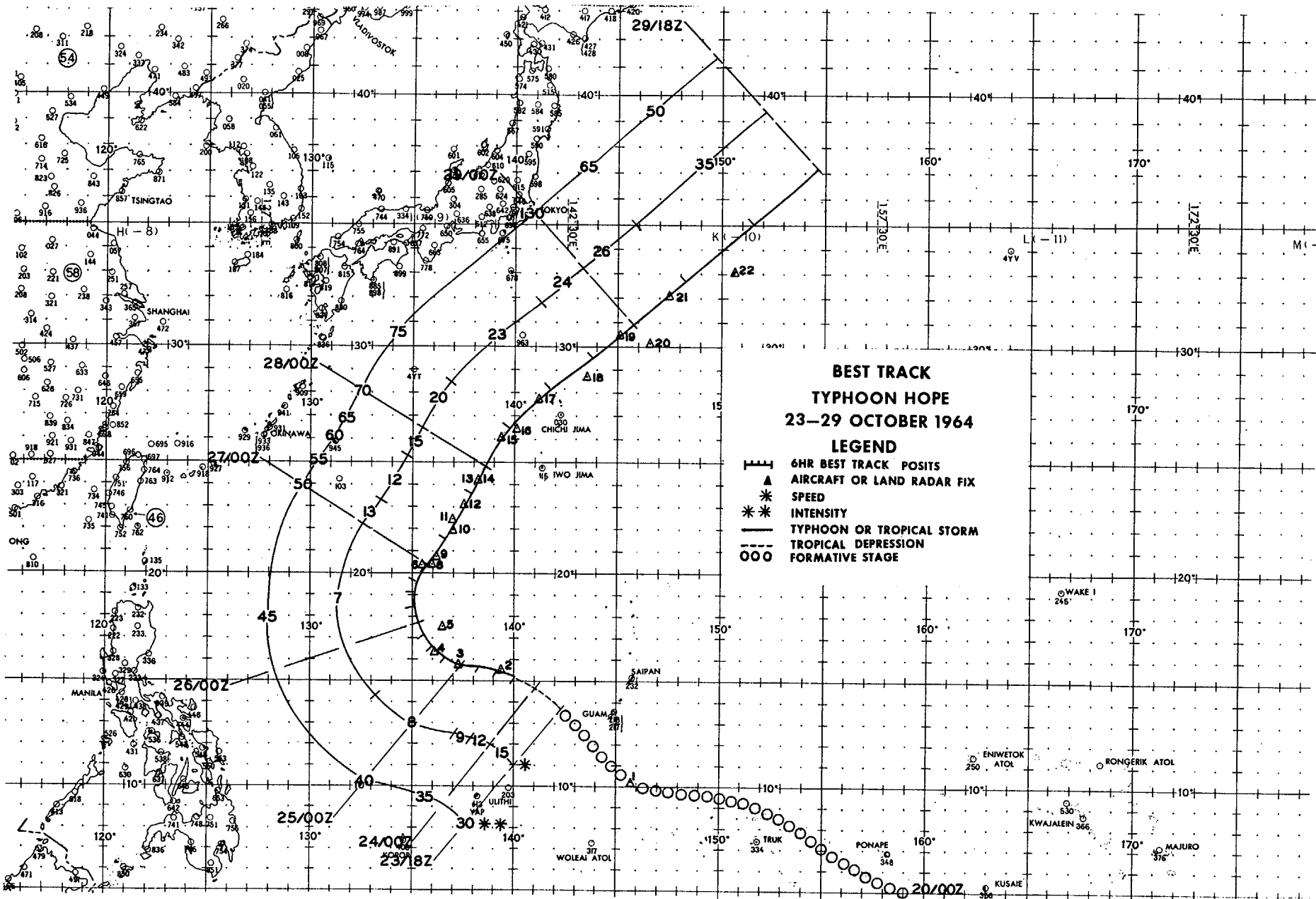
1. Junction vortex at 200000Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

1. Initial - SW quadrant of anticyclone
2. Upon reaching typhoon intensity - N quadrant of anticyclone

III. FINAL DISPOSITION

A. Extratropical



Map showing the best track of Typhoon Hope from October 20 to 29, 1964. The map covers the Western Pacific region from 120°E to 175°E and 10°N to 40°N. It includes the coastlines of Japan, the Philippines, and Micronesia. The typhoon track is shown as a series of connected points and lines, with intensity levels (1-75) and stages (002, 18Z, 17Z, 12Z, 07Z) labeled along the path. A legend in the lower right explains the symbols used for track positions, fixes, speed, intensity, and storm stages.

## EYE FIXES TYPHOON HOPE

FIX NO.	TIME	POSIT	UNIT METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	222200Z	10.2N 145.9E	56-P-2	1500ft	--	12	1003	---	26/26	NO WALL CLDS. MULTIPLE CALM CNTRS
2	240950Z	15.5N 139.4E	VW1-P-25	1500ft	--	--	1002	---	--/--	NO RDR PRESENTATION CNTR EST FM PRESSURES
3	250530Z	15.8N 137.3E	56-P-2	677mb	20	25	1000	3079	11/11	NO DEFINITE EYE
4	251030Z	16.4N 136.1E	VW1-P-15	1000ft	--	23	999	---	--/--	NO WND OR RDR CNTRS
5	260450Z	17.5N 136.5E	56-P-3	689mb	25	15	996	3045	9/6	NO DEFINITE SFC CNTR SFC WND LGT/VRBL RADIUS 50 MI
6	262205Z	20.4N 135.5E	54-R-3	30000ft	--	35	---	---	-30/--	CNTR DETERMINED BY CONVERGING SPIRAL BANDS
7	262210Z	20.4N 135.6E	56-P-1	707mb	25	25	994	3063	15/10	CIRC 10 MI DIA NO WALL CLDS
8	270300Z	20.4N 136.0E	56-P-1	708mb	25	30	999	3066	16/9	CIRC 10 MI DIA NO WALL CLDS
9	270522Z	20.7N 136.2E	54-R-0	30000ft	--	--	---	---	--/--	NO WALL CLDS CNTR DETERMINED BY CONVERGING SPIRAL BANDS
10	270851Z	22.0N 137.0E	VW1-P-5	1000ft	--	55	983	---	27/21	ELLIP NW/SE 16 MI DIA OPEN NE
11	271010Z	22.4N 137.0E	VW1-R-5	1500ft	--	--	---	---	--/--	OVAL 23 MI E/W 13 MI N/S
12	271545Z	23.2N 137.6E	VW1-R-5	5000ft	--	--	---	---	--/--	CIRC 16 MI DIA OPEN N & S
13	272200Z	24.3N 138.3E	56-P-5	700mb	50	50	979	2932	18/12	CIRC 30 MI DIA OPEN W
14	272209Z	24.3N 138.3E	54-R-5	30000ft	30	60	---	---	--/--	CIRC 16 MI DIA WALL CLD 4 MI THICK
15	280400Z	26.1N 139.3E	56-P-5	681mb	60	70	973	2883	20/6	CIRC 40 MI DIA OPEN E & W

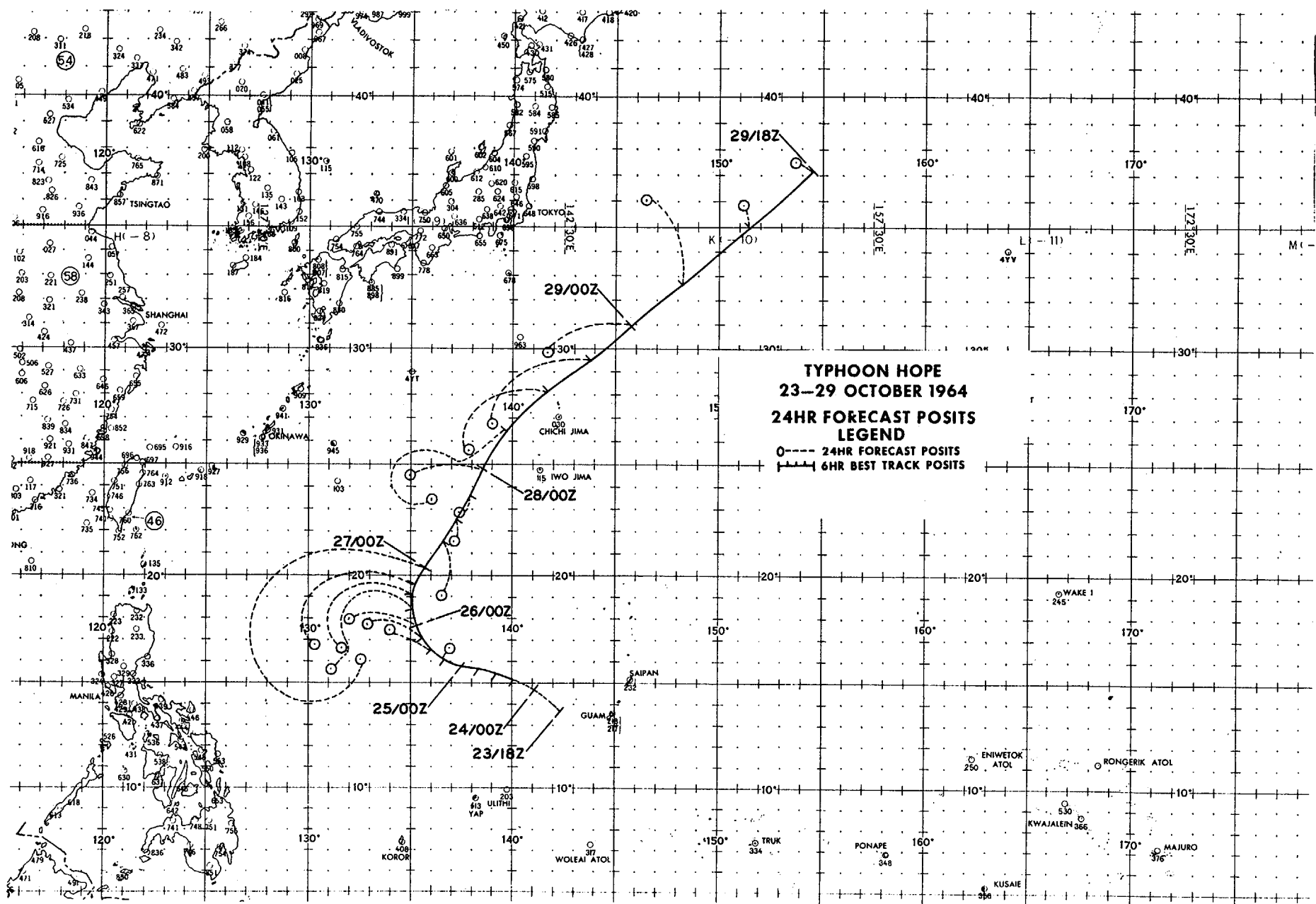
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FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
16	280557Z	26.5N 140.1E	TIROS	---	--	--	---	---	--/--	FAINT EYE VSBL
17	281015Z	27.7N 141.2E	VW1-P-10	1500ft	--	--	976	---	24/17	CIRC 80 MI DIA OPEN SW QUAD
18	281632Z	28.8N 143.6E	VW1-R-10	10000ft	--	--	---	---	--/--	NO CLSD CNTR. TERMINATION OF FEEDER BANDS FORM CLR AREA 166 MI DIA
19	282215Z	30.4N 145.1E	56-P-2	697mb	30	70	981	2902	13/10	ILL DEFINED NO WALL CLDS
20	282212Z	30.2N 146.7E	54-V-5	30000ft	20	90	---	---	-23/--	NO DEFINED EYE NEG WALL CLDS
21	290410Z	32.1N 147.4E	56-P-15	682mb	30	130	992	2954	10/7	NO SFC EYE
22	290950Z	33.1N 150.6E	VW1-R-20	1000ft	--	--	---	---	--/--	CIRC 40 MI DIA OPEN NE SECONDARY CNTR 34.4N 150.6E

