

Tropical Cyclone Leo 24/03/1977 to 28/03/1977

(i) General

Cyclone "Leo" was the fifth and last tropical cyclone of the season. It was the third to occur near the northwest coast of Australia. A preexisting depression moved off the West Kimberley coast and developed to tropical cyclone intensity as it moved southwestward. When located to the north of Port Hedland it recurved southward and then southeastward and crossed the coast. It was at its most intense stage when it crossed the coast with a central pressure estimated to be 955 mb and maximum winds estimated to be 165 km/h.

Considerable damage was caused by the strong winds and flooding in coastal and nearby inland areas along "Leo's" path. Total damage was estimated at about \$3 million.

(ii) Development

On 21 March a low pressure area, 1004 mb, was centred about 130 km west of Darwin. The low moved inland over the northern part of the Kimberley and further deepening was temporarily prevented. On 24 March the low moved offshore near Adele Island and began intensifying. Development occurred rapidly and on the morning of 26 March the cyclone had reached the T 5 stage in the Dvorak classification. At that time the central pressure was estimated to be about 965 mb. The tropical cyclone probably continued to intensify during that day reaching its peak intensity at about the same time as it made landfall just before 261845 GMT. The minimum central pressure was probably about 955 mb. At 262000 GMT a mean sea level pressure of 981 mb was reported from Port Hedland. This was the lowest measured pressure associated with "Leo".

After landfall the cyclone moved southeastward and filled rapidly.

(iii) Features of the Track

The path followed by "Leo" is depicted in Figure 5.1. "Leo" had a lifetime of four days and travelled about 1400 km crossing the coast near Spit Point about 50 km northeast of Port Hedland at about 261845 GMT. The system described a classical track moving firstly southwesterly and then recurving to the south and later the southeast. Landfall however was farther north than is climatologically usual in March.

When the low pressure system which had been present over the northern part of Western Australia for some days previously moved off the coast near Kuri Bay on 24 March it travelled in a westerly direction at about 16 km/h. Near Adele Island the direction of motion became more southwesterly but the speed remained constant at about 16 km/h. As the system deepened it slowed to about 10 km/h and on 26 March recurved to a southerly direction. After about 12 hours motion towards the south "Leo" began moving in a southsoutheasterly direction still at about 12 km/h. After crossing the coast the direction and speed were maintained for several hours but as the cyclone weakened its course became eastsoutheasterly at 16 km/h.

The early recurvature of the cyclone was probably associated with the approach of a deep upper level trough from the southwest associated with a significant cold front which entered the southwestern part of the State on 26 March and continued to move eastward thereafter.

(iv) Rainfall, Flooding and Flood Damage

The area of heavy rainfall closely paralleled the track of the cyclone after landfall. Figure 5.2 shows the 48 hour isohyeta for the period ending 0900 WST 28 March. The highest totals were 375 mm at Lalla Rookh and 228 mm at Strelley. 152 mm fell at Port Hedland in the same period.

After the cyclone creeks and rivers in the affected area were reported to be running at high levels; the Coongan River was said to be "at its highest for many years". The Nullagine River was reported in flood, roads near Port Hedland were flooded and serious washaways occurred in the Port Hedland, Goldsworthy and Marble Bar areas. The Port Hedland to Goldsworthy railway was cut by the flood water of the Strelley and De Grey Rivers.

(v) Winds and Wind Damage

From reports received it seems there were no ships at any time close to the cyclone's centre. The maximum wind reported from a ship was 80 km/h by the "Shinzui Maru" at 250400 GMT. The ship was then about 160 km northnorthwest of the centre and the wind westerly. Selected ship reports are given in Table 5.1.

Over land the highest wind gust reported was 200 km/h at Port Hedland at 0401 WST 27 March when the wind was southerly. This gust occurred when "Leo" had crossed the coast but was at its closest point to Port Hedland. As "Leo" approached from the north the southeasterly winds at Port Hedland reached gale force (63 km/h) about 261330 GMT. The winds gradually veered to the south but they did not drop below gale force until about 270200 GMT.

At 270400 GMT Marble Bar reported a southeasterly wind of 84 km/h. "Leo" was then very close to that station.

Wind damage to structures and trees was reported from several towns and stations. The roofs of about 40 houses were damaged in Port Hedland. At Marble Bar and Goldsworthy some roofs were either completely removed or were partly damaged. Windmill damage was sustained at Bamboo Springs and Wallal and presumably at many other stations.

