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PROGRAMME**

Report No. TCP-21

**TROPICAL CYCLONE OPERATIONAL PLAN  
FOR THE BAY OF BENGAL AND THE ARABIAN SEA**

**2007 Edition**



**SECRETARIAT OF THE WORLD METEOROLOGICAL ORGANIZATION  
GENEVA - SWITZERLAND**

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# CHAPTER I

## GENERAL

### 1.1 Introduction

The loss of life and property and human suffering caused by tropical cyclones in coastal areas in various parts of the globe are well known. These disasters are, on occasion, particularly severe in the Bay of Bengal region. The northern part of the Bay of Bengal is known for its potential to generate dangerous high storm tides - a major killer when associated with cyclonic storms. In the past, out of 10 recorded cases of very heavy loss of life (ranging from about 40,000 to well over 200,000) in the world due to tropical cyclones, 8 cases were in the Bay of Bengal and the Arabian Sea (5 in Bangladesh and 3 in India). The world's highest recorded storm tide of 45 feet occurred in this region (1876, Bakherganj cyclone near Meghna Estuary, Bangladesh). These facts amply illustrate the importance of an efficient cyclone warning service in this region. Recognizing these facts, the World Meteorological Organization (WMO) and the Economic and Social Commission for Asia and the Pacific (ESCAP) jointly established the Panel on Tropical Cyclones in 1972 as an inter-governmental body. Its membership comprises countries affected by tropical cyclones in the Bay of Bengal and the Arabian Sea. Originally its member countries were Bangladesh, India, Myanmar, Pakistan, Sri Lanka and Thailand. Later Maldives joined this Panel in 1982 followed by Sultanate of Oman in 1997.

The Panel is one of the five regional tropical cyclone bodies established as part of the WMO Tropical Cyclone Programme (TCP) which aims at promoting and coordinating the planning and implementation of measures to mitigate tropical cyclone disasters on a world-wide basis.

The main objective of the WMO/ESCAP Panel on Tropical Cyclones is to promote measures to improve tropical cyclone warning systems in the Bay of Bengal and the Arabian Sea.

As part of this endeavour, the Panel at its twelfth session adopted a comprehensive cyclone operational plan for this region. The basic purpose of the operational plan is to facilitate the most effective tropical cyclone warning system for the region with existing facilities. In doing so the plan defines the sharing of responsibilities among Panel countries for the various segments of the system and records the coordination and cooperation achieved. The plan records the agreed arrangements for standardization of operational procedures, efficient exchange of various data related to tropical cyclone warnings, issue of cyclone advisories from a central location having the required facilities for this purpose, archival of data and issue of a tropical weather outlook for the benefit of the region.

The operational plan contains an explicit formulation of the procedures adopted in the Bay of Bengal and Arabian Sea region for the preparation, distribution and exchange of information and warnings pertaining to tropical cyclones. Experience has shown that it is of great advantage to have an explicit statement of the regional procedures to be followed in the event of a cyclone, and this document is designed to serve as a valuable source of information always available for reference by the forecaster and other users, particularly under operational conditions. Relevant information, which is not subject to regional agreement is given in the annexes to the plan.

A technical plan aiming at the development and improvement of the cyclone warning system of the region has been drawn up by the Panel. Implementation of some items under the technical plan would lead to a strengthening of the operational plan.

The operational plan is evolutionary in nature. It is intended that the text of the plan be updated or revised from time to time by the Panel and that each item of information given in the annexes to the plan be kept up to date by the member country concerned.

## **1.2 Terminology used in the region**

### **1.2.1 *General***

Panel members or member countries or countries  
Zone of disturbed weather\*

### **1.2.2 *Classification of cyclonic disturbances and tropical cyclones***

Cyclonic disturbance (generic term: i) - viii))

- i) Low or low pressure area
- ii) Well marked low<sup>+</sup>
- iii) Depression or tropical depression
- iv) Deep Depression\*

Tropical cyclone (generic term: v) - viii))

- v) Cyclonic storm
- vi) Severe Cyclonic storm
- vii) Very severe cyclonic storm
- viii) Super cyclonic storm

### **1.2.3 *Tropical cyclone characteristics***

- i) Position or location
- ii) Eye
- iii) Centre
- iv) Centre fix
- v) Central pressure
- vi) Pressure depth
- vii) Direction of movement
- viii) Speed of movement
- ix) Mean wind speed or sustained wind speed
- x) Maximum wind speed
- xi) Gust
- xii) Storm surge
- xiii) Storm tide