TYPHOON HOPE 23 OCT-29 OCT 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
231800Z	13.7N	142.3E	-----		-----	
240000Z	14.7N	141.1E	-----		-----	
240600Z	15.1N	140.0E	-----		-----	
241200Z	15.4N	139.2E	-----		-----	
241800Z	15.6N	138.3E	-----		-----	
250000Z	15.7N	137.4E	-----		-----	
250600Z	16.1N	136.7E	021-36		-----	
251200Z	16.5N	135.9E	298-128		-----	
251800Z	17.1N	135.5E	286-156		-----	
260000Z	17.7N	135.2E	275-182		-----	
260600Z	18.4N	135.1E	237-268		265-166	
261200Z	19.1N	135.1E	236-253		266-338	
261800Z	19.8N	135.3E	240-330		264-416	
270000Z	20.4N	135.8E	217-315		261-486	
270600Z	21.5N	136.6E	184-152		241-585	
271200Z	22.5N	137.2E	186-54		245-696	
271800Z	23.6N	137.9E	215-40		245-808	
280000Z	24.8N	138.6E	265-197		230-757	
280600Z	26.5N	139.8E	228-278		208-323	
281200Z	28.2N	141.8E	234-264		221-277	
281800Z	29.5N	143.8E	237-303		227-378	
290000Z	31.0N	145.9E	253-229		246-430	
290600Z	32.7N	148.3E	336-220		238-746	
291200Z	35.1N	151.5E	338-57		236-770	
291800Z	37.3N	154.7E	286-56		235-834	

AVERAGE 24 HOUR ERROR - 185MI  
 AVERAGE 48 HOUR ERROR - 534MI



TYPHOON IRIS - 021200Z to 041200Z NOVEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning -  $2\frac{1}{4}$
2. Calendar days of typhoon intensity -  $\frac{1}{2}$
3. Total distance traveled during tropical warning period - 414 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 994mb, 031008Z
2. Minimum observed 700mb height - 2990m, 032230Z and 040330Z
3. Maximum surface wind - 65 kts
4. Max radius of surface circulation - 400 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of Polar Trough with increased divergent flow at 200mb

B. Initial surface vortex

1. Junction vortex at 010600Z
2. Surface pressure less than 1006mb

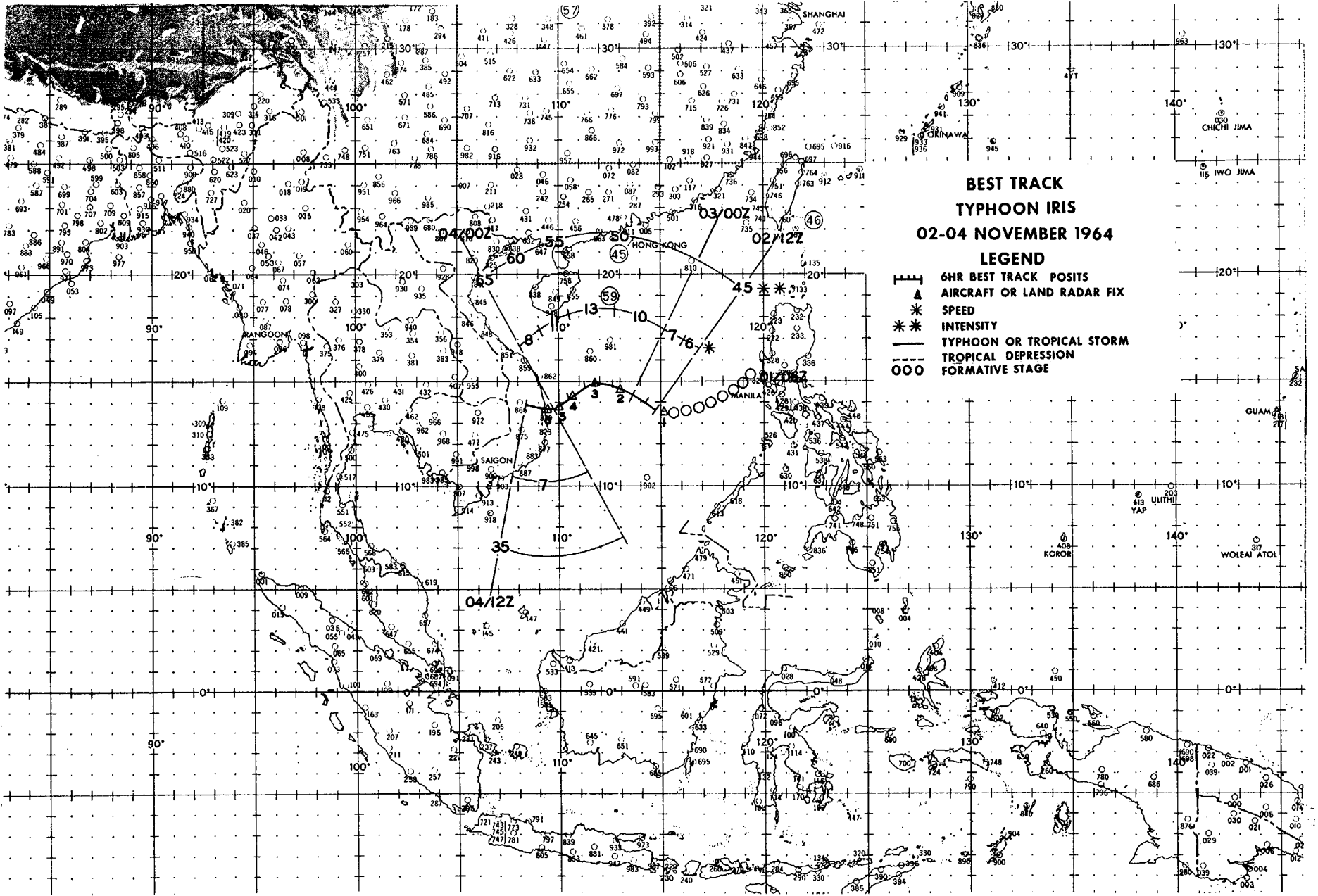
C. 200mb flow above surface vortex

1. Initial - S quadrant of anticyclone
2. Upon reaching typhoon intensity - S quadrant of anticyclone

III. FINAL DISPOSITION

A. Dissipated over land





**BEST TRACK  
TYPHOON IRIS  
02-04 NOVEMBER 1964**

- LEGEND**
- 6HR BEST TRACK POSITS
  - ▲ AIRCRAFT OR LAND RADAR FIX
  - \* SPEED
  - \*\* INTENSITY
  - TYPHOON OR TROPICAL STORM
  - - - TROPICAL DEPRESSION
  - OOO FORMATIVE STAGE

EYE FIXES TYPHOON IRIS

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	020854Z	13.6N 115.1E	VW1-P-5	1500ft	--	20	1003	---	--/--	NO RDR PRESENTATION WND CNTR 40 MI DIA
2	030400Z	14.6N 113.0E	56-P-5	688mb	30	50	998	3045	10/10	CIRC 10 MI DIA OPEN W
3	031008Z	14.9N 111.8E	VW1-P-3	1000ft	--	55	994	---	23/16	ELLIP 25 MI N/S 17 MI E/W WALL CLD 7 MI THICK
4	031600Z	14.4N 110.6E	VW1-R-3	1800ft	--	--	---	---	--/--	CIRC 18 MI DIA WALL CLDS 3 MI THICK
5	032230Z	13.7N 110.0E	56-P-5	706mb	40	35	---	2990	15/13	CIRC 25 MI DIA OPEN SE
6	040330Z	13.7N 109.4E	56-P-1	678mb	38	80	---	2990	12/08	CIRC 12 MI DIA

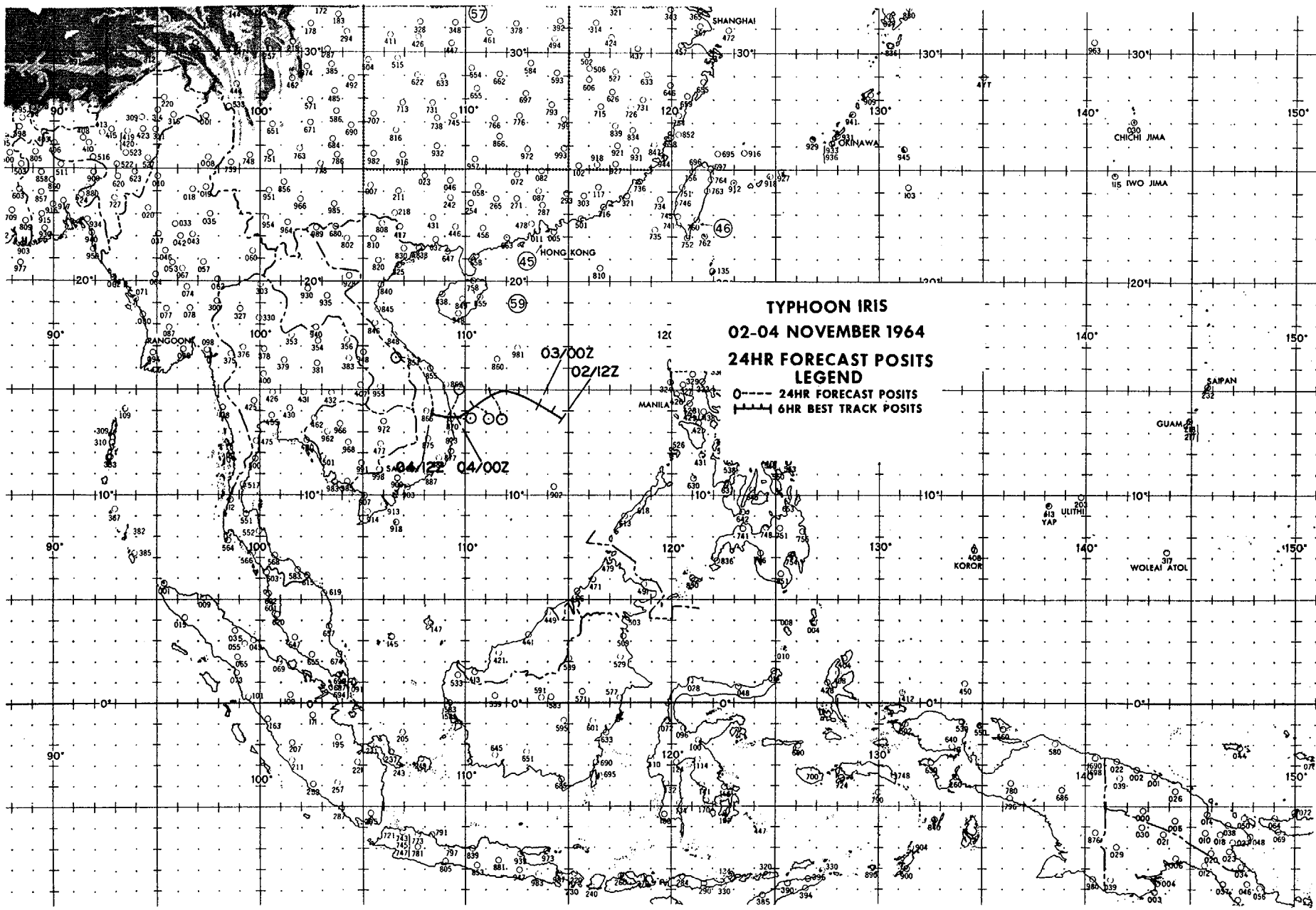
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TYPHOON IRIS 02 NOV-04 NOV 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
021200Z	13.7N	114.8E	-----		-----	
021800Z	13.9N	114.3E	-----		-----	
030000Z	14.3N	113.6E	-----		-----	
030600Z	14.7N	112.7E	-----		-----	
031200Z	14.8N	111.3E	159	-80	-----	
031800Z	14.2N	110.4E	123	-50	-----	
040000Z	13.7N	109.8E	096	-36	-----	
040600Z	13.7N	109.1E	027	-88	-----	
041200Z	13.8N	108.3E	328	-188	111	-38

