

# CHAPTER II - RECONNAISSANCE AND FIXES

## 1. GENERAL

The Joint Typhoon Warning Center depends on reconnaissance to provide necessary, accurate, and timely meteorological information in support of each warning. JTWC relies primarily on three reconnaissance platforms: aircraft, satellite, and radar. In data rich areas synoptic data are also used to supplement the above. Optimum utilization of all available reconnaissance resources is obtained through the Selective Reconnaissance Program (SRP); various factors are considered in selecting a specific reconnaissance platform including capabilities and limitations, and the tropical cyclone's threat to life and property both afloat and ashore. A summary of reconnaissance fixes received during 1984 is included in Section 6 of this chapter.

## 2. RECONNAISSANCE AVAILABILITY

### a. Aircraft

Aircraft weather reconnaissance for the JTWC is performed by the 54th Weather Reconnaissance Squadron (54th WRS) located at Andersen Air Force Base, Guam. The 54th WRS is presently equipped with six WC-130 aircraft and, from July through October, is augmented by three additional aircraft from the 53rd WRS, Keesler Air Force Base, Mississippi, bringing the total number of available aircraft to nine. The JTWC reconnaissance requirements are provided daily to the Tropical Cyclone Aircraft Reconnaissance Coordinator (TCARC), who marries the tasking from the JTWC with the available airframes from the 54th WRS.

As in previous years, aircraft reconnaissance provided direct measurements of height, temperature, flight-level winds, sea-level pressure, estimated surface winds (when observable), and numerous additional parameters. The meteorological data are gathered by the Aerial Reconnaissance Weather Officer (ARWO) and dropsonde operators of Detachment 3, 1st Weather Wing who fly with the 54th WRS. These data provide the Typhoon Duty Officer (TDO) with indications of changing tropical cyclone characteristics, radii of associated winds and current tropical cyclone position and intensity. Another important aspect is the availability of the data for research on tropical cyclone analysis and forecasting.

### b. Satellite

Satellite fixes from USAF/USN ground sites and USN ships provide day and night coverage in the JTWC area of responsibility. Interpretation of this satellite imagery provides tropical cyclone positions and estimates of current and forecast intensities through the Dvorak technique.

### c. Radar

Land radar provides positioning data on well developed tropical cyclones when in the proximity (usually within 175 nm (324 km)) of the radar sites in the Philippines, Taiwan, Hong Kong, Japan, South Korea, Kwajalein, and Guam.

### d. Synoptic

In 1984 JTWC also determined tropical cyclone positions based on the analysis of the surface/gradient level synoptic data. These positions were helpful in situations where the vertical structure of the tropical cyclone was weak or accurate surface positions from aircraft or satellite were not available.

## 3. AIRCRAFT RECONNAISSANCE SUMMARY

During the 1984 tropical cyclone season, the JTWC levied 210 vortex fixes and 53 investigative missions of which 14 were flown into disturbances which did not develop. In addition to the levied fixes, 251 intermediate fixes were also obtained. The average vector error for all aircraft fixes received at the JTWC during 1984 was 12 nm (22 km).

Aircraft reconnaissance effectiveness is summarized in Table 2-1 using the criteria set forth in CINCPACINST 3140.1 (series).

TABLE 2-1. AIRCRAFT RECONNAISSANCE EFFECTIVENESS			
EFFECTIVENESS	NUMBER OF LEVIED FIXES		PERCENT
COMPLETED ON TIME	202		96.1
EARLY	2		1.0
LATE	4		1.9
MISSED	2		1.0
	TOTAL		100.0
LEVIED VS. MISSED FIXES			
AVERAGE 1965-1970	LEVIED	MISSED	PERCENT
	507	10	2.0
1971	802	61	7.6
1972	624	126	20.2
1973	227	13	5.7
1974	358	30	8.4
1975	217	7	3.2
1976	317	11	3.5
1977	203	3	1.5
1978	290	2	0.7
1979	289	14	4.8
1980	213	4	1.9
1981	201	3	1.5
1982	276	17	6.2
1983	157	3	1.9
1984	210	2	1.0

