CHAPTER II — RECONNAISSANCE & COMMUNICATION

1. GENERAL

During the 1972 typhoon season there were three primary methods--satellite, radar, and aircraft--utilized to accomplish reconnaissance. Aircraft reconnaissance remained the primary means for cyclone reconnaissance; however, greater emphasis was placed on the use of satellite-derived information due to a reduction of reconnaissance resources in November 1971.

2. RECONNAISSANCE RESPONSIBILITY AND SCHEDULING

Aircraft weather reconnaissance is performed in the JTWC area by the 54th Weather Reconnaissance Squadron (54 WRS). The squadron, composed of nine WC-130 aircraft, is located at Andersen Air Force Base, Guam.

The JTWC reconnaissance schedule is sent daily to the Tropical Cyclone Reconnaissance Coordinator. This schedule includes areas to be investigated, forecast positions of cyclones to be fixed and standard synoptic tracks to be flown.

Four fixes per day, at six-hour intervals, are required on all significant tropical cyclones in the JTWC primary area of responsibility (see inside front cover). Two fixes per day are required in the secondary area. Additional fixes and other information may be requested by operational commanders through the JTWC (CINCPAC-INST 3140.1K, 1971).

3. AIRCRAFT RECONNAISSANCE SUMMARY

Beginning with Typhoon Lola in May, the JTWC employed satellite and radar, on a selective basis, to position tropical cyclones in order to conserve aircraft and crews. Of 713 required fixes, 15% were obtained by satellite or radar. By selecting the mode of fixing, 109 fixes were eliminated from the aircraft levy. Of the 127 investigative missions required, 38% were performed by satellite, conserving 48 aircraft sorties. Whenever observing conditions permitted, satellite and radar were utilized, except in instances where aircraft fixes were required by operational commanders.

Table 2-1 summarizes aircraft reconnaissance fixes. 624 fixes were levied of which 538 or 86.2% were 6-hourly. The intermediate fixes (3-hourly) accounted for 12.5% and there were three 1-hourly fixes levied. Five fixes were levied for the Bay of Bengal area representing 0.8% of the total.

The aircraft missions for 1972 included 17 synoptic tracks, 81 investigatives and 624 fixes. The lower half of Table 2-1 compares the total of 705 fixes and investigatives levied with the annual average of 706 compiled over a 10-year period. The coverage provided by SRP reduced this total from 862 required fixes and investigatives. This is a total savings of 19% from May. Reconnaissance effectiveness, the top of Table 2-2, separates the fixes into 6-hourly, 3-hourly, and 1-hourly categories. Of a total of 624 fixes levied, 126 were missed. This represents a 20.2% missed rate as compared to the 1971 average of 7.6%. These statistics were developed by the same system of crediting fixes as was used in 1971 (FWC/JTWC, 1971).

In addition to the fixes missed, 2.1% and 8.5% of the fixes were too early or too late respectively. This is a 5% increase from the previous year. Early and late fixes are considered together as each degrades the quality of warnings.

The bottom half of Table 2-2 compares fixes levied with fixes missed. During the

TABLE 2-1. FIX SUMMARY

538	6-HRLY FIXES LEVIED (WESTPAC)	86.2%
78	INTERMEDIATE (3-HRLY FIXES)	12.5%
3	1-HRLY FIXES	0.5%
5	FIXES IN SECONDARY AREA (BAY OF BENGAL)	0.8%
624		

COMPARISON OF FIXES AND INVESTIGATIVES LEVIED IN 1972 TO LONG TERM AVERAGE

LEVIED FIXES	624
LEVIED INVESTIGATIVES	81
	705

ANNUAL AVERAGE LEVIED FIXES/INVESTIGATIVES 706 (1962 - 1971)

TABLE 2-2. RECONNAISSANCE EFFECTIVENESS

	ALL	6 HRLY	3 HRLY	1 HRLY
COMPLETED ON TIME	433	370	60	3
EARLY	13	10	3	0
LATE	52	46	6	0
MISSED	126	117	9	0
TOTAL	624	543	78	3

LEVIED VS. MISSED FIXES

		LEVIED	MISSED	PERCENT
AVERAGE	1965-1970	507	10	2.0%
	1971	802 (620 6HR, 182 3HR)	61 (44 6HR, 17 3HR)	7.6%
	1972	624 (543 6HR, 78 3HR, 3 1HR)	126 (117 6HR, 9 3HR)	20.2%

period from 1965-1970, when a different crediting criteria was used, an average of 2% of all fixes were missed. In 1971 a more rigid system of scoring reconnaissance was adopted, resulting in an increase in the missed-fix ratio. This season, continuing with the 1971 criteria, a large increase was noted, especially in the 6-hourly rate. The combined 6-hourly and 3-hourly missed-fix percentage rate was 2-1/2 times the 1971 rate.