AVERAGE 24 HOUR ERROR - 88MI  
 AVERAGE 48 HOUR ERROR - 38MI



**TYPHOON IRIS**  
**02-04 NOVEMBER 1964**  
**24HR FORECAST POSITS**  
**LEGEND**  
 ○--- 24HR FORECAST POSITS  
 ——— 6HR BEST TRACK POSITS

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TYPHOON JOAN - 061200Z to 081800Z NOVEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning -  $4\frac{1}{2}$
2. Calendar days of typhoon intensity -  $\frac{1}{2}$
3. Total distance traveled during tropical warning period - 528 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 999mb, 071000Z
2. Minimum observed 700mb height - 2997m, 071545Z
3. Maximum surface wind - 70 kts
4. Max radius of surface circulation - 325 mi

II. DEVELOPMENT

A. Initial impetus - Fracture of Polar Trough

B. Initial surface vortex

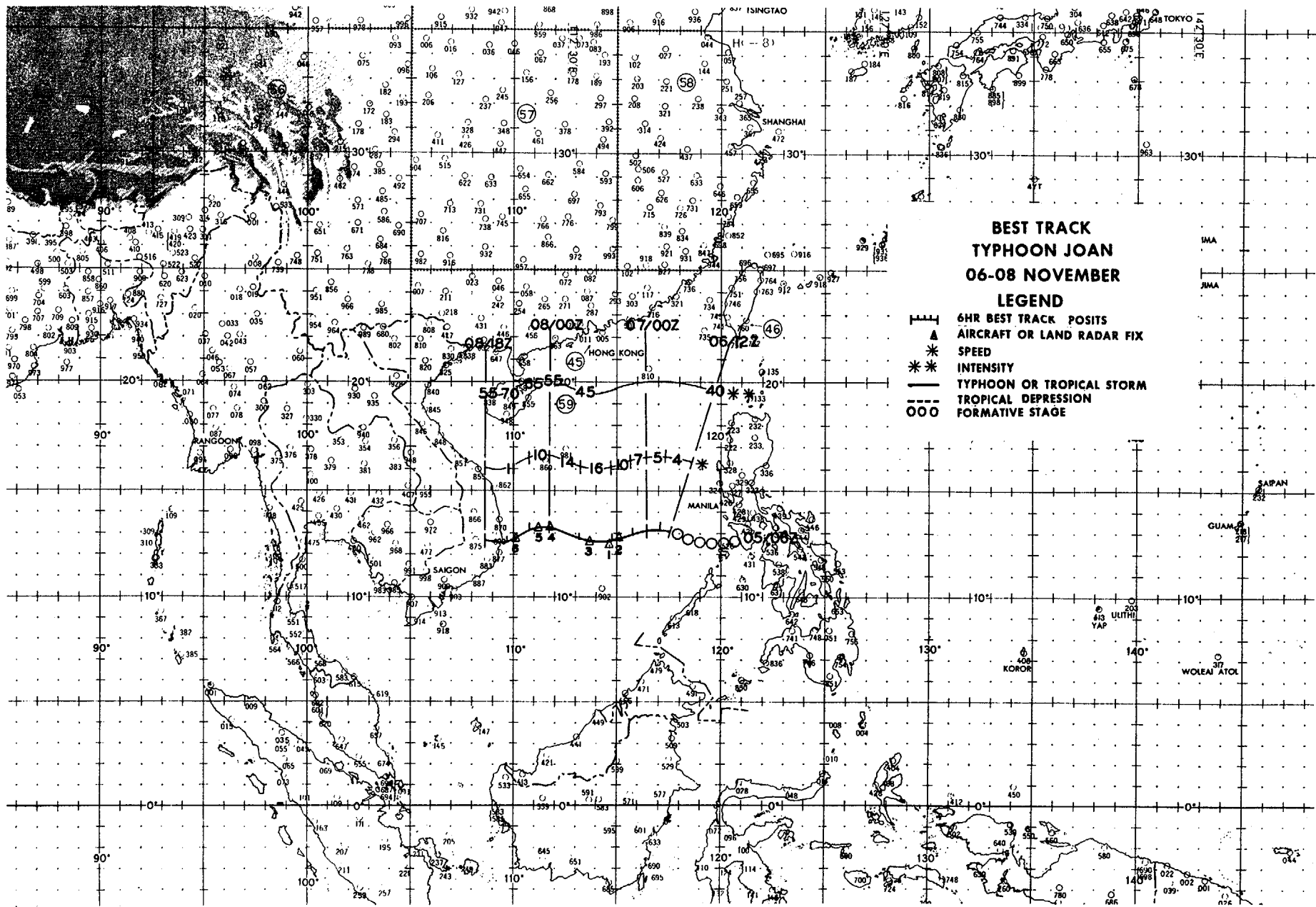
1. Junction vortex at 050600Z
2. Surface pressure less than 1004mb

C. 200mb flow above surface vortex

1. Initial - SE quadrant of anticyclone
2. Upon reaching typhoon intensity - S quadrant of anticyclone

III. FINAL DISPOSITION

- A. Dissipated over land



## EYE FIXES TYPHOON JOAN

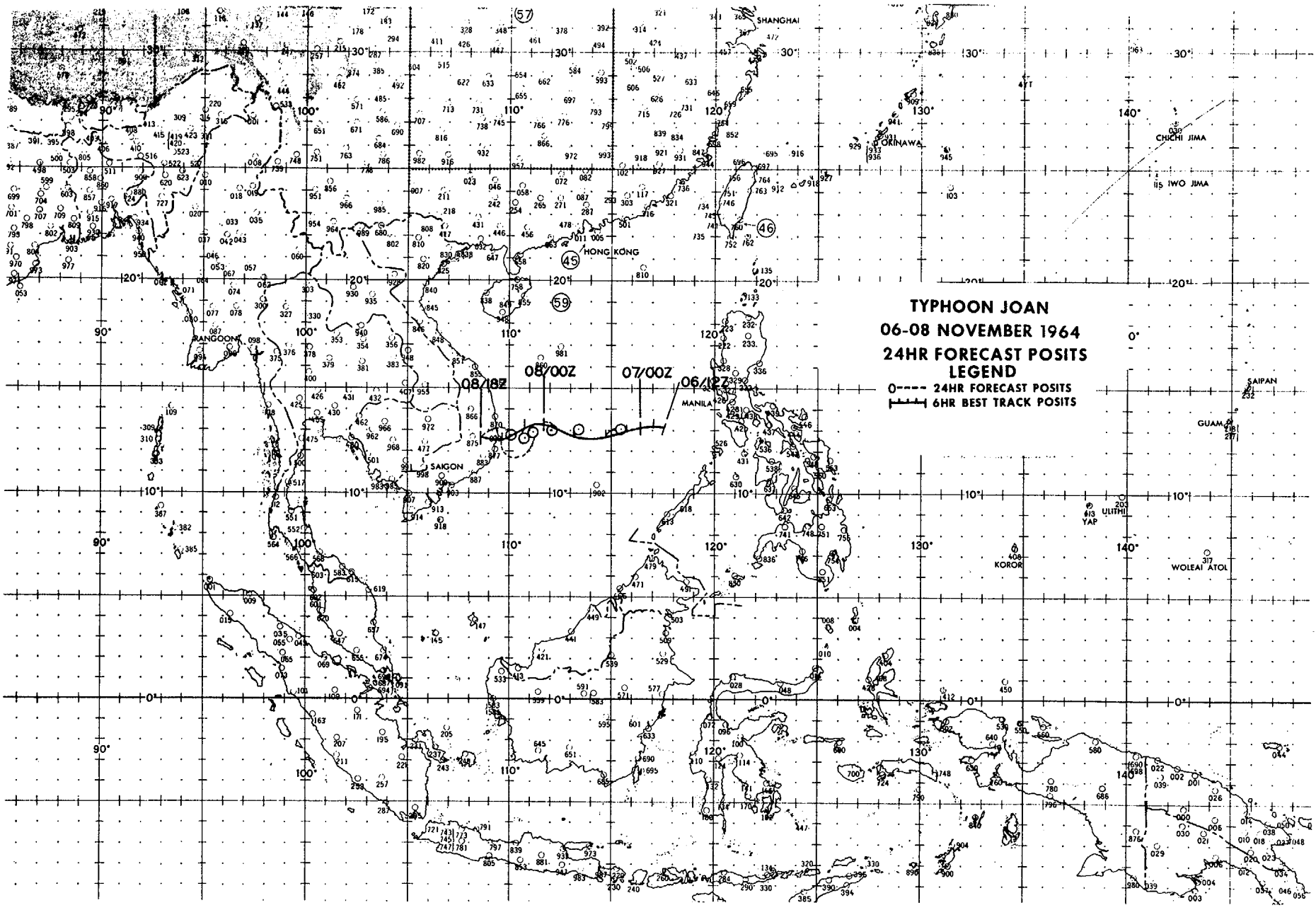
FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	070418Z	12.5N 114.7E	56-P-2	696mb	25	20	---	3124	--/--	NEG WALL CLDS. CNTR OF 20 MI CALM AREA REPORTED
2	071000Z	12.8N 115.2E	VW1-P-10	1200ft	--	20	999	---	--/--	NEG WALL CLDS. PRES CNTR 40 MI NE WND CNTR
3	071545Z	12.7N 113.7E	VW1-P-10	10000ft	--	--	---	2997	12/--	NEG WALL CLD. CNTR CIRC 30 MI DIA
4	072350Z	13.2N 111.8E	56-P-5	710mb	25	25	---	3079	13/10	LGT WALL CLDS CIRC 10 MI DIA
5	080300Z	13.2N 111.3E	56-P-5	709mb	45	55	1000	3072	13/11	LGT WALL CLDS CIRC 30 MI DIA EST 700MB HGT 100 MTRS HIGH
6	081000Z	12.7N 110.2E	VW1-P-5	1500ft	--	--	1001	---	23/19	NEG RDR CNTR WND CNTR 5 MI DIA

**TYPHOON JOAN 06 NOV-08 NOV 1964**  
**POSITION AND FORECAST VERIFICATION DATA**

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
061200Z	13.1N	117.5E	-----		-----	
061800Z	13.1N	117.1E	-----		-----	
070000Z	13.1N	116.6E	-----		-----	
070600Z	13.0N	115.8E	-----		-----	
071200Z	12.8N	114.9E		068-40	-----	
071800Z	12.8N	113.2E		054-22	-----	
080000Z	13.2N	111.8E		117-24	-----	
080600Z	13.0N	110.8E		176-32	-----	
081200Z	12.7N	109.8E		080-78		074-85
081800Z	12.7N	108.7E		083-85		077-88

**AVERAGE 24 HOUR ERROR - 47MI**  
**AVERAGE 48 HOUR ERROR - 87MI**





**TYPHOON JOAN**  
**06-08 NOVEMBER 1964**  
**24HR FORECAST POSITS**  
**LEGEND**  
 O----- 24HR FORECAST POSITS  
 ———— 6HR BEST TRACK POSITS

TYPHOON KATE - 130000Z to 161200Z NOVEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning - 4
2. Calendar days of typhoon intensity - 1½
3. Total distance traveled during tropical warning period - 492 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 986mb, 151005Z
2. Minimum observed 700mb height - 3008m, 152230Z
3. Maximum surface wind - 80 kts
4. Max radius of surface circulation - 375 mi.