(vi) Seas, Swell, Storm Surges and Related Damage

Seas and swell estimates are included in the selected ship reports in Table 5.1. The highest seas reported were 3.5 m experienced by the "Shinzui Meru" at 251300 and 252300 GMT when the ship was north of the cyclone centre at distances of 240 km and 290 km respectively.

The highest swell reported was 5 m from the "Niihata Maru" at 260600 GMT when the ship was 215 km westnorthwest of "Leo".

No storm surges were reported.

At Port Hedland several commercial and private vessels sustained damage.

(vii) Satellite Analysis

The NOAA 5 meteorological satellite passed over the Region twice each. day. Selected data from NOAA 5 is given in Table 5.2. A cloud mass associated with a surface low pressure system moved from the Joseph Bonaparte Gulf on 21 March across the northern part of the Kimberley. In the photograph NOAA 5 of 232357 GMT orbit 2937 it was apparent that the cloud mass would move off the coast near Kuri Bay and that development into a tropical cyclone was highly likely. Rapid development did occur, for in the photograph NOAA 5 242313 GMT orbit 2949, the system was assessed as T 3.5 in the Dvorak classification. The cyclone at this time appeared in the cloud photograph as possessing a small central dense overcast (CDO) and a broad outer cloud band encircling about one half of the CDO. In the subsequent 24 hours the rapid development continued. The CDO became larger and the broad band completely encircled the CDO. The Dvorak assessment was T 5 at this time. It is likely that deepening proceeded further during 26 March but no further visual photographs were received until the morning of 27 March, By that time "Leo" had moved inland and the cloud system was breaking up.

(viii) Radar Reports

Tropical cyclone "Leo" was tracked by meteorological radar at both Broome and Port Hedland during stages of its movement.

At 250100 GMT the edge of the "eye" of the cyclone was visible on the Broome radar and it remained visible until 251000 GMT after which time the "eye" moved out of range. At no time was the "eye" closer than 200 km to Broome thus the radar echoes are those from the mid-troposphere.

Regular radar observations were made at the Port Hedland Meteorological radar from 251215 GMT to 270145 GMT. At 251915 GMT a part of the eye- wall became visible. From that time until 270145 GMT when the system was inland near Carlindi Station the "eye" of the cyclone was continually tracked. The radar reports show that landfall was made between 261815 GMT and 261845 GMT and that "Leo" passed within about 50 km of Port Hedland.

Estimates of the eye diameter based on radar reports indicate that the eye decreased in size from about 75 km when "Leo" was 200 km north of Port Hedland to about 55 km when it was 150 km north of Port Hedland. Subsequently the eye decreased again as "Leo" approached the coast and was about 45 km in diameter at landfall. During the next few hours the "eye" became even smaller reaching a minimum size of about 25 km when 75 km eastsoutheast of Port Hedland. The varying altitude at which the radar intersects the cyclone at different distances from the radar site is probably important in explaining the initial decrease in diameter.

Table 5.1 Selected Ship Reports

Ship	Position °S °E	Date/ Time	Bearing/ Distance	Wind Direction/	Sea (m)	Swell (m)	Weather	Pressure (mb)
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			(GMT)	from Centre (km)	Speed (km/h)				
Shinzui Maru	15.0	120.2	250400	NNW 200	W 80	3.0	W3.5	Moderate continuous rain	1005.5
Shinzui Maru	15.2	119.5	251300	N 225	W 59	3.5	NW3.5	Rain in sight	1007.5
Shinzui Maru	16.5	118.7	252300	N 290	W 61	3.5	SSW4	Slight continuous rain	997.5
Niihata Maru	18.7	116.7	260600	WNW 215	S 48	2.5	5.0		1007.0

Table 5.2 Data from Satellite Photographs

Satellite Name	Orbit Number	Date/ Time (GMT)	Estimated posn. of centre		Final T No.	Min. Sea Level Pressure (mb)
			°S	°E		
NOAA 5	2925	230041	15.0	129.0	2	1005
	2937	232357	15.6	124.8	2	1005
	2949	242313	16.4	121.5	3.5	990
	2962	260025	18.2	118.9	5	965
	2974	262341	20.5	119.2	(landfall)	-
	2987	280054	21.8	122.8	-	-