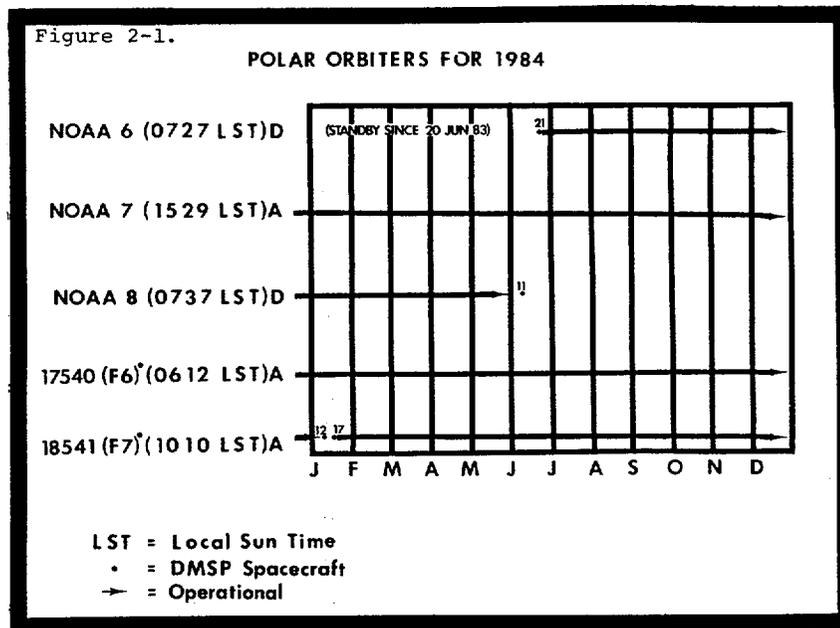
#### 4. SATELLITE RECONNAISSANCE SUMMARY

The Air Force provides satellite reconnaissance support to JTWC using imagery from a variety of spacecraft. The tropical cyclone satellite surveillance network consists of both tactical and centralized facilities. Tactical DMSP sites are located at Nimitz Hill, Guam; Clark AB, Republic of the Philippines; Kadena AB, Japan; Osan AB, Korea; and Hickam AFB, Hawaii. These sites provide a combined coverage that includes most of the JTWC area of responsibility in the western North Pacific from near the dateline westward to the Malay Peninsula. JTWC relies on the Air Force Global Weather Central (AFGWC) to provide coverage over the remainder of its area of responsibility using stored satellite data. The Naval Oceanography Command Detachment, Diego Garcia, provides NOAA polar orbiting coverage in the central Indian Ocean as a supplement to this support. U. S. Navy ships equipped for direct readout also provided supplementary support.

AFGWC, located at Offutt AFB, Nebraska, is the centralized member of the tropical cyclone satellite surveillance network. In support of JTWC, AFGWC processes stored imagery from DMSP and NOAA spacecraft. Imagery processed at AFGWC is recorded onboard the spacecraft as it passes over the earth. Later, these data are downlinked to AFGWC via a network of command/readout sites and communication satellites. This enables AFGWC to obtain the coverage necessary to fix all tropical systems of interest to JTWC. AFGWC has the primary responsibility to provide tropical cyclone surveillance over the entire Indian Ocean, southwest Pacific, and portions of the western North Pacific on both sides of the dateline. Additionally, AFGWC can be tasked to provide tropical cyclone positions in the entire western North Pacific as backup to coverage routinely available in that region.

The hub of the network is Det 1, 1WW, collocated with JTWC on Nimitz Hill, Guam. Based on available satellite coverage, Det 1 coordinates satellite reconnaissance requirements with JTWC and tasks the individual network sites for the necessary tropical cyclone fixes. Therefore, when a position from a polar-orbiting satellite is required as the basis for a warning, called a "levied fix", a dual-site tasking concept can be applied. Under this concept, two sites are tasked to fix the tropical cyclone from the same satellite pass. This provides the necessary redundancy to virtually guarantee JTWC a successful satellite fix on the tropical cyclone. Using this dual-site concept, the satellite reconnaissance network is capable of meeting all of JTWC's levied satellite fix requirements.