II. DEVELOPMENT

A. Initial impetus - Fracture of Polar Trough

B. Initial surface vortex

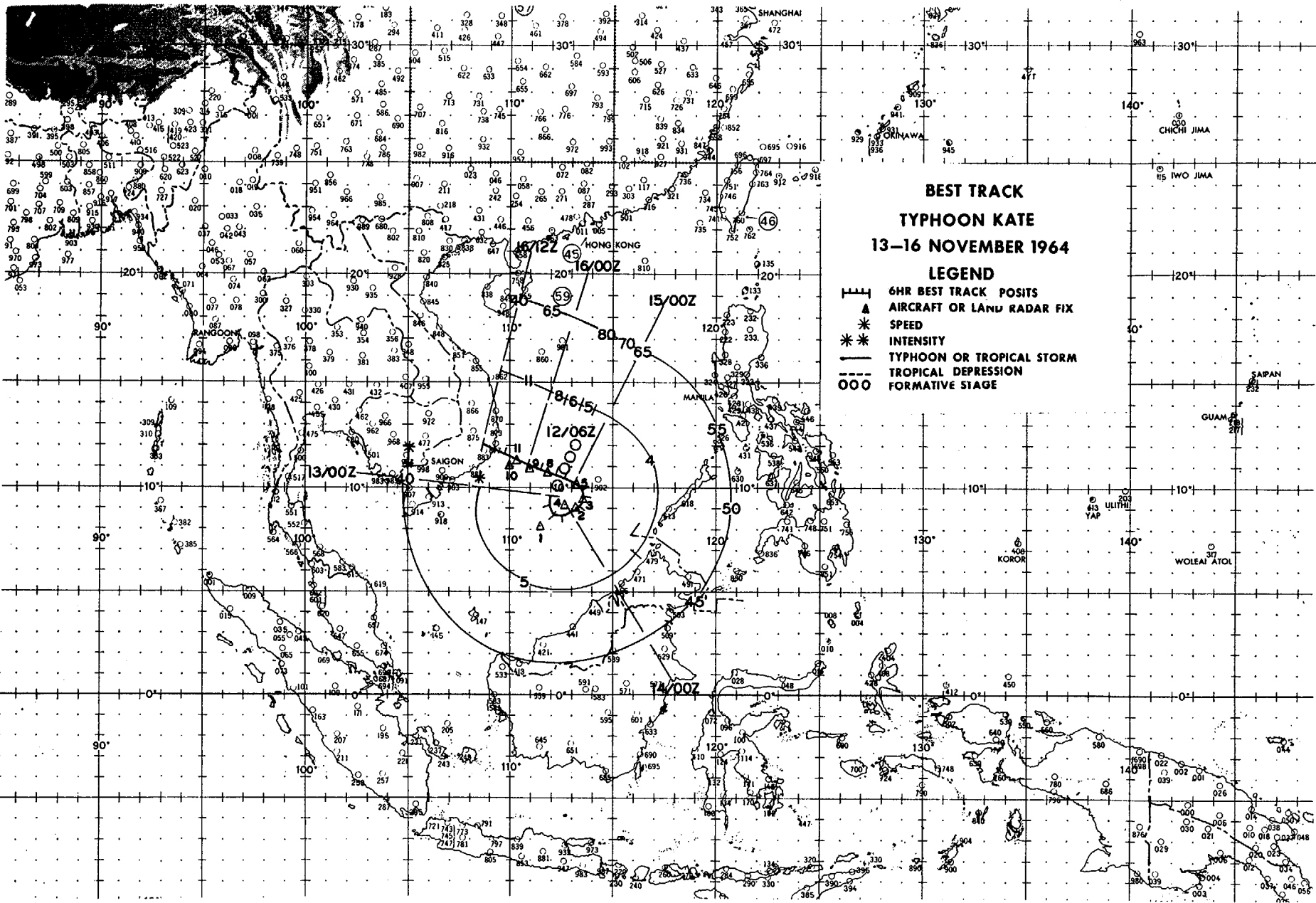
1. Junction vortex at 120600Z
2. Surface pressure less than 1005mb

C. 200mb flow above surface vortex

1. Initial - S quadrant of anticyclone
2. Upon reaching typhoon intensity - S quadrant of anticyclone

III. FINAL DISPOSITION

A. Dissipated over land



**BEST TRACK  
TYPHOON KATE  
13-16 NOVEMBER 1964**

- LEGEND**
- |||| 6HR BEST TRACK POSITS
  - ▲ AIRCRAFT OR LAND RADAR FIX
  - \* SPEED
  - \* \* INTENSITY
  - TYPHOON OR TROPICAL STORM
  - - - TROPICAL DEPRESSION
  - OOO FORMATIVE STAGE

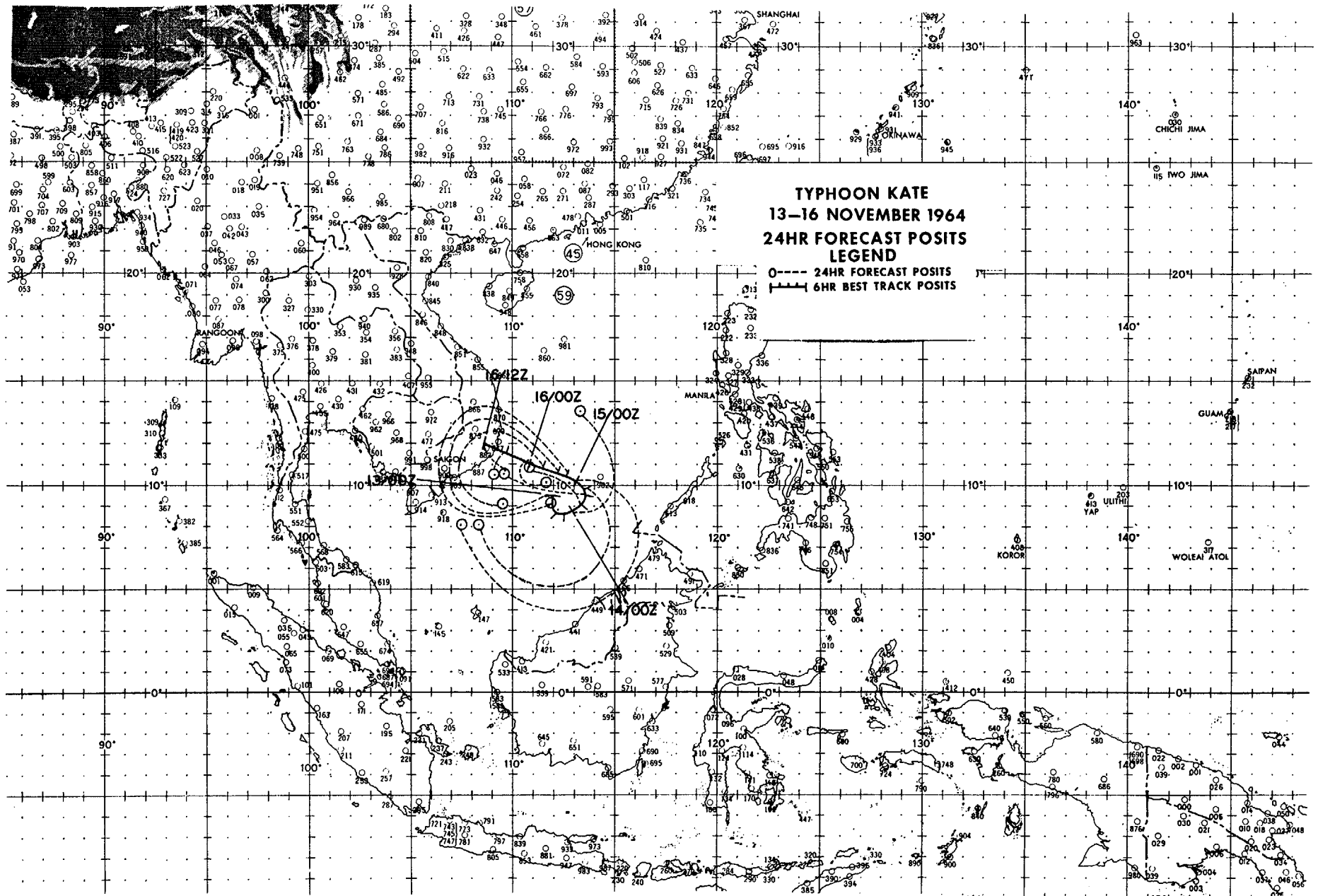
## EYE FIXES TYPHOON KATE

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	131638Z	08.1N 111.4E	VW1-R-15	1200ft	--	--	--	--	--	CNTR ESTIMATED. OPEN E SEMI
2	140430Z	09.0N 113.2E	56-P-5	708MB	30	40	1000	3063	11/09	CIRC 25 MI DIA OPEN NE
3	140945Z	09.4N 113.4E	VW1-P-5	1000ft	--	40	996	--	25/22	CIRC 15 MI DIA. RADAR EYE 210 DEG 25 MI FM WND EYE
4	141515Z	09.1N 112.7E	VW1-P-10	1500ft	--	45	992	--	--/--	APRNT RADAR CNTR 231 DEG 58 MI FM PRES CNTR
5	142230Z	10.1N 113.2E	56-P-3	700MB	30	--	992	3018	12/09	CIRC, 10 MI DIA SFC CALM. NO WALL CLDS
229	150400Z	10.4N 112.5E	56-P-4	700MB	50	60	995	3030	14/10	CIRC, 20 MI DIA SFC CALM. NO WALL CLDS
7	151005Z	10.5N 112.5E	VW1-P-3	800ft	--	80	986	--	25/23	EYE OPEN, NO WALL CLDS. COMPLETE WND CIRCULATION
8	151536Z	10.7N 111.8E	VW1-P-3	1100ft	--	--	991	--	25/22	NO RDR EYE. WND EYE ELLIP 20 MI E/W 12 MI N/S
9	152230Z	10.9N 111.0E	56-P-7	700MB	50	--	988	3008	10/08	CIRC 40 MI DIA OPEN SE
10	160117Z	11.0N 110.0E	TIROS	--	--	--	--	--	--	--
11	160300Z	11.3N 110.3E	56-P-4	700MB	50	110	992	3039	11/05	ELLIP 5 MI SFC EYE OPEN E SEMI