Figure 2-1 compares fixes missed to the monthly fix requirements and multiple-storm days. The 174 fixes levied in July account for about 28% of all fixes levied in 1972. July also included 44% of the multiple-storm days (20) and 40% of the fixes missed (50).

Figure 2-2 compares the percentage of fixes and investigatives missed/late versus the number of storms per day. Thirty-two percent of the annual total of levied fixes and investigatives were missed on four-storm days. This illustrates the load that is placed on the aircraft reconnaissance assets during periods of multiple-storm days. Despite the 48 sorties and 109 fixes obtained by satellite and radar, the percentage of fixes missed/late on single-storm days was twice as large as the average for 1971.

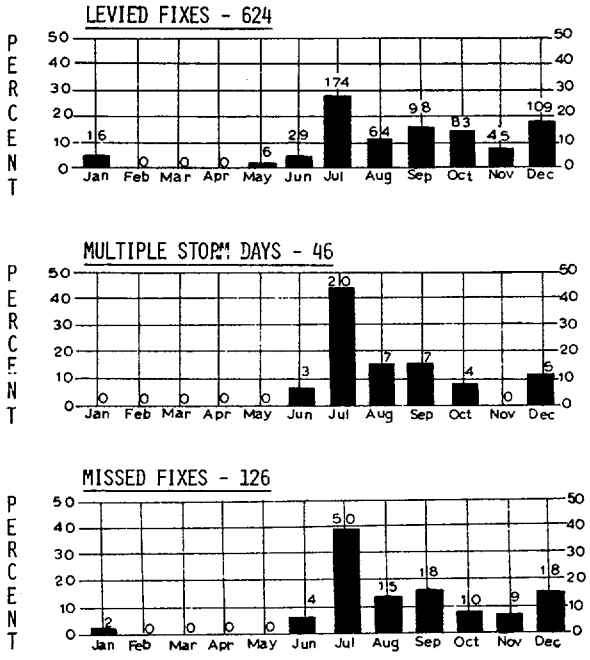

FIGURE 2-1. *Missed fixes for 1972 compared to monthly fix requirements and multiple storm days.*

Figure 2-3 relates levied requirements to multiple-storm days and missed fixes/investigatives by month. The major peaks occurred in July and September when four tropical cyclones were active concurrently. The peak in October was a result of almost continuous storm activity. The peak in December resulted from a period of two concurrent storms.

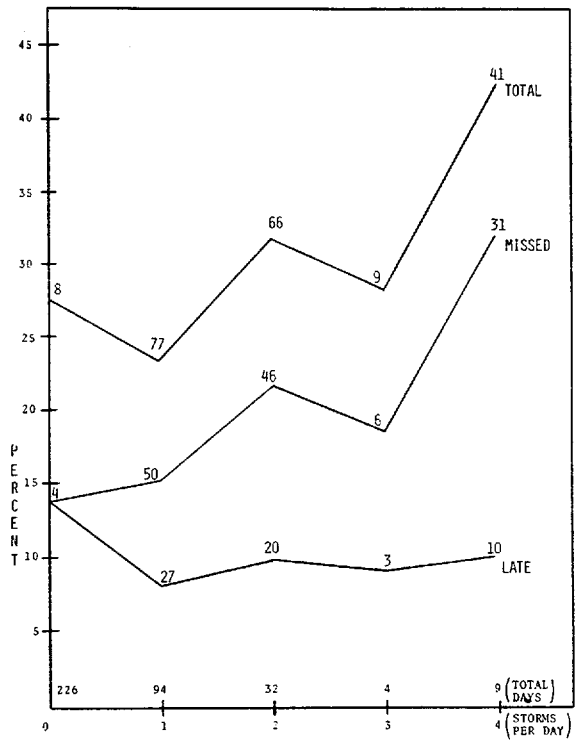

FIGURE 2-2. *Percentage of fixes and investigatives missed/late vs. storms per day.*