### **1.2.4 *Terms related to the warning and warning system***

- i) Name of the Tropical Cyclone
- ii) Tropical cyclone season or cyclone season
- iii) Tropical cyclone advisories
- iv) Tropical cyclone information bulletin
- v) Satellite information
- vi) Pre-cyclone watch\*\*
- vii) Cyclone Alert\*
- viii) Cyclone Warning\*
- ix) Post landfall outlook\*\*
- x) Visual storm signal
- xi) Squally wind
- xii) Gale wind
- xiii) High sea bulletin
- xiv) Coastal weather bulletin
- xv) Bulletin or cyclone warning bulletin

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\*\* Term used nationally in India

\* Term used nationally in Bangladesh, India and Pakistan;

+ Term used nationally in Bangladesh.



### 1.3 **Meaning of terms used for international exchange**

**Average wind speed:** Speed of the wind averaged over the previous 10 minutes (mean surface wind) as read from the anemogram or the 3 minutes mean determined with the non-recording anemometer or estimated wind at sea by the mariners using the Beaufort scale.

**Bulletin:** Cyclone warning bulletin

**Central pressure of a tropical cyclone:** Surface pressure at the centre of the tropical cyclone as measured or estimated.

**Centre fix of the tropical cyclone:** The estimated location of the centre of a tropical cyclone (obtained by means other than the aircraft probing of the cyclone i.e. fixation of the centre with the help of land-based and other radars, satellite and conventional observations like surface and upper-air observations, ships' reports, commercial aircraft observations, etc.)

**Centre of the tropical cyclone:** The centre of the cloud eye or, if not discernible, of the wind / pressure centre.

**Confidence in the centre position:** Degree of confidence in the centre position of a tropical cyclone expressed as the radius of the smallest circle within which the centre may be located by the analysis. "Position good" implies a radius of 30 nautical miles (55 kilometers) or less, "Position fair", a radius of 30 to 60 nautical miles (55 to 110 km) and "Position poor", a radius of greater than 60 nautical miles (110 km).

**Cyclone:** Tropical cyclone

**Cyclone Alert\*:** A priority message for the Government officials containing tropical cyclone information and advisories issued generally 48 hours before the commencement of adverse weather.\*\*

A priority message for the Government officials containing information on the formation of a tropical disturbance as soon as it is detected.+

**Cyclone warning\*:** A priority message containing tropical cyclone warning and advisories issued generally 24 hours in advance of the commencement of adverse weather.

**Cyclone warning bulletin:** A priority message for exchange of tropical cyclone information and advisories.

**Cyclonic disturbance:** A non-frontal synoptic scale low pressure area originating over tropical waters with organized convection and definite cyclonic wind circulation.

**Cyclonic storm:** A cyclonic disturbance in which the maximum average surface wind speed is in the range of 34 to 47 knots (62 to 88 km/h).

**Depression:** A cyclonic disturbance in which the maximum sustained surface wind speed is between 17 and 33 knots (31 and 61 km/h). If the maximum sustained wind speed lies in the range 28 knots (52 km/h) to 33 knots (61 km/h) the system may be called a "deep depression". \*

A cyclonic disturbance in which the maximum sustained surface wind speed is between 22 and 33 knots (41 and 61 km/h). If the maximum sustained wind speed lies in the range 28 knots (52 km/h) to 33 knots (61 km/h) the system may be called a "deep depression". +

**Direction of movement of the tropical cyclone:** The direction towards which the centre of the tropical cyclone is moving.

\* Term used nationally in Bangladesh, India and Pakistan.

\*\* Pre-defined, based on minimum limit of rainfall during 24 hours or actual wind speed or both.

+ Meaning of term as used nationally in Bangladesh

**Eye of the tropical cyclone:** The relatively clear and calm area inside the circular wall of convective clouds, the geometric centre of which is the centre of the tropical cyclone.

**Gale force wind:** Average surface wind speed of 34 to 47 knots (62 to 88 km/h).

**GMDSS:** Global Maritime Distress and Safety System

**Gust:** Instantaneous peak value of surface wind speed, recorded or expected.

**Hurricane force wind:** Average surface wind speed of 64 knots or more.

**Low or low pressure area:** An area enclosed by a closed isobar with minimum pressure inside when mean surface wind is less than 17 knots (31 km/h).