TYPHOON KATE 13 NOV-16 NOV 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR	48 HOUR ERROR
	LAT.	LONG.	DEG. DISTANCE	DEG. DISTANCE
130000Z	09.5N	112.0E	-----	-----
130600Z	09.1N	111.9E	-----	-----
131200Z	08.6N	112.0E	-----	-----
131800Z	08.6N	112.5E	-----	-----
140000Z	08.8N	112.9E	006-292	-----
140600Z	09.1N	113.3E	308-180	-----
141200Z	09.5N	113.4E	286-230	-----
141800Z	09.8N	113.4E	250-314	-----
150000Z	10.2N	113.1E	249-351	306-272
150600Z	10.3N	112.7E	212-95	270-312
151200Z	10.5N	112.3E	189-77	268-395
151800Z	10.7N	111.5E	230-150	246-388
160000Z	11.1N	110.8E	136-77	244-395
160600Z	11.5N	109.8E	207-78	196-159
161200Z	12.0N	108.6E	143-113	180-168

AVERAGE 24 HOUR ERROR - 178MI  
 AVERAGE 48 HOUR ERROR - 298MI



TYPHOON LOUISE - 150600Z to 201200Z NOVEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning - 6
2. Calendar days of typhoon intensity - 4½
3. Total distance traveled during tropical warning period - 1032 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 914mb, 180300Z
2. Minimum observed 700mb height - 2350m, 180300Z
3. Maximum surface wind - 165 kts
4. Max radius of surface circulation - 500mi

II. DEVELOPMENT

A. Initial impetus - Superposition of polar trough with easterly wave and subsequent fracture

B. Initial surface vortex

1. Junction vortex at 121800Z
2. Surface pressure less than 1004mb

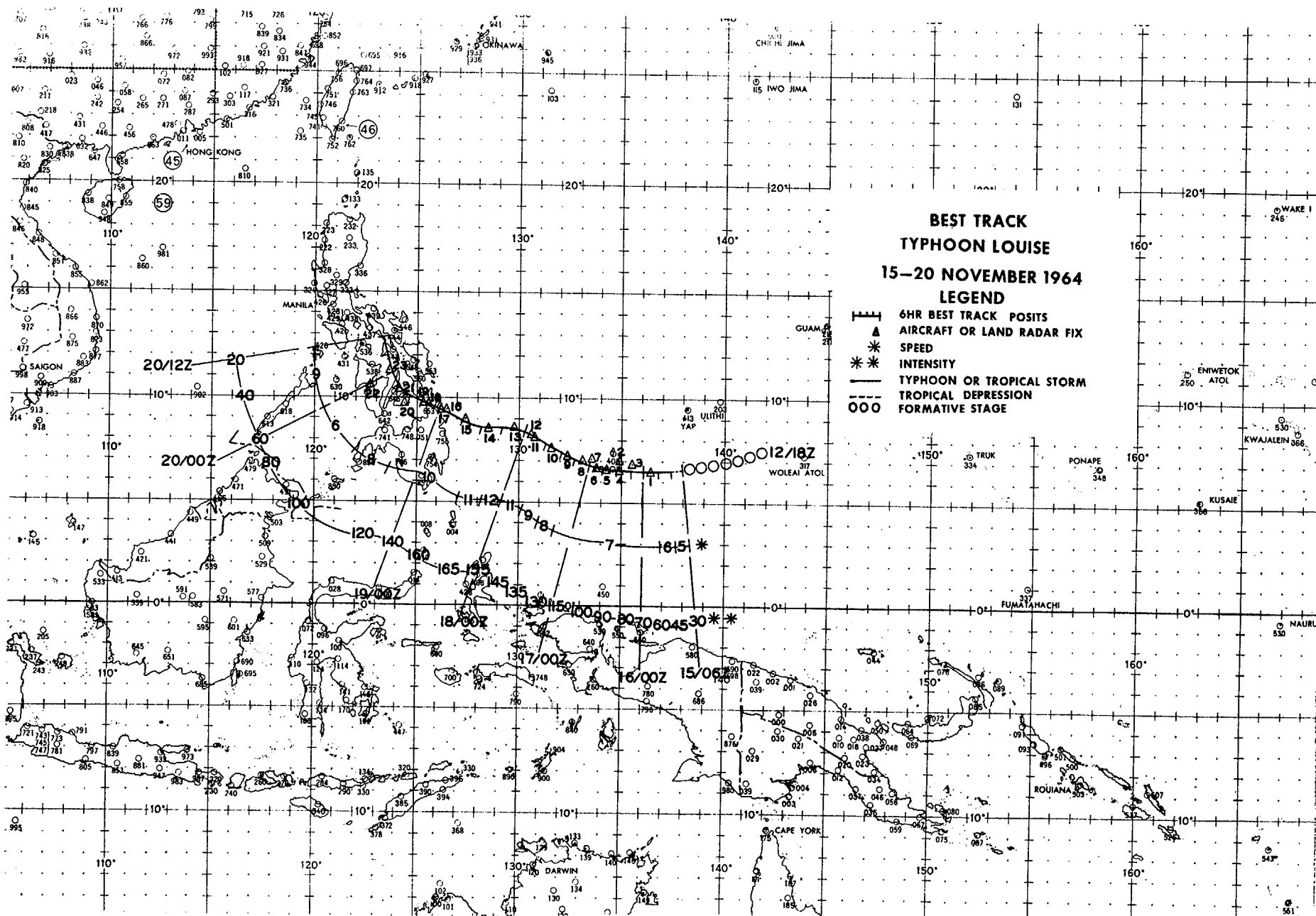
C. 200mb flow above surface vortex

1. Initial - E quadrant of anticyclone
2. Upon reaching typhoon intensity - S of E-W

ridge

III. FINAL DISPOSITION

A. Dissipated over land



**BEST TRACK  
TYPHOON LOUISE  
15-20 NOVEMBER 1964  
LEGEND**

- 6HR BEST TRACK POSITS
- ▲ AIRCRAFT OR LAND RADAR FIX
- \* SPEED
- \*\* INTENSITY
- TYPHOON OR TROPICAL STORM
- TROPICAL DEPRESSION
- OOO FORMATIVE STAGE



## EYE FIXES TYPHOON LOUISE

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	152204Z	06.5N 136.4E	VW1-P-10	1000ft	--	45	985	--	26/18	ELLIP 25 MI N/S 20 MI E/W OPEN NW
2	152334Z	07.0N 135.0E	TIROS	--	--	--	--	--	--	--
3	160400Z	06.9N 135.5E	54-R-1	30000ft	35	50	--	--	-25/--	OVAL 50X40 MI WALL CLD 10 MI THICK OPEN S & SW QUAD
4	161000Z	06.5N 135.0E	VW1-R-2	1500ft	--	--	--	--	--	CIRC 35 MI DIA WALL CLD 9 MI THICK
5	161545Z	06.6N 134.3E	VW1-R-1	10000ft	--	--	--	--	--	CIRC 25 MI DIA WALL CLD 7 MI THICK
6	162200Z	06.7N 133.9E	54-R-5	31000ft	--	50	--	--	-31/--	CIRC 40 MI DIA WALL CLD 5 MI THICK
7	162230Z	07.1N 133.6E	56-P-3	700MB	90	55	954	2731	20/15	CIRC 17 MI DIA WALL CLDS MOD ALL QUADS
8	170300Z	07.0N 133.1E	56-P-4	700MB	105	125	943	2606	22/16	--
9	171000Z	07.2N 132.4E	VW1-R-10	1500ft	--	--	--	--	--	CIRC 13 MI DIA WALL CLD 10 MI THICK TAPERS TO 4 MI NE
10	171540Z	07.5N 131.6E	VW1-R-5	3000ft	--	--	--	--	--	CIRC 13 MI DIA WALL CLD 11 MI THICK
11	172149Z	08.1N 130.8E	54-R-5	30000ft	--	--	--	--	-22/--	OVAL 12 MI N/S 18 MI E/W WALL CLD 3 MI THICK

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
12	172200Z	08.2N 130.7E	56-P-3	700MB	110	130	934	2499	16/15	ELLIPT 18 MI NE/SW 15 MI NW/SE
13	180300Z	08.6N 129.8E	56-P-3	700MB	150	160	914	2350	22/18	CIRC 12 MI DIA
14	180945Z	08.5N 128.4E	VW1-R-2	10000ft	--	--	--	--	--	CIRC 11 MI DIA WALL CLD 6 MI THICK
15	181545Z	09.0N 127.4E	VW1-R-3	10000ft	--	--	--	--	--	CIRC 11 MI DIA WALL CLD 5 MI THICK
16	182300Z	09.5N 126.5E	TIROS	--	--	--	--	--	--	EYE VSBL
17	182310Z	09.4N 126.3E	56-R-3	500MB	--	--	--	--	--	CIRC 8 MI DIA WALL CLD 5-8 MI THICK. CONCENTRIC STRONG FEEDER BANDS ALL QUADS
18	190340Z	09.8N 125.5E	56-R-3	500MB	--	--	--	--	--	CIRC 5 MI DIA WALL CLD 5-8 MI THICK. CONCENTRIC STRONG FEEDER BANDS ALL QUADS
19	190400Z	09.8N 125.4E	54-R-1	30000ft	--	--	--	--	--	CIRC 7 MI DIA WALL CLD 3 MI THICK
20	190935Z	09.8N 124.5E	VW1-R-2	9000ft	--	--	--	--	--	CIRC 10 MI DIA WALL CLD 5-8 MI THICK
21	191600Z	10.4N 124.1E	VW1-R-5	9000ft	--	--	--	--	--	CIRC 15 MI DIA WALL CLDS BRKN UP IN N SEMI

