CHAPTER I

OPERATIONAL PROCEDURES

A. GENERAL

The primary product of the Joint Typhoon Warning Center (JTWC) is the tropical cyclone warning. Operational procedures preceding issuance of a warning include thorough analysis of all reconnaissance reports and conventional synoptic data and the use of various forecasting aids to assist in forecasting movement and intensity.

Hand analyzed charts from Fleet Weather Central Guam and numerical charts produced by Fleet Numerical Weather Central Monterey and Fleet Weather Central Pearl are supplemented by meso-scale and intermediate time analyses at JTWC. Communications services are provided by the Fleet Weather Central Nimitz Hill division of Naval Communications Station, Guam.

B. ANALYSES AND DATA SOURCES

1. FWC ANALYSES:

a. Surface isobaric; 0000Z, 0600Z, 1200Z, and 1800Z.

b. Surface isobaric; micro-analyses of South China Sea; 0000Z, 0600Z, 1200Z, and 1800Z.

c. Gradient level streamlines; 0000Z, 0600Z**, 1200Z, and 1800Z**.

d. 850 mb streamlines; 0000Z and 1200Z. **

e. 700 mb streamlines; 0000Z and 1200Z. **

f. 500 mb streamlines; 0000Z and 1200Z. **

g. 200 mb streamlines; 0000Z and 1200Z. **

h. Sea Surface Temperature Charts; 5-day mean and daily.

i. Checkerboards (Stidd diagrams) of selected tropical stations.

j. Time cross sections of selected tropical stations. *

k. AROWAGRAM for Guam.

* discontinued 1 July
** discontinued 1 Nov

2. JTWC ANALYSES:

a. Sectional surface charts; hourly and 3-hourly as required.

b. Reconnaissance data.

c. 700 mb meso-scale contours; 0000Z and 1200Z.

d. 500 mb meso-scale contours; 0000Z and 1200Z.

e. 300 mb meso-scale contours; 0000Z and 1200Z.

f. Stidd diagram for selected stations as required when special observations are requested.

g. 500 mb contour; Western North Pacific; 0000Z and 1200Z.

3. SATELLITE DATA

JTWC received excellent cloud picture coverage in 1968 from ESSA II and ESSA VI satellite systems and from digitized rectified mosaics transmitted from the ATS satellite. These satellite pictures were extremely valuable in detecting and monitoring tropical disturbances before they reached the tropical depression stage. During 1968 exchange of satellite data with FWC Pearl and FWF Sangley over the NEDN data link became a routine operation providing nearly complete satellite picture coverage of the JTWC area of responsibility on a once daily basis. Determination of tropical cyclone reconnaissance requirements was made on the basis of ESSA II and ESSA VI pictures and analysis of conventional data. It was rarely necessary to schedule synoptic flights for initial detection. Investigative reconnaissance missions requested were confined to cloud masses identified as formative tropical cyclones. Some initial investigative flights reported extensive flat-gradient areas with seas "calm enough for water skis" where satellite picture analysis called for surface circulations up to 35 knots. A tendency to overestimate surface winds from satellite pictures in the early stages of a tropical cyclone existed in many storms of 1968.

Addition of infrared sensors to the planned APT satellites for 1969 will increase coverage by providing pictures twice a day, once during daylight and once in

darkness. This addition will be particularly significant while storms are forming and initial recon requirements are being formulated.

4. Land Radar:

Installation of weather radar at FWC Guam was not completed in time for the 1968 typhoon season; but will be an important addition to the tracking capabilities for storms in the vicinity of Guam in 1969. Extensive use of radar from Andersen AFB aided close-in tracking during 1968. Excellent land radar coverage of tropical storm Polly on August 10th and 11th along Japan aided greatly in tracking and forecasting her unusual southwesterly movement. U. S. Navy ship and land radar fixes on Typhoon Bess as she moved in an erratic southwesterly track toward the Tonkin Gulf were valuable aids. Many other radar reports from the Trust Territories, Taiwan, South Vietnam, Okinawa, Japan and the Philippines contributed significantly to a successful 1968 season.

5. Computer products, 0000Z and 1200Z:

a. Hemispheric analyses and barotropic prognoses for 1000mb, 700mb, 500mb, 300mb, and 200mb.

b. Decomposition fields of the 500mb (SD, SR and SL) analyses and prognoses. The SD, SR, and SL fields correspond to small scale disturbances, mean flow and long wave pattern respectively.

c. Tropical persistence fields from FWC Pearl were used during the year. Computer analysis replaced FWC Guam hand analysis of tropical streamlines for the 700mb, 500mb 400mb 300mb and 200mb levels.

d. The HATRACK typhoon steering program based on SR analysis and prognostic fields was used on an operational time basis for evaluation and as a forecast aid.

e. The TYRACK typhoon steering program was introduced in October and was operationally used and evaluated for the remainder of the season. This program utilizes the FWC Pearl tropical persistence fields for determining forecast movement.