The network provides JTWC with several products and services. The main service is one of surveillance. Each site reviews its daily satellite coverage for indications of tropical cyclone development. If an area exhibits the potential for development, JTWC is notified. Once JTWC issues either a formation alert or warning, the network is tasked to provide three products: tropical cyclone positions, intensity estimates, and 24-hour intensity forecasts. Satellite tropical cyclone positions are assigned position code numbers (PCN) depending on the availability of geography for precise gridding, and the degree of organization of the tropical cyclone's cloud system (Table 2-2). During 1984, the network provided JTWC with a total of 1971 satellite fixes on tropical systems in the western North Pacific. Another 184 fixes were made for tropical systems in the North Indian Ocean. A comparison of those fixes made on numbered tropical cyclones in the western North Pacific with their corresponding JTWC best track positions is shown in Table 2-3. Estimates of the tropical cyclone's current intensity and 24-hour intensity forecast are



made once each day by applying the Dvorak technique (NOAA Technical Memorandum NESDIS 45 as revised) to visual imagery. A similar technique using enhanced infrared imagery is under development.

Four polar orbiters were available throughout the season. Figure 2-1 shows the status of operational polar orbiters. NOAA 6 was reactivated a year after being placed in standby mode (20 June 1983) to compensate for the untimely loss of NOAA 8. Although not shown NOAA 9 was successfully launched on 12 December and should be of benefit in 1985.

## 5. RADAR RECONNAISSANCE SUMMARY

Fourteen of the 30 significant tropical cyclones in the western North Pacific during 1984 passed within range of land based radar with sufficient cloud pattern organization to be fixed. The land radar fixes that were obtained and transmitted to JTWC totaled 510. Two radar fixes were obtained by reconnaissance aircraft.

The WMO radar code defines three categories of accuracy: good (within 10 km (5nm)), fair (within 10 to 30 km (5 to 16 nm)), and poor (within 30 to 50 km (16 to 27nm)). This year 510 radar fixes were coded in this manner; 167 were good, 156 were fair, and 187 poor. Compared to the JTWC best track, the mean vector deviation for land radar sites was 20 nm (37 km). Excellent support through timely and accurate radar fix positioning allowed JTWC to track and forecast tropical cyclone movement through even the most difficult erratic tracks.

As in previous years, no radar reports were received on North Indian Ocean tropical cyclones.

TABLE 2-2. POSITION CODE NUMBERS

PCN	METHOD OF CENTER DETERMINATION/GRIDDING
1	EYE/GEOGRAPHY
2	EYE/EPHEMERIS
3	WELL DEFINED CC/GEOGRAPHY
4	WELL DEFINED CC/EPHEMERIS
5	POORLY DEFINED CC/GEOGRAPHY
6	POORLY DEFINED CC/EPHEMERIS

## 6. TROPICAL CYCLONE FIX DATA

A total of 2918 fixes on 30 western North Pacific tropical cyclones and 193 fixes on four North Indian Ocean tropical cyclones were received at JTWC. Table 2-4, Fix Platform Summary, delineates the number of fixes per platform for each individual tropical cyclone. Season totals and percentages are also indicated.

Annex A includes individual fix data for each tropical cyclone. Fix data are divided into four categories: Satellite, Aircraft, Radar, and Synoptic. Those fixes labeled with an asterisk (\*) were determined to be unrepresentative of the surface center and were not used in determining the best tracks. Within each category, the first three columns are as follows:

FIX NO. - Sequential fix number

TIME (Z) - GMT time in day, hours and minutes

FIX POSITION - Latitude and longitude to the nearest tenth of a degree

TABLE 2-3. MEAN DEVIATION (NM) OF ALL SATELLITE DERIVED TROPICAL CYCLONE POSITIONS FROM THE JTWC BEST TRACK POSITIONS. NUMBER OF CASES (IN PARENTHESES).