**Maximum sustained wind:** Maximum value of the average wind speed at the surface.

**Mean wind speed:** Average wind speed.

**Name of the Tropical Cyclone:** Once wind speed in a cyclonic disturbance attains a 34 kt threshold value it will be given an identification name by RSMC - tropical cyclones New Delhi from the consolidated name list.

**Panel members or member countries or countries:** Countries constituting the WMO/ESCAP Panel on Tropical Cyclones viz: Bangladesh, India, Maldives, Myanmar, Oman (Sultanate of), Pakistan, Sri Lanka and Thailand.

**Post-Landfall Outlook:** This bulletin is issued 12 hours before cyclone landfall and contains more specific forecasts about place and time of landfall.

**Pre Cyclone Watch:** This bulletin contains early warning about likely development of a cyclonic storm and an indication of the coastal belt likely to experience adverse weather.

**Severe cyclonic storm:** A cyclonic disturbance in which the maximum average surface wind speed is in the range of 48 to 63 knots (89 to 118 km/h).

**+Severe cyclonic storm with a core of hurricane winds:** A cyclonic disturbance in which the maximum average surface wind speed is 64 knots (119 km/h) or more.

**Speed of movement of the tropical cyclone:** Speed of movement of the centre of the tropical cyclone.

**Squally wind:** When sudden increases of wind speed occur in squalls with the increased speed reaching a minimum of 22 knots (40 km/h) and persist for at least one minute.

**Storm force wind:** Average surface wind speed of 48 to 63 knots.

**Storm season:** The periods April to May and October to December during which most of the cyclonic storms occur in the Bay of Bengal and Arabian Sea.

The periods April to May and October to mid-December during which most of the cyclonic storms occur in the Bay of Bengal and Arabian Sea. <sup>+</sup>

**Storm surge:** The difference between the actual water level under the influence of a meteorological disturbance (storm tide) and the level, which would have been reached in the absence of the meteorological disturbance (i.e. astronomical tide). (Storm surge results mainly from the shoreward movement of water under the action of wind stress. A minor contribution is also made by the hydrostatic rise of water resulting from the lowered barometric pressure.)

**Storm tide:** The actual water level as influenced by a weather disturbance. The storm tide consists of the normal astronomical tide and the storm surge.

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<sup>+</sup> Meaning of term as used nationally in Bangladesh

**Super cyclone:** A cyclonic disturbance in which maximum wind speed is 120 knots and above (222 km/h and above).

**Tropical cyclone:** Generic term for a non-frontal synoptic scale cyclone originating over tropical or sub-tropical waters with organized convection and definite cyclonic surface wind circulation. The term is also used for a storm in the South-West Indian Ocean in which the maximum of the sustained wind speed<sup>#</sup> is estimated to be in the range of 64 to 90 knots and in the South Pacific and South-East Indian Ocean with the maximum of the sustained wind speed over 33 knots.)

(Note: <sup>#</sup>**Maximum sustained wind speed:** Average period of one, three or ten minutes depending upon the regional practices.)

**Tropical cyclone advisory:** A priority message for exchanging information, internationally, on tropical cyclones in the Bay of Bengal and the Arabian Sea.

**Tropical depression:** Depression.

**Tropical storm:** Tropical cyclone.

**Tropical Weather Outlook:** A priority message for exchange between the Panel countries of synoptic and satellite inferences for the Bay of Bengal and the Arabian Sea region.

**Very severe cyclonic storm:** A cyclonic disturbance in which maximum wind average is 64 knots to 119 knots (119 to 221 km/h).

**Visual storm signals:** Visual signals displayed at coastal points to warn ships of squally winds, gales and tropical cyclones.

**Weather warning:** Meteorological message issued to provide appropriate warnings of hazardous weather conditions.

**Zone of disturbed weather:** A zone in which the pressure is low relative to the surrounding region and there is convective cloud masses which are not organized.

#### **1.4 Units used**

##### **1.4.1 *Units used in international exchange***

- (i) Distance in nautical miles, the unit (nm) being stated.
- (ii) Location (position) by degrees and where possible tenths of degrees of latitude and longitude preferably expressed by words.
- (iii) Direction to the nearest sixteen points of the compass given in words.
- (iv) Speed (wind speed and direction of movement of tropical cyclones) in knots, the unit (kt) being stated.