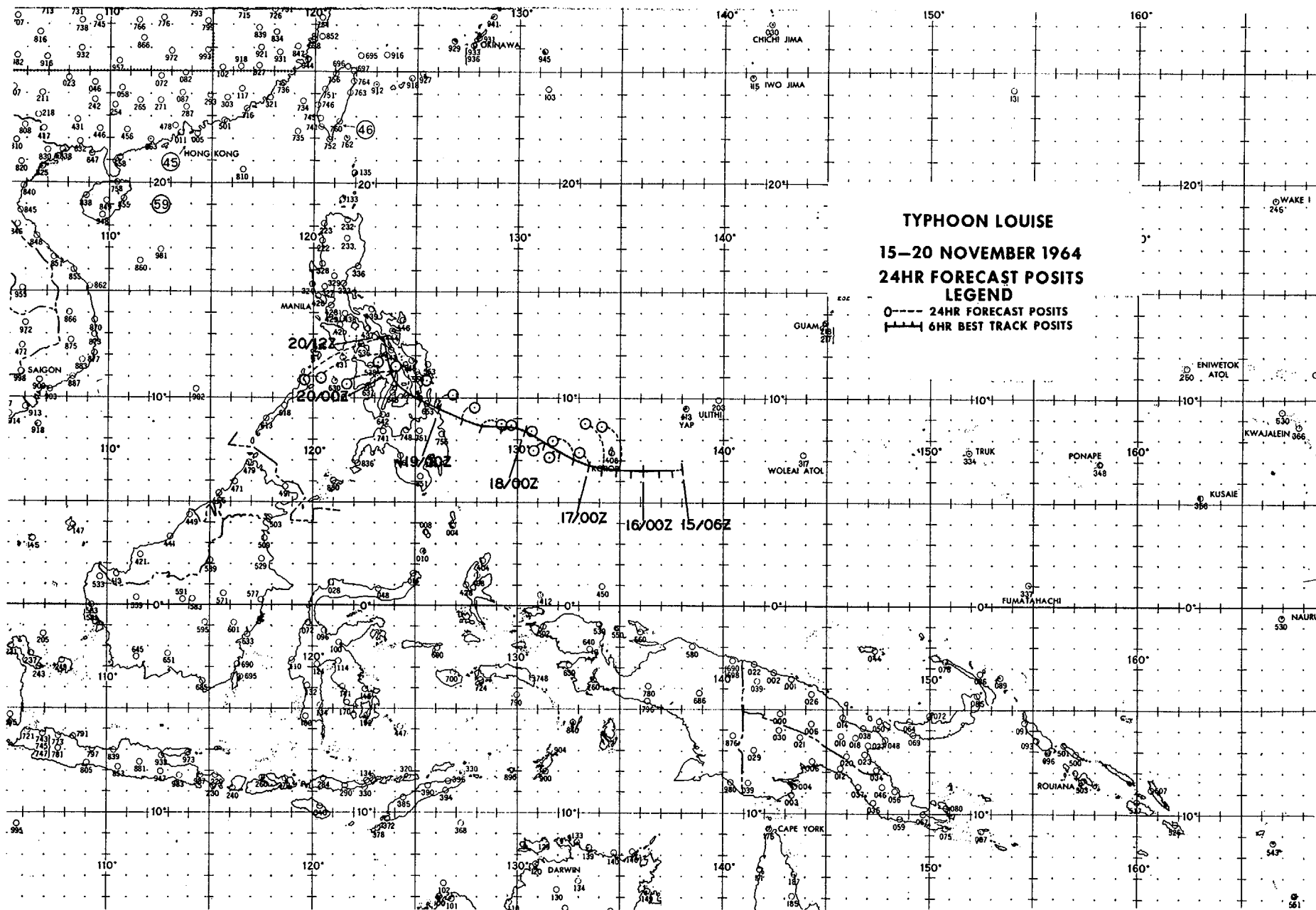
235

FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
22	192307Z	10.5N 122.8E	56-R-2	577MB	--	--	--	--	--	CIRC 10 MI DIA WEAK S- SFC WND 330/60 KTS 60 MI WSW OF EYE
23	200455Z	11.3N 123.7E	56-P-1	500MB	--	50	990	--	-3/-9	CIRC 30 MI DIA

TYPHOON LOUISE 15 NOV-20 NOV 1964  
 POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
150600Z	06.6N	138.0E	-----		-----	
151200Z	06.5N	137.5E	-----		-----	
151800Z	06.5N	136.9E	-----		-----	
160000Z	06.5N	136.2E	-----		-----	
160600Z	06.5N	135.4E	-----		-----	
161200Z	06.6N	134.8E	341-129		-----	
161800Z	06.7N	134.1E	340-129		-----	
170000Z	06.8N	133.4E	311-38		-----	
170600Z	07.1N	132.8E	306-86		-----	
171200Z	07.4N	132.1E	244-34		-----	
171800Z	07.8N	131.3E	232-30		-----	
180000Z	08.4N	130.3E	074-17		278-69	
180600Z	08.6N	129.2E	079-30		303-108	
181200Z	08.6N	128.1E	087-73		003-18	
181800Z	09.0N	127.2E	064-52		033-30	
190000Z	09.5N	126.2E	051-62		053-63	
190600Z	09.8N	125.2E	022-60		056-68	
191200Z	10.1N	124.4E	345-85		070-78	
191800Z	10.6N	124.0E	322-84		021-40	
200000Z	11.1N	123.8E	256-138		307-67	
200600Z	12.0N	123.6E	253-216		274-134	
201200Z	12.9N	123.3E	-----		-----	

AVERAGE 24 HOUR ERROR - 79MI  
 AVERAGE 48 HOUR ERROR - 68MI



TYPHOON OPAL - 081800Z to 160600Z DECEMBER

I. DATA

A. Statistics

1. Calendar days of tropical warning - 7 3/4
2. Calendar days of typhoon intensity - 5 3/4
3. Total distance traveled during tropical warning period - 2352 mi

B. Characteristics as a typhoon

1. Minimum observed SLP - 903mb, 112200Z
2. Minimum observed 700mb height - 2249m, 112200Z
3. Maximum surface wind - 170 kts
4. Max radius of surface circulation - 650 mi

II. DEVELOPMENT

A. Initial impetus - Superposition of polar trough with easterly wave and subsequent fracture

B. Initial surface vortex

1. Junction vortex at 080000Z
2. Surface pressure less than 1008mb

C. 200mb flow above surface vortex

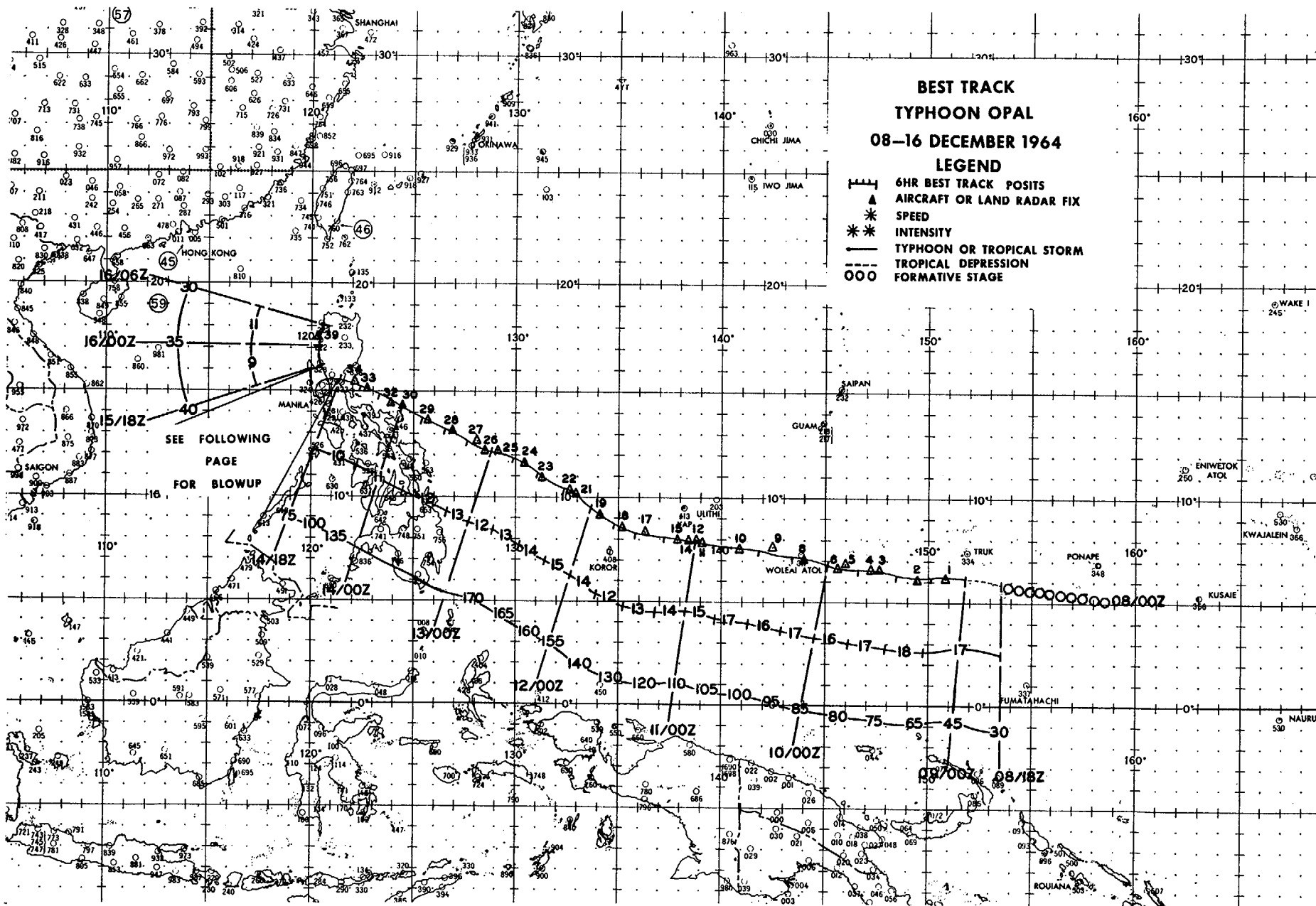
1. Initial - SW quadrant of anticyclone
2. Upon reaching typhoon intensity - S quadrant of anticyclone