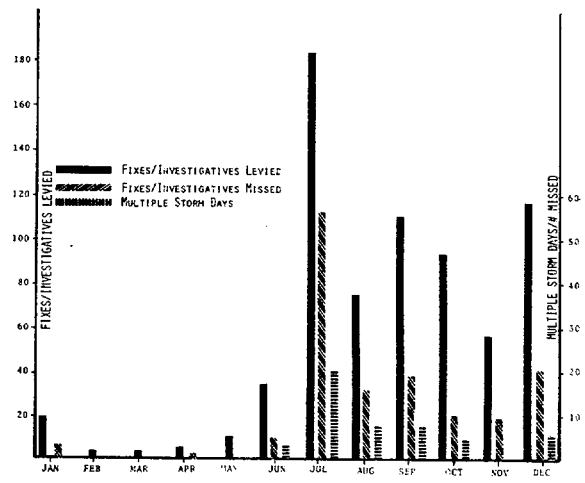

FIGURE 2-3. *Levied requirements vs. missed fixes/investigatives as related to multiple storm days.*

4. RADAR RECONNAISSANCE SUMMARY

Over 700 land and ship radar reports were received during the 1972 season. These reports are normally received hourly whenever a storm is within the envelope of radar coverage. The majority of the reports from land stations were from Japan, including the Ryukyus and Taiwan. Radar reports from ships were received almost exclusively from the South China Sea.

Since the radar is normally remote from the storm, ability to position a cyclone is a function of signal attenuation, range, organization of the cyclone and operator skill (NAVAIR 50-1P-2, 1967). The mean deviation, from the best track, for all radar reports on cyclones was 17 nm. The mean deviation for radar reports on cyclones of typhoon strength was 16 nm.

Positioning errors occurred when the wall cloud was weak or open, creating false impressions of the actual storm movement. During Typhoon Betty, for example, land radars reported her stationary from 160800Z until 161100Z at which time they showed her tracking southeast. During this time Betty was actually moving north-northwest at 13 kt. Positioning errors also generate unrealistic speed movements. Radar fix-to-fix computations produced some speeds in excess of 200 kt.

Another source of positioning error is present when a storm is near the maximum radar range. In these cases the radar paints only the tops of clouds near the wall and a complete presentation of the eye, if defined, is not possible.

Despite these errors and limitations, radar was used very effectively to track cyclones. Typhoon Lorna provided an excellent example of the efficacy of radar for tracking a well-developed tropical cyclone. Lorna was tracked solely by radar from 1240Z on the 1st of October through 0540Z on the 5th. Due to geographic flight restrictions, aircraft were unable to penetrate during this period.

5. COMMUNICATIONS

a. AIR TO GROUND:

Current air-to-ground communications procedures were implemented five years ago and functioned effectively in 1972. Reconnaissance information is normally received from the aircraft by JTWC via voice phone patch through Andersen, and occasionally from Clark aeronautical station. If the transmission from the aircraft is not of patch quality, data can be relayed over the telephone by the weather monitor in the aeronautical station. If the weather monitor can not complete a direct phone patch or relay, he places the message on a teletype circuit but this usually results in excessive delay.

Figure 2-4 compares the 33.8 minute average delay in receipt of center data messages in 1972 with recent years. Under ideal circumstances the weather observer transmits the complete message 20 to 25 minutes after fixing the center of the storm. The small rise in delay times noted in 1971 and 1972 is attributed to the number of multiple-cyclone situations in those years and the system's inability to handle more than one voice report at a time.

Table 2-3 shows that the percent of fix messages received over one hour after fix time remained nearly constant in recent years, but the percent of fix messages received after warning time rose significantly in 1971 and again in 1972.

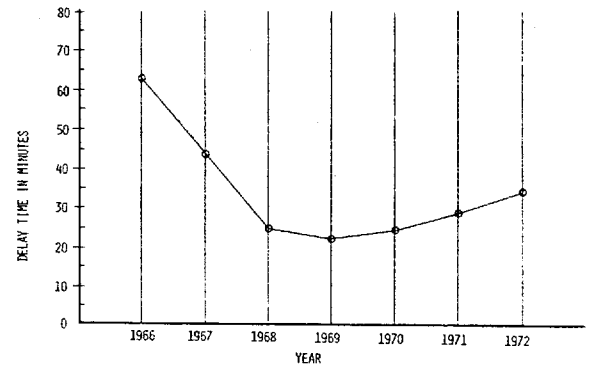

FIGURE 2-4. *Comparison of 1972 average delay times with those of previous years.*

The preliminary eye data message was instituted in 1972 as a means of reducing the delay in receipt of position and intensity information. These preliminary messages are much shorter than the complete report and reduce the time required for preparation and transmission. Figure 2-5 illustrates that the delay in receipt of this information is nearly halved by the use of the preliminary messages. The solid bars represent the delay of the complete center data message and hatched bars portray preliminary message delays. The number of reports considered are in parentheses.