##### **1.4.2 *Units used in national bulletins***

- (i) Distance in kilometres (km).
- (ii) Location in longitude and latitude (degrees and tenths of degrees) or bearing in sixteen points of compass and distance from well-known fixed place.
- (iii) Direction in sixteen points of compass.
- (iv) Speed in km/h.

## CHAPTER II

### TROPICAL CYCLONE WARNINGS AND ADVISORIES

#### 2.1 General

The responsibility for warning the human settlements on land which are threatened by a tropical cyclone rests in all cases with the National Meteorological Services (NMS). These national responsibilities are not subject to regional agreement. Therefore the cyclone warning systems pertaining to international users and exchanges among the Panel countries are described in this chapter and the cyclone warning systems for Panel countries are described briefly in the annex to this chapter (Annex II-A).

#### 2.2 Classification of cyclonic disturbances

Classifications of cyclonic disturbances for the Bay of Bengal and the Arabian Sea region for the exchange of messages among the Panel countries are given below:

<u>Weather system</u>	<u>Maximum wind speed</u>
1. Low pressure area	Wind speed less than 17 kt (31 km/h)
2. Depression	Wind speed between 17 and 27 kt (31 and 51 km/h)
3. Deep Depression	Wind speed between 28 and 33 kt (52 and 61 km/h)
4. Cyclonic storm	Wind speed between 34 and 47 kt (62 and 88 km/h)
5. Severe cyclonic storm	Wind speed between 48 and 63 kt (89 and 118 km/h)
6. Very severe cyclonic storm	Wind speed between 64 and 119 kt (119 and 221 km/h)
7. Super cyclonic storm	Wind speed 120 kt (222 km/h) and above

#### 2.3 Identification of tropical cyclones

As soon as wind speed in a cyclonic disturbance attains a 34 kt threshold value it will be given an identification name by RSMC - tropical cyclones New Delhi from the consolidated name list (Table 1 on page II-4). The identification system will cover both the Arabian Sea and the Bay of Bengal.

If the life of a cyclonic disturbance spans two calendar years it will be accounted for in the year in which it has intensified to the stage where the wind speed has attained the 34 kt threshold value.

#### 2.4 Tropical weather outlook

The tropical weather outlook will be prepared once daily by RSMC - tropical cyclones New Delhi throughout the year. It is being transmitted on the GTS at 06 UTC every day. The outlook covering the Bay of Bengal and the Arabian Sea indicates possible development of tropical depressions over the sea. An additional outlook will be transmitted again over the GTS at 1700 UTC when a depression is located and expected to intensify into a cyclonic storm.

The outlook will also provide brief descriptions of tropical depressions and storms affecting the area broadly. It will give the location, intensity and movement of the system, as well as a general statement of land areas coming under threat.

As long as no tropical cyclone is observed in the region the outlook will include only the messages issued on a regional basis. When a system reaches the cyclonic storm stage (wind speed 34 kt), RSMC - tropical cyclones New Delhi will, in addition, issue cyclonic storm advisories.

## **2.5 Tropical cyclone advisories**

When a tropical low pressure system reaches the cyclonic storm stage, or is shortly expected to reach that intensity, RSMC - tropical cyclones New Delhi will issue tropical cyclone advisories. Advisories will be issued at 00, 03, 06, 09, 12, 15, 18 and 21 UTC. The area of responsibility for the issue of tropical cyclone advisories by RSMC - Tropical Cyclones New Delhi cover sea areas of north Indian Ocean to the north of 5°N/10°N between 45°E to 100°E. Supplementary advisories may be issued as necessitated by circumstances, e.g., change in intensity or movement.

Tropical cyclone advisories will contain information on the identification name, the present location, intensity and movement (present and past twelve hours) of the storm, and its forecast position, movement, intensity, maximum average surface wind, highest gust speed and sea conditions (in qualitative terms) wherever possible. Important information obtained from radar observations and any relevant ship reports from the affected areas will be repeated at the end of the advisory.

Advisories will be exchanged under appropriate headings for regional distribution by RTH New Delhi on the GTS.