III. FINAL DISPOSITION

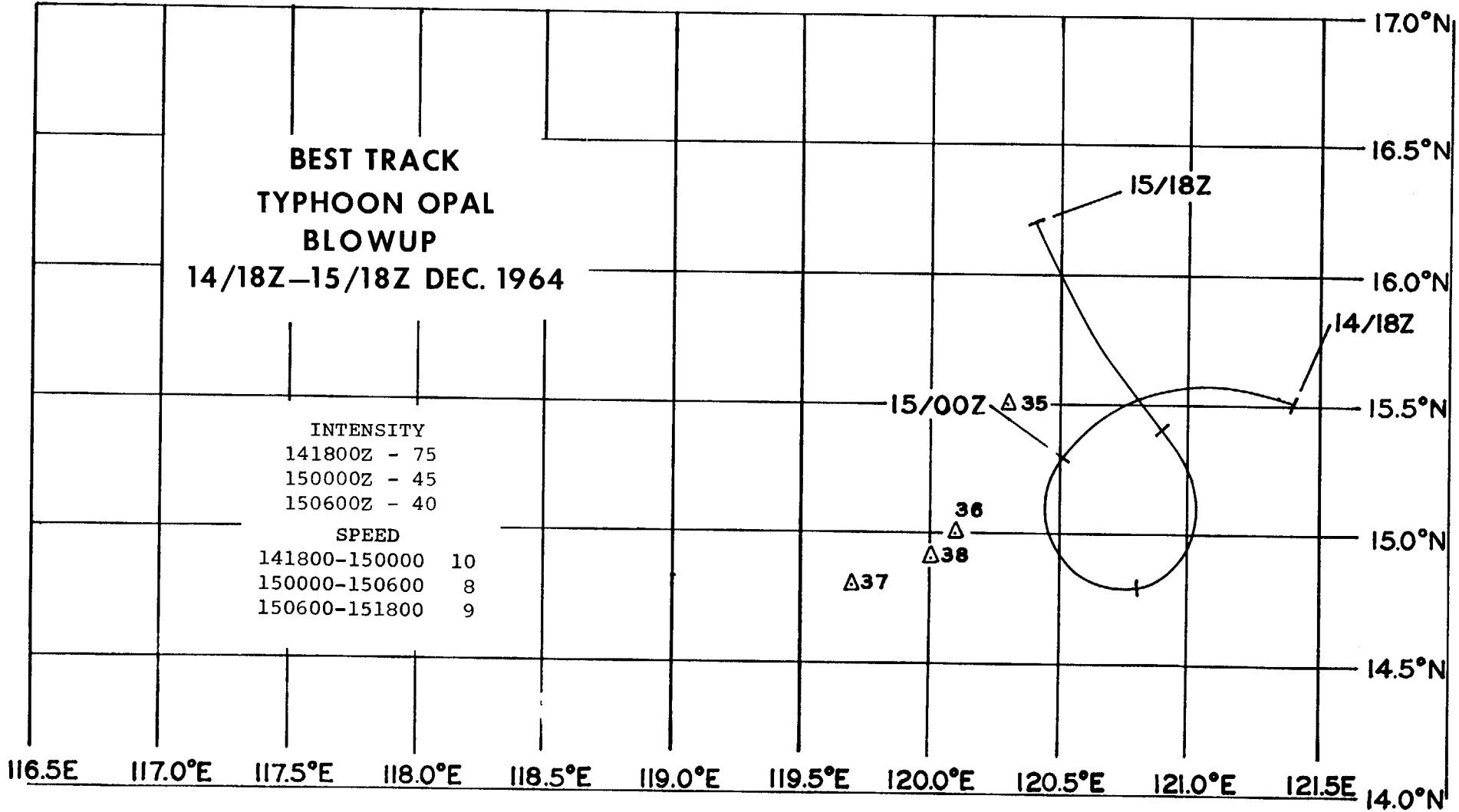
A. Extratropical

**BEST TRACK  
TYPHOON OPAL  
08-16 DECEMBER 1964**

- LEGEND**
- ⎓ 6HR BEST TRACK POSITS
  - ▲ AIRCRAFT OR LAND RADAR FIX
  - \* SPEED
  - \*\* INTENSITY
  - TYPHOON OR TROPICAL STORM
  - - - TROPICAL DEPRESSION
  - OOO FORMATIVE STAGE



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## EYE FIXES TYPHOON OPAL

FIX NO.	TIME	POSIT	UNIT-METHOD-ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
1	090400Z	06.2N 150.8E	VW1-P-5	1000ft	--	60	986	--	26/20	CIRC 25 MI DIA OPEN E
2	090634Z	06.0N 149.5E	TIROS	--	--	--	--	--	--	--
3	091415Z	06.5N 147.6E	VW1-R-3	1500ft	--	--	--	--	--	CIRC 20 MI DIA OPEN N THRU E
4	091600Z	06.5N 147.2E	VW1-R-3	10000ft	--	--	--	--	--	OVAL 20 MI DIA E-W AXIS OPEN N
5	092010Z	06.8N 146.0E	VW1-P-2	1500ft	--	70	981	--	--	OVAL 20 MI DIA E-W AXIS 10 MI N-S OPEN N
6	092200Z	06.6N 145.6E	54-R-15	30000ft	--	--	--	--	-30/--	CIRC 25 MI DIA WALL CLD 10 MI THICK
7	092210Z	06.3N 145.7E	56-P-5	700MB	50	60	986	2993	15/11	CIRC 10 MI DIA OPEN N WALL CLD 5 MI THICK
8	100400Z	07.0N 144.0E	56-P-2	700MB	65	85	980	2935	17/13	CIRC 50 MI DIA OPEN N WALL CLD 6 MI THICK
9	100945Z	07.6N 142.4E	VW1-R-5	10000ft	--	--	--	--	--	CIRC 50 MI DIA OPEN SE QUAD WALL CLD 10 MI THICK
10	101530Z	07.5N 140.9E	VW1-P-10	10000ft	--	--	--	2893	15/10	CIRC 35 MI DIA WALL CLD 10 MI THICK
11	102121Z	07.8N 139.1E	54-R-5	30000ft	--	--	--	--	-25/--	NO WALL CLD OBSERVED
12	102245Z	07.9N 138.8E	56-P-6	700MB	90	110	956	2937	18/13	CIRC 25 MI DIA

FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
13	102255Z	07.8N 138.8E	54-R-5	30000ft	115	100	--	--	--	--
14	110032Z	07.9N 138.5E	54-R-5	30000ft	--	--	--	--	--	--
15	110300Z	07.9N 137.9E	56-P-5	700MB	90	100	950	2676	20/15	ELLIP 22 MI E-W 17 MI N-S
16	110400Z	08.0N 137.7E	54-R-10	31000ft	--	--	--	--	--	NO WALL CLD OBSERVED
17	110946Z	08.3N 136.3E	VW1-R-3	5000ft	--	--	--	--	--	CIRC 14 MI DIA WALL CLD 10 MI THICK
18	111545Z	08.5N 135.2E	VW1-R-5	10000ft	--	--	--	--	--	CIRC 12 MI DIA WALL CLD 7 MI THICK
243 19	112200Z	09.1N 134.1E	56-P-5	700MB	90	150	903	2249	27/19	CIRC 8 MI DIA WALL CLD 3 MI THICK SEVERE TURB S QUAD
20	112202Z	09.2N 134.2E	54-R-5	30000ft	--	--	--	--	--/--	CIRC 18 MI DIA WALL CLD 5 MI THICK
21	120345Z	10.2N 133.0E	56-R-6	700MB	--	--	--	--	--/--	CIRC 9 MI DIA WALL CLD 6 MI THICK
22	120400Z	10.3N 132.7E	54-R-5	30000ft	--	--	--	--	--/--	CIRC 8 MI DIA WALL CLD 5 MI THICK
23	121010Z	10.8N 131.3E	VW1-R-5	1500ft	--	--	--	--	--/--	CIRC 9 MI DIA WALL CLD 6 MI THICK
24	121546Z	11.6N 130.4E	VW1-R-5	9000ft	--	--	--	--	--/--	CIRC 26 MI DIA WALL CLD 14 MI THICK

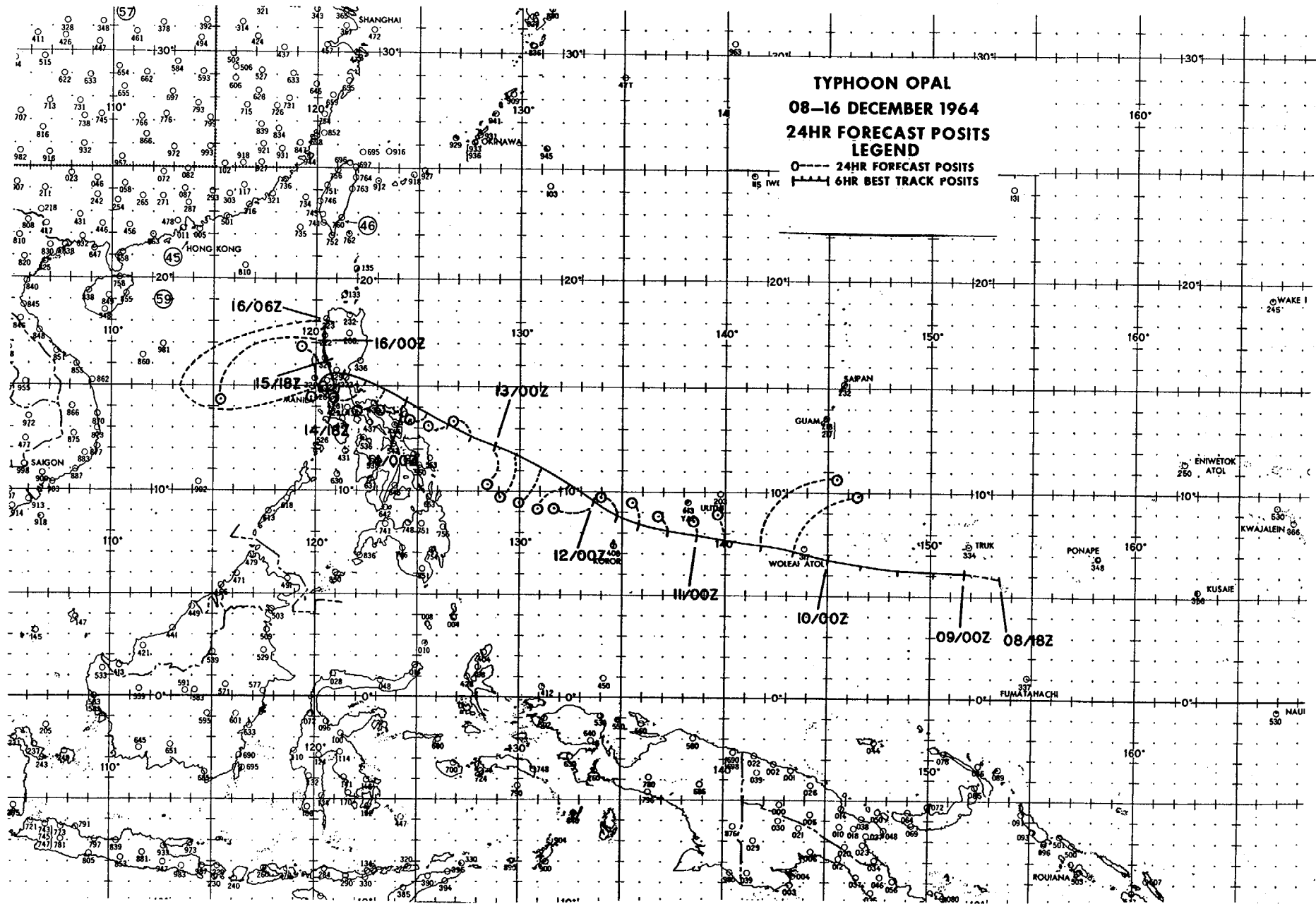
FIX NO.	TIME	POSIT	UNIT- METHOD -ACCY	FLT LVL	FLT LVL	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
25	122207Z	12.2N 129.2E	54-R-5	28000ft	--	120	--	--	-24/--	CIRC 25 MI DIA WALL CLD 10 MI THICK
26	130300Z	12.2N 128.5E	56-R-5	500MB	--	--	--	--	--/--	CIRC 56 MI DIA WALL CLD 10 MI THICK SFC WINDS 150 KTS 30 MI E OF WALL CLD
27	130405Z	12.7N 128.1E	54-R-15	30000ft	--	--	--	--	--/--	NO RADAR WALL CLDS
28	131000Z	13.2N 126.9E	VW1-R-3	9000ft	--	--	--	--	--/--	CONCENTRIC EYE INNER EYE 8 MI DIA WALL CLD 4 MI THICK, OUTER EYE 40 MI DIA WALL CLD 10 MI THICK
244 29	131600Z	13.6N 125.7E	VW1-R-3	9000ft	--	--	--	--	--/--	CIRC 10 MI DIA WALL CLD 15 MI THICK WEST SEMI 6 MI THICK E SEMI
30	132210Z	14.3N 124.5E	54-R-5	30000ft	75	--	--	--	--/--	NO WALL CLDS
31	132220Z	14.1N 124.7E	56-P-1	700MB	90	200	956	2719	26/10	CIRC 25 MI DIA OPEN E QUAD WALL CLD 15 MI THICK
32	140300Z	14.4N 123.9E	56-R-1	700MB	--	--	--	--	--/--	CIRC 25 MI DIA WALL CLD 15 MI THICK SFC WND 175 KTS 30 MI E OF CENTER
33	140945Z	15.1N 122.7E	VW1-P-10	900ft	--	100	962	--	--/--	EYE NOT WELL DEFINED 44 MI DIA OPEN E SEMI
34	141600Z	15.4N 122.1E	VW1-R-10	4000ft	--	--	--	--	--/--	CENTER VERY WEAK AND POORLY DEFINED