C. FORECAST AIDS

1. CLIMATOLOGY

The following climatological publications were utilized:

a. Tropical Cyclones in the Western Pacific and China Sea Area (Royal Observatory, Hong Kong), covering 70 years of typhoon tracks.

b. Climatological Aid to Forecasting Typhoon Movement (1st Weather Wing).

c. Climatological 24-Hour Typhoon Movement (McCabe, J. T., 1961).

d. Western Pacific Typhoon Tracks, 1950-1959 (FWC/JTWC).

e. Far East Climate Atlas (First Weather Wing February 1963).

f. Annual Typhoon Report, 1965 (FWC/JTWC), covering tracks for 1953-1965.

g. Annual Typhoon Report, 1966 (FWC/JTWC), covering tracks for 1965-1966.

2. PERSISTENCE

Extrapolation of storm movement using average speed and mean direction was the most reliable method for 12 to 24 hour forecast.

3. COMPUTER PRODUCTS:

a. The HATRACK typhoon steering program was run on the FWC Guam computer on an operational basis during 1968. Steering forecasts were made using the decomposition mean Flow Fields (SR) of the 1000mb, 700mb, and 500mb levels for both analysis and prognostic fields through 72 hours. Empirical modification based on apparent error in earlier forecasts was used to obtain improved forecast positions.

b. TYRACK computer forecast steering from the 700mb 500mb 400mb, 300mb mean 700/500mb and mean

700/500/300mb levels were used in October and November.

4. OBJECTIVE TECHNIQUES

During 1968 the following individual objective forecasting methods were employed:

a. ARAKAWA - surface pressure grid model.

b. HATRACK - based on 1000mb SR analysis.

c. HATRACK - based on 1000mb SR prognosis.

d. HATRACK - based on 700mb SR analysis.

e. HATRACK - modified from 700mb SR analysis.

f. HATRACK - based on 700mb SR prognosis.

g. HATRACK - modified from 700mb SR prognosis for 12 hr error.

h. HATRACK - modified from 700mb SR prognosis for 24 hr error.

i. HATRACK - based on 500mb SR analysis.

j. HATRACK - based on 500mb SR prognosis.

k. TYRACK - based on program-selected best steering level from Pearl tropical fields.

Evaluation of these techniques is contained in Chapter III.

D. FORECASTING PROCEDURE

An initial track based on climatology and extrapolation is developed for a 3 to 4 day period. The track is modified by considering the existing and forecast upper air patterns, numerical steering forecasts and the ARAKAWA objective method.

Subsequent forecasts become "educated" by longer period averaging of extrapolation error in speed and direction and through modification of computer forecasts to compensate for errors observed in earlier computer forecasts. A combination of extrapolation and climatol-

ogy is the starting point for each forecast, with meso-scale analysis of the 700, 500 and 300mb charts and the ARAKAWA objective forecast model used to modify or reinforce the extrapolation forecast. Position of tropical cyclones with respect to the 700mb high center and ridge to the north and the 700mb trough or break in the ridge to the west are the primary keys to 24 hour forecasting of recurvature or speed changes. The 200mb level has been used to anticipate changes in itensity through assumptions of divergence in the southeast quadrant and convergence in the southwest quadrant of anticyclones. Tropical cyclones approaching a 200mb anticyclone from the southeast are forecasted to intensify and those emerging from the west side of a 200mb anticyclone are normally forecasted to weaken.

Extended range forecasting is based on extrapolation of the 24 hour track with reversion toward climatology and modified by 500 and 300mb forecast contours.

The resulting official forecast is an integration of both objective and subjective techniques with persistence in speed and direction the weighted favorite for short term forecasts.

E. WARNINGS

Tropical cyclone warnings are numbered consecutively without regard for upgrading or downgrading of the storm between intensity stages. If warnings are discontinued and the storm again intensifies, warnings are numbered consecutively from the last warning issued. Ammended or corrected warnings are given the same number as the warnings they modify. Forecast positions are issued as follows:

Tropical depressions	24 hr
Tropical storms	12, 24 and 48 hr (72 hr at 05Z and 17Z only)
Typhoons	12, 24, and 48 hr (72 hr at 05Z and 17Z only)

Forecast periods are stated with respect to warning time. Thus a 24 hour forecast verifies 26 hours after the aircraft fix data, 29 hours after the latest surface synoptic chart and 29 to 35 hours after the latest

upper air charts.

Warning forecast positions are verified against the corresponding post analysis "best track" positions. A summary of results from 1968 is presented in Chapter III.

F. PROGNOSTIC REASONING MESSAGE

Whenever warnings are being issued, an amplifying message is issued at 06Z and 18Z. This prognostic reasoning message is intended to provide meteorological units ashore and afloat with technical and non-technican reasoning appropriate to the behavior of current storms and the logic of the latest JTWC warnings.

G. TROPICAL WEATHER SUMMARY

This message is issued daily from May through December and otherwise when significant tropical cyclogenesis is forecasted or observed. It is issued at 0600Z and combined with the prognostic reasoning message when warnings are being issued. It describes the location, intensity and likelihood of development of all tropical low pressure areas and significant cloud "blobs" detected by satellite.