### **Examples:**

----- DEMS 16

RSMC - TROPICAL CYCLONES, NEW DELHI, 21 NOVEMBER 1981 TROPICAL WEATHER OUTLOOK FOR BAY OF BENGAL AND ARABIAN SEA VALID NEXT 24 HOURS ISSUED AT 0600 UTC SATELLITE PICTURES THIS MORNING INDICATE AN AREA OF CONVECTIVE ACTIVITY SOUTH OF THE ANDAMANS. THERE IS NO EVIDENCE OF ORGANIZED CIRCULATION AS YET, BUT THE CLOUD MASS APPEARS TO HAVE A POTENTIAL FOR DEVELOPMENT IN THE NEXT FORTY EIGHT HOURS

DEMS 130300 UTC

TROPICAL CYCLONE ADVISORY

RSMC - TROPICAL CYCLONES, NEW DELHI

SEVERE CYCLONIC STORM (NAME) WAS CENTRED AT 13/0000 UTC WITHIN 30 NAUTICAL MILES OF 12.8°N 72.9°E RPT 12.8°N 72.9°E MOVEMENT WNW 10 KT OVER PAST 12 HOURS, CENTRAL PRESSURE ESTIMATED LESS THAN 996 HPA. INTENSITY FROM SATELLITE IMAGERY T3.5 MAXIMUM AVERAGE SURFACE WINDS OF THE ORDER OF 50 KNOTS GUSTING TO 60KT NEAR CENTRE. (SEA HIGH TO VERY HIGH\*) FORECAST:

INTENSIFICATION PROCEEDING LIKELY REACH T4.5 BY 14/0000 UTC WITH WINDS OF 75 KT GUSTING TO 90 KT NEAR CENTRE. MOVEMENT LIKELY CHANGE TO NORTH 10 KT IN NEXT 12 HOURS.

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\* Optional

## **2.6 Tropical cyclone warnings for the high seas**

The World Meteorological Organization (WMO) in its Manual on Marine Meteorological Services has recommended the issue of weather and sea bulletins for the high seas in six parts. The first part relates to tropical storm warnings in plain language. Areas of responsibility of each nation for issuing the tropical storm warnings are pre-assigned.

The cyclone warning centres issuing forecasts and warnings for the benefit of the ships on the high seas in the Panel countries are listed in the table below. The area covered by these stations in their bulletins, name of the coastal radio stations with their call signs from where the tropical cyclone warnings are broadcast, are given in Table 2.

Tropical cyclone warnings for the high seas will contain the following:

- (a) Type of warning and name of the centre;
- (b) Name of the system
- (c) Date and time of reference in UTC;
- (d) Type of disturbance (depression, cyclonic storm, etc.);
- (e) Location in terms of latitude and longitude or with reference to well-known landmarks;
- (f) Direction and speed of movement of the disturbance;
- (g) Extent of affected area;
- (h) Wind speed or force and direction in the affected areas;
- (i) Sea and swell condition in affected areas (in qualitative terms);
- (j) Other important information such as future position of disturbances.

Items (a), (b), (c), (d), (e), (f), (g) and (h) listed above should always be included in the warning bulletins.

**Example:**

VWM 0345 UTC 13 NOVEMBER 1981 CYCLONE WARNING CENTRE KOLKATA WARNING OF TROPICAL STORM. SEVERE CYCLONIC STORM (NAME) IN BAY OF BENGAL CENTRED AT 0300 UTC 13 NOVEMBER 1981 WITHIN HALF A DEGREE OF LATITUDE 12.8 DEGREES NORTH LONGITUDE 82.9 DEGREES EAST REPEAT 12.8°N 82.9°E AAA PRESENT MOVEMENT NORTH-NORTH WEST EIGHT KT AAA CENTRAL PRESSURE 980 HPA (MAXIMUM SUSTAINED WIND 60 KT GUSTS 75 KT). AREAS 60 KT WIND WITHIN RADIUS 80 NM AND AREAS 34 KT WIND WITHIN 300 NM RADIUS AAA STATE OF SEA HIGH TO VERY HIGH WITHIN 300 KM OF TROPICAL STORM CENTRE AAA SYSTEM LIKELY TO INTENSIFY AND MOVE IN A NORTHERLY DIRECTION AT 10 KT AAA (NEXT BULLETIN 0645 UTC) REPEAT STORM (NAME) CENTRE 0300 UTC 13 NOVEMBER 1981 12.8°N 82.9°E AAA