PCN	WESTERN NORTH PACIFIC OCEAN				NORTH INDIAN OCEAN			
	1972-1983 AVERAGE		1984		1980-1983		1984	
	(ALL SITES)		(ALL SITES)		(ALL SITES)		(ALL SITES)	
1	13.7	(1843)	12.4	(119)	16.2	(27)	17.8	(13)
2	17.3	(802)	15.7	(97)	9.0	(4)	32.1	(3)
3	20.3	(2691)	23.6	(259)	21.8	(11)	19.0	(2)
4	23.1	(999)	25.1	(134)	21.8	(5)	136.0	(3)
5	36.8	(4395)	43.6	(317)	33.1	(87)	36.5	(84)
6	40.9	(2298)	42.4	(265)	35.1	(83)	62.7	(23)
1&2	14.4	(2645)	13.9	(216)	15.5	(31)	20.5	(16)
3&4	20.9	(3690)	24.1	(393)	26.3	(16)	89.2	(5)
5&6	38.0	(6693)	43.0	(582)	32.2	(170)	42.2	(107)
TOTAL NUMBER OF CASES	(13028)		(1191)		(217)		(128)	

TABLE 2-4. FIX PLATFORM SUMMARY FOR 1984

FIX PLATFORM SUMMARY

<u>WESTERN NORTH PACIFIC</u>			<u>AIRCRAFT</u>	<u>SATELLITE</u>	<u>RADAR</u>	<u>SYNOPTIC</u>	<u>TOTAL</u>
TS	VERNON	(01W)	--	26	--	--	26
TS	WYNNE	(02W)	23	103	37	3	166
TY	ALEX	(03W)	5	40	34	3	82
TS	BETTY	(04W)	2	62	31	--	95
TY	CARY	(05W)	29	85	--	--	114
TY	DINAH	(06W)	28	85	--	--	113
TY	ED	(07W)	19	82	102	--	203
TS	FREDA	(08W)	5	39	12	--	56
TD	09W	(09W)	2	63	--	--	65
TS	GERALD	(10W)	9	68	52	3	132
TY	HOLLY	(11W)	21	81	117	1	220
TD	12W	(12W)	2	19	--	--	21
TY	IKE	(13W)	33	110	38	3	184
TS	JUNE	(14W)	7	46	14	--	67
TY	KELLY	(15W)	11	57	--	--	68
TS	LYNN	(16W)	--	41	--	2	43
TS	MAURY	(17W)	13	23	--	--	36
TS	NINA	(18W)	2	34	2	--	38
TY	OGDEN	(19W)	9	42	--	--	51
TY	PHYLLIS	(20W)	10	37	--	--	47
TS	ROY	(21W)	6	26	--	--	32
TS	SUSAN	(22W)	--	26	--	--	26
TD	23W	(23W)	1	11	--	--	12
TY	THAD	(24W)	14	60	--	--	74
STY	VANESSA	(25W)	27	114	13	--	154
TY	WARREN	(26W)	22	112	12	1	147
TY	AGNES	(27W)	19	108	4	--	131
STY	BILL	(28W)	46	163	44	--	253
TY	CLARA	(29W)	28	93	--	2	123
TY	DOYLE	(30W)	24	115	--	--	139

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TOTAL	417	1971	512	18	2918
% OF TOTAL NR OF FIXES	14.3	67.6	17.5	.6	100.0

<u>INDIAN OCEAN</u>		<u>SATELLITE</u>	<u>SYNOPTIC</u>	<u>TOTAL</u>
TC	01A	18	--	18
TC	02B	40	2	42
TC	03B	37	3	40
TC	04B	89	4	93

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TOTAL	184	9	193
% OF TOTAL NR OF FIXES	95.3	4.7	100.0

Depending upon the category, the remainder of the format varies as follows:

a. Satellite

(1) ACCRY - Position Code Number is used to indicate the accuracy of the fix position. A "1" or "2" indicates relatively high accuracy and a "5" or "6" relatively low accuracy.

(2) DVORAK CODE - Intensity evaluation and trend (Figure 2-2, Table 2-5). (For specifics, refer to NOAA TM; NESDIS - 45).

(3) COMMENTS - For explanation of abbreviations, see Appendix I.

(4) SITE - ICAO call sign of the specific satellite tracking station.

b. Aircraft

(1) FLT LVL - The constant pressure surface level, in millibars or altitude, in feet, maintained during the penetration. The normal level flow in developed tropical cyclones, due to turbulence factors, is 700 mb. Low-level missions are normally flown at 1500 ft (457 m).

(2) 700 MB HGT - Minimum height of the 700 mb pressure surface within the vortex recorded in meters.

(3) OBS MSLP - If the surface center can be visually detected (e.g., in the eye), the minimum sea-level pressure is obtained by a dropsonde release above the surface vortex center. If the fix is made at the 1500-foot level, the sea level pressure is extrapolated from that level.