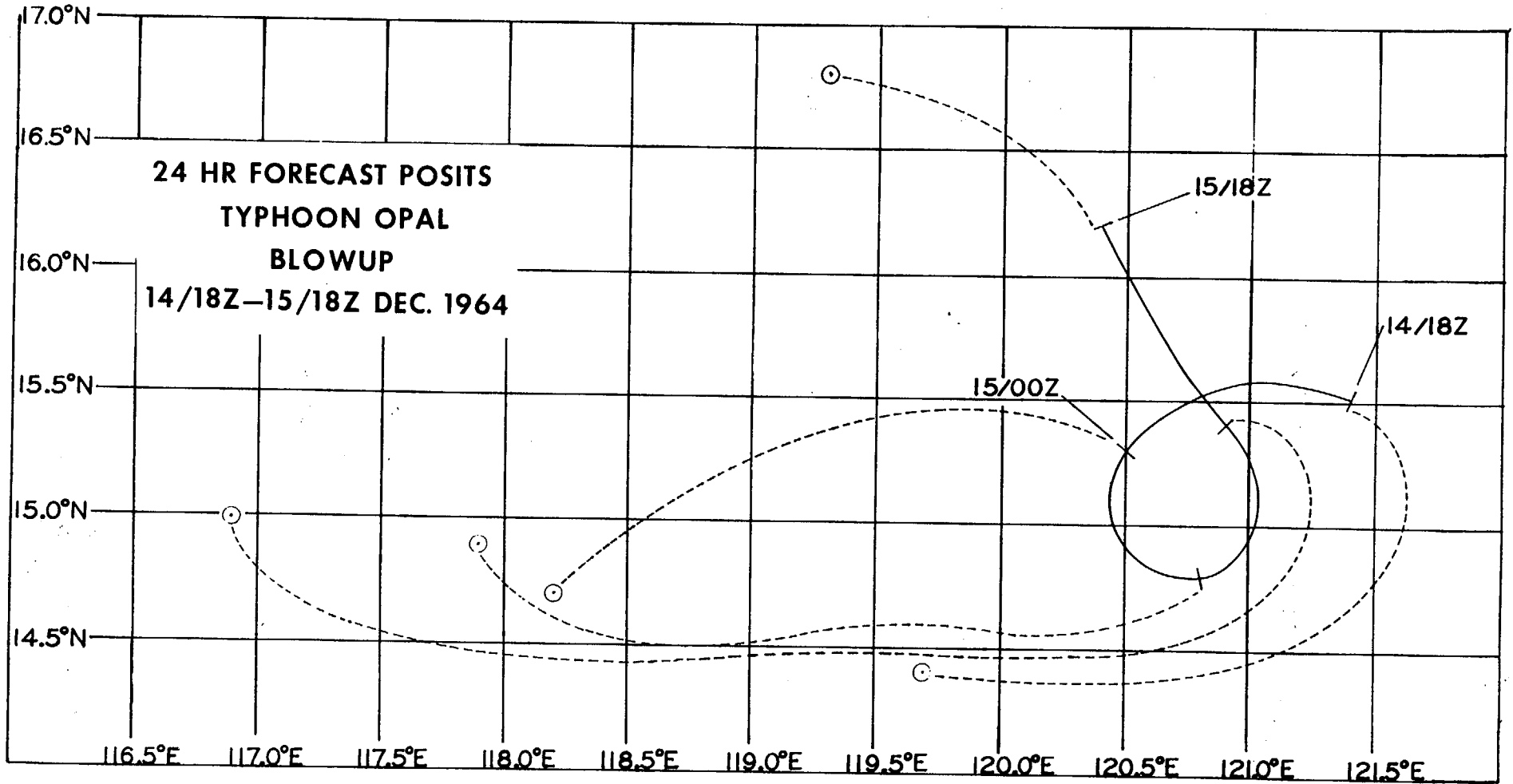
FIX NO.	TIME	POSIT	UNIT-METHOD -ACCY	FLT LVL	FLT LVL WND	OBS SFC WND	OBS MIN SLP	MIN 700MB HGT	FLT LVL TT/TD	REMARKS
35	142240Z	15.5N 120.3E	56-P-1	500MB	45	--	--	--	-5/--	NO WALL CLDS
36	150240Z	15.0N 120.1E	56-P-1	500MB	30	35	--	--	-5/-5	NO WALL CLDS
37	150400Z	14.8N 119.7E	54-R-5	30000ft	40	--	--	--	--/--	OVAL 50 MI DIA WALL CLD 15 MI THICK OPEN NW & SW
38	151006Z	14.9N 120.0E	VW1-P-20	600ft	--	--	992	--	24/15	NO WALL CLDS PRESS CENTER FIXED
39	160000Z	17.5N 119.3E	56-P-2	500MB	30	25	--	--	-6/-6	NO WALL CLDS

TYPHOON OPAL 08 DEC-16 DEC 1964  
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION		24 HOUR ERROR		48 HOUR ERROR	
	LAT.	LONG.	DEG.	DISTANCE	DEG.	DISTANCE
081800Z	05.8N	153.4E	-----		-----	
090000Z	06.1N	151.8E	-----		-----	
090600Z	06.2N	150.2E	-----		-----	
091200Z	06.3N	148.4E	-----		-----	
091800Z	06.6N	146.7E	-----		-----	
100000Z	06.7N	145.1E	-----		-----	
100600Z	07.2N	143.4E	050-	237	-----	
101200Z	07.5N	141.8E	049-	283	-----	
101800Z	07.6N	140.1E	344-	83	-----	
110000Z	07.8N	138.7E	342-	40	-----	
110600Z	08.1N	137.2E	330-	48	225-	430
111200Z	08.3N	135.9E	340-	80	224-	473
111800Z	08.7N	134.8E	320-	75	330-	140
120000Z	09.5N	133.6E	260-	110	280-	75
120600Z	10.4N	132.3E	229-	113	265-	96
121200Z	11.1N	131.1E	213-	120	273-	108
121800Z	11.8N	129.9E	203-	135	265-	135
130000Z	12.2N	128.8E	189-	122	248-	240
130600Z	12.7N	127.6E	312-	50	238-	204
131200Z	13.2N	126.5E	263-	60	222-	177
131800Z	13.7N	125.4E	244-	44	214-	175
140000Z	14.2N	124.4E	245-	70	197-	177
140600Z	14.8N	123.3E	233-	98	264-	121
141200Z	15.2N	122.4E	241-	100	239-	174
141800Z	15.5N	121.4E	237-	115	234-	175
150000Z	15.3N	120.5E	255-	140	243-	193
150600Z	14.8N	120.8E	274-	168	258-	280
151200Z	15.4N	120.9E	262-	235	257-	350
151800Z	16.2N	120.4E	295-	74	252-	325
160000Z	17.1N	120.3E	240-	342	253-	483

AVERAGE 24 HOUR ERROR - 123MI  
AVERAGE 48 HOUR ERROR - 227MI





## APPENDIX A

### ABBREVIATIONS AND DEFINITIONS

1. Certain words that appear frequently in this report are abbreviated as follows:

CINCPAC	Commander in Chief, Pacific
CINCPACAF	Commander in Chief, Pacific Air Force
CIRC	circular
CLD(S)	cloud(s)
CLSD	closed
DEG	degree
DIA	diameter
ELLIP	elliptical
ELONG	elongated
FAFWC	Fuchu Air Force Weather Central, Fuchu Air Station, Japan
54WRS	54th Weather Reconnaissance Squadron, Andersen Air Force Base, Guam, M. I.
56WRS	56th Weather Reconnaissance Squadron, Yokota Air Base, Japan
FNWF	Fleet Numerical Weather Facility, Monterey, California
FWC/JTWC	Fleet Weather Central/Joint Typhoon Warning Center, Guam, M. I.
ITC	Intertropical Zone of Convergence
JMA	Japan Meteorological Agency
JMG PACOM	Joint Meteorological Group, Pacific Command
K (KILO) Time	Mariana Islands local time
MI, mi	nautical miles
MB(S), mb(s)	millibar(s)
MPT	Mid-Pacific trough
NA	not applicable
NMC	National Meteorological Center (formerly JNWP, Joint Numerical Weather Prediction)
SEMI	Semicircle
QUAD(S)	quadrant(s)
VW-1	Airborne Early Warning Squadron ONE, NAS Agana, Guam
WESTPAC	Western North Pacific Area

2. An investigation is the traverse of a reconnaissance aircraft over an area containing a suspected circulation.



3. A fix is the determination of the position of a tropical cyclone at a precise time. Generally, the term "fix" is used when the position of the cyclone has been determined by a reconnaissance aircraft penetration or by airborne, land or ship radar. In the case of a reconnaissance aircraft penetration, the actual fix may be based on one or more of the following: visual observation, radar, surface pressure, surface or upper level winds, constant pressure height, and temperature/dew point.

4. A sortie is defined as a flight by one aircraft with one or more objectives; i.e., it may make one or more fixes and/or one or more investigations on one or more tropical cyclones.

5. The term "tropical cyclone" or "cyclone" as used in this publication has two definitions dependent upon usage.

A. "Tropical cyclone" or "cyclone" is used to describe a suspected tropical cyclonic circulation which appears capable of intensification. Each such circulation is assigned a "cyclone number" for the purposes of reconnaissance to assure that records regarding it are not confused with those of another circulation.

B. "Tropical cyclone" or "cyclone" is used in the general sense, e.g., "Typhoon JOAN was the most intense tropical cyclone of 1959," or "Tropical cyclones more frequently develop during August and September."

(1) A "Tropical Depression" (TD) as used by JTWC is a tropical cyclone with a confirmed cyclonic circulation for which warnings are being issued and whose surface wind speeds do not exceed 33 kts. Tropical depressions are numbered.

(2) A "Tropical Storm" (TS) is a tropical cyclone in which the maximum surface wind speed is no more than 63 kts but greater than 33 kts. Tropical storms are named.

(3) A "Typhoon" is a tropical cyclone located W of 180 DEG longitude in which the maximum surface wind speed is 64 kts or greater.

6. Recurvature - That point at which the cyclone ceases movement to the W of N and commences moving to the E of N.

7. Vortices:

A. Embedded vortex of easterly wave - closed cyclonic circulation along easterly wave and separated from ITC.

B. Junction vortex - closed cyclonic circulation at the junction of easterly wave and ITC.

C. Embedded vortex of ITC - closed cyclonic circulation along ITC with absence of easterly wave.