TABLE 1

## TABLE FOR NAMING TROPICAL CYCLONES FOR THE BAY OF BENGAL AND ARABIAN SEA

Panel Member	Column one		Column two		Column three		Column four	
	Names	Pron'	Names	Pron'	Names	Pron'	Names	Pron'
<u>B'desh</u>	Onil	Onil	Ogni	Og-ni	Nisha	Ni-sha	Giri	Gi-ri
India	Agni	Ag'ni	Akash	Aakaa'sh	Bijli	Bij'li	Jal	Jal
Maldives	Hibaru	--	Gonu	--	Aila	--	Keila	--
Myanmar	Pyarr	Pyarr	Yemyin	Ye-myin	Phyan	Phyan	Thane	Thane
Oman	Baaz	Ba-az	Sidr	Sidr'	Ward	War'd	Murjan	Mur'jaan
Pakistan	Fanoos	Fanoos	Nargis	Nar gis	Laila	Lai la	Nilam	Ni lam
Sri Lanka	Mala	--	Rashmi	Rash'mi	Bandu	--	Mahasen	--
Thailand	Mukda	Muuk-dar	Khai Muk	Ki-muuk	Phet	Pet	Phailin	Pi-lin

Panel Member	Column five		Column six		Column seven		Column eight	
	Names	Pron'	Names	Pron'	Names	Pron'	Names	Pron'
<u>B'desh</u>	Helen	Helen	Chapala	Cho-po-la	Ockhi	Ok-khi	Fani	Foni
India	Lehar	Le'har	Megh	Me'gh	Sagar	Saa'gar	Vayu	Vaa'yu
Maldives	Madi	--	Roanu	--	Mekunu	--	Hikaa	--
Myanmar	Nanauk	Na-nauk	Kyant	Kyant	Daye	Da-ye	Kyarr	Kyarr
Oman	Hudhud	Hud'hud	Nada	N'nada	Luban	L'luban	Maha	M'maha
Pakistan	Nilofar	Ni lofar	Vardah	Var dah	Titli	Titli	Bulbul	Bul bul
Sri Lanka	Priya	--	Asiri	Aa'siri	Gigum	Gi'gum	Soba	--
Thailand	Komen	Goh-men	Mora	Moh-rar	Phethai	Pay-ti	Amphan	Um-pun

TABLE 2

## STATIONS ISSUING CYCLONE WARNINGS FOR SHIPS ON THE HIGH SEAS

Station	Call sign of Coastal Radio Station	Area covered
Bangladesh, Chittagong	ASC	Bay of Bengal north of 18°N Lat.
India, Mumbai		Arabian Sea north of Lat. 5°N and east of Long. 60°E excluding the area north of Lat. 20°N and west of Long. 68°E. The eastern boundary of the Arabian Sea for which these bulletins are issued by Mumbai is Long. 80°E meridian excluding the Gulf of Mannar.
India, Kolkata		Bay of Bengal north of Lat. 5°N except the area between the coastline on the east and the line drawn through the points 18°N 94.5°E, 18°N 92°E, 13.5°N 92°E, 13.5°N 94°E, 10°N 94°E, 10°N 95°E and 5°N 95°E. The western boundary of the sea area for which bulletins are issued by Kolkata is up to and inclusive of the Gulf of Mannar (i.e., 77.5°E meridian).
*India, Chennai		Bay of Bengal bulletins issued by ACWC Kolkata are being broadcast through Navtex, Chennai by Narrow Band Direct Printing (NBDP)
Myanmar, Yangon	XYR	Bay of Bengal except area west of Long. 92°E and South of 10°N Lat.
Oman (Sultanate of)	A4M	Muscat Coastal Radio Station
Pakistan, Karachi	ASK	Arabian Sea north of 20°N, Gulf of Oman and Persian Gulf.
Sri Lanka, Colombo	4PB	Indian Ocean, Arabian Sea and Bay of Bengal from the equator to 10°N between 60°E and 95°E. The area 5°N to 10°N between 60°E and 95°E is an overlap with India.
Thailand, Bangkok	HSA HSS	Gulf of Thailand, west of southern Thailand. Strait of Malacca and South China Sea.

\* Under the new Marine Meteorological Broadcast system, GMDSS (Global Marine Distress Safety System) of IMO/WMO, India issues two bulletins at 0900 and 1800 UTC everyday for broadcast through INMARSAT SAFETY SYSTEM. Additional bulletins are broadcast during Cyclone period.