TABLE 2-3. 1972 AIR/GROUND DELAY STATISTICS COMPARED WITH PREVIOUS YEARS

	1967	1968	1969	1970	1971	1972
% FIX MESSAGES DELAYED OVER ONE HOUR	16%	4%	3%	5%	6%	6%
% FIX MESSAGES RECEIVED AFTER WARNING TIME	3.1%	0.7%	0.6%	0.9%	2.1%	5.5%

Figure 2-5 also illustrates the difference in delay times between the various means of delivery; phone patch and relay being the most expeditious while the infrequently-used teletype relay resulted in delays of over 55 minutes. Most fix reports from the Bay of Bengal had to be relayed due to weak signal strength or inability of the aircraft to raise Clark Airways. This resulted in considerable delay in receipt of the data.

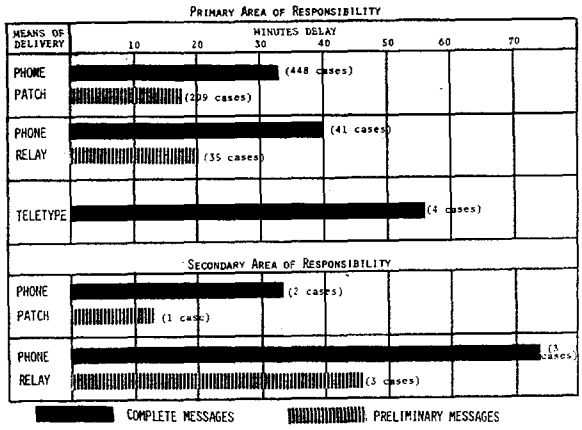

FIGURE 2-5. *1972 eye message delay statistics.*

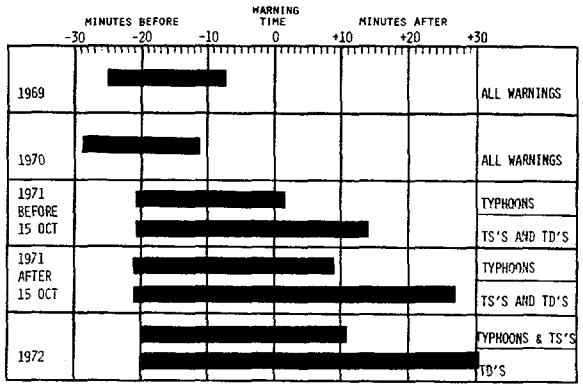

FIGURE 2-6. *AUTODIN message handling times.*

b. OUTGOING COMMUNICATIONS:

The present warning handling procedure was initiated in October 1971. By agreement with the Nimitz Hill Message Center, a special content indicator causes warnings to be placed in the communications system before other IMMEDIATE but after FLASH traffic awaiting transmission. Typhoon and tropical storm warnings are handled in this manner while tropical depression warnings are treated as normal IMMEDIATE messages.

Figure 2-6 shows a comparison of the delays encountered in transmission of warning messages in 1972 with the years through 1969. In 1972, warnings were delivered to the Nimitz Hill Message Center an average of 20 minutes before warning time (represented by the left-hand limit of the bar) and transmitted on AUTODIN an average of 30.7 minutes later (represented by the right-hand limit of the bar). This closely parallels the delays realized in 1971 after the use of the special content indicator was initiated. These statistics represent the average time required to enter the warnings into the communications system. Actual time of receipt at a station depends on factors beyond the control of JTWC or its servicing communications center.

REFERENCES:

CINCPACINST 3140.1K, "Tropical Cyclone Operations Manual," III-2, Sect 3.3.1, November 1971.

FWC/JTWC, Annual Typhoon Report, Guam, Marianas Islands, p 2-13, 1971.

NAVAIR 50-1P-2, Weather Radar Manual, Ch. 3, August 1967.