(4) MAX-SFC-WND - The maximum surface wind (knots) is an estimate made by the ARWO based on sea state. This observation is limited to the region of the flight path and may not be representative of the entire tropical cyclone. Availability of data is also dependent upon the absence of undercast conditions and the presence of adequate illumination. The positions of the maximum flight level wind and the maximum observed surface wind do not necessarily coincide.

(5) MAX-FLT-LVL-WND - Wind speed (knots) at flight level is measured by the AN/APN 147 doppler radar system aboard the WC-130 aircraft. This measurement may not represent the maximum flight level wind associated with the tropical cyclone because the aircraft only samples those portions of the tropical cyclone along the flight path. In many instances, the flight path is through the weak sector of the tropical cyclone. In areas of heavy rainfall, the doppler radar may track energy reflected from precipitation rather than from the sea surface, thus, preventing accurate wind speed measurement. In obvious cases, such erroneous wind data will not be reported. In addition, the doppler radar system on the WC-130 restricts wind measurements to drift angles less than or equal to 27 degrees if the wind is normal (perpendicular) to the aircraft heading.

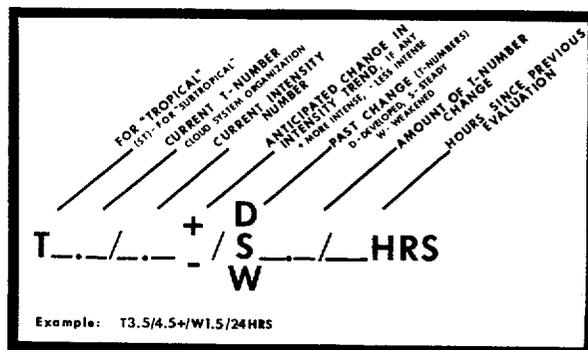


Figure 2-2. The current T-number is 3.5 but the current intensity estimate is 4.5 (equivalent to 77 kt). The cloud system has weakened by 1.5 T-numbers since the previous evaluation conducted 24 hours earlier. The plus (+) symbol indicates an expected reversal of the weakening trend or very little further weakening of the tropical cyclone during the next 24-hour period.

TABLE 2-5. MAXIMUM SUSTAINED WIND SPEED (KT) AS A FUNCTION OF DVORAK CI & FI (CURRENT & FORECAST INTENSITY) NUMBER AND MINIMUM SEA LEVEL PRESSURE (MSLP)

TROPICAL CYCLONE INTENSITY NUMBER	WIND SPEED	MSLP (NW PACIFIC)
0.0	<25	--
0.5	25	--
1.0	25	--
1.5	25	--
2.0	30	1003
2.5	35	999
3.0	45	994
3.5	55	988
4.0	65	981
4.5	77	973
5.0	90	964
5.5	102	954
6.0	115	942
6.5	127	929
7.0	140	915
7.5	155	900
8.0	170	884

(6) ACCRY - Fix position accuracy. Both navigational (OMEGA and LORAN) and meteorological (by the ARWO) estimates are given in nautical miles.

(7) EYE SHAPE - Geometrical representation of the eye based on the aircraft radar presentation. The eye shape is reported only if the center is 50 percent or more surrounded by wall cloud.

(8) EYE DIAM/ORIENTATION - Diameter of the eye in nautical miles. When an elliptical eye is present, the lengths of the major and minor axes and the orientation of the major axis are respectively listed. When concentric eye walls are present, each diameter is listed.

c. Radar

(1) RADAR - Specific type of

platform (land, aircraft, or ship) utilized for fix.

(2) ACCRY - Accuracy of fix position (good, fair, or poor) as given in the WMO ground radar weather observation code (FM20-V).

(3) EYE SHAPE - Geometrical representation of the eye given in plain language (circular, elliptical, etc.).

(4) EYE DIAM - Diameter of eye given in kilometers.

(5) RAOB CODE - Taken directly from WMO ground weather radar observation code FM20-V. The first group specifies the vortex parameters, while the second group describes the movement of the vortex center.

(6) RADAR POSITION - Latitude and longitude of tracking station given in tenths of a degree.

(7) SITE - WMO station number of the specific tracking station.