AREAS OF RESPONSIBILITY AND DESIGNATED NATIONAL METEOROLOGICAL SERVICES FOR THE ISSUE OF WARNINGS AND WEATHER AND SEA BULLETINS FOR THE GMDSS

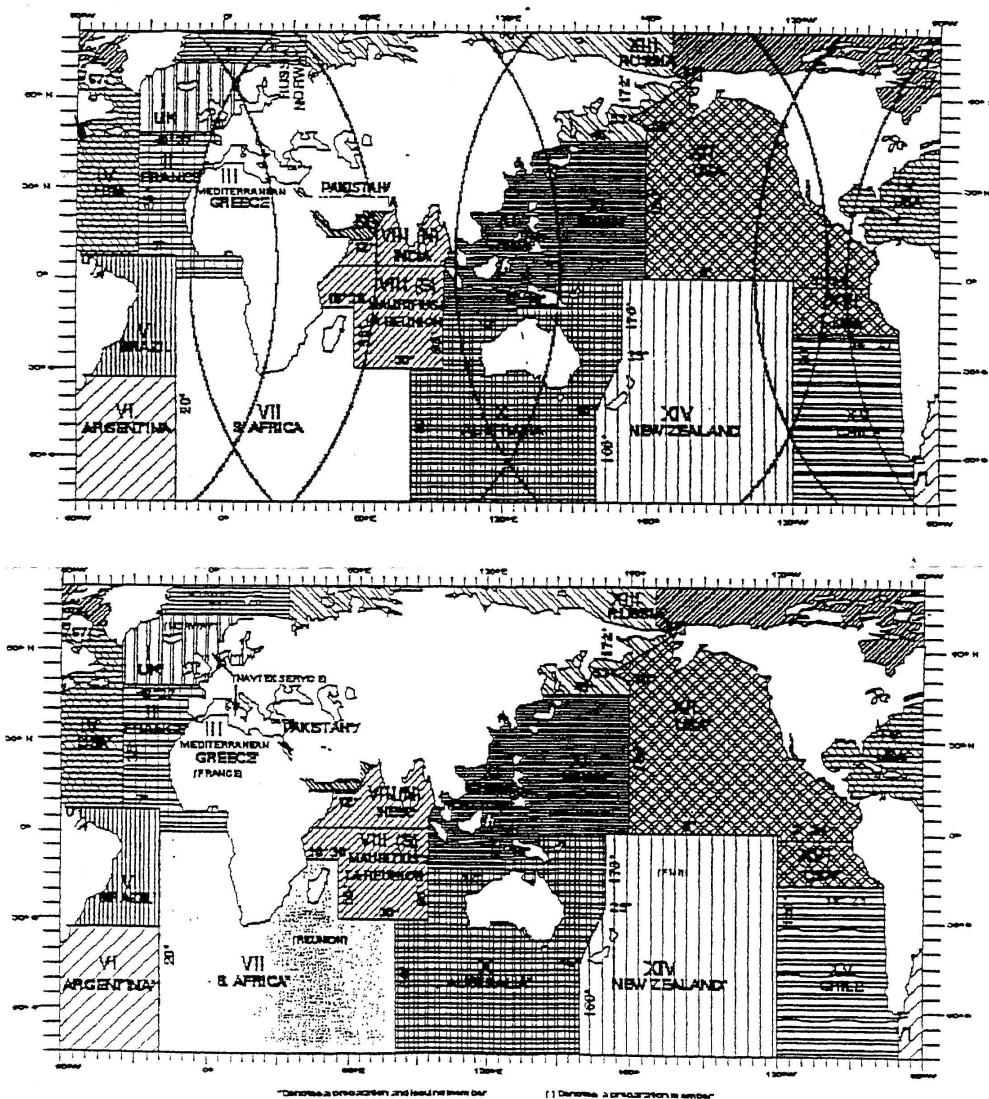


Figure 1

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## 2.7 Warnings and advisories for aviation

In accordance with the International Civil Aviation Organization (ICAO) Annex 3 — *Meteorological Service for International Air Navigation*/ WMO Technical Regulations [C.3.1], tropical cyclone warnings, required for the international air navigation, are issued by designated meteorological watch offices (MWO) as SIGMET messages, including an outlook, giving information for up to 24 hours ahead concerning the expected positions and maximum surface wind of the centre of the tropical cyclone. Each MWO provides information for one or more specified Flight Information Regions (FIRs) or Upper Information Regions (UIRs). The boundaries of the FIRs/UIRs are defined in ICAO Air Navigation Plans (ANP) for the-Asia (ASIA), Middle East (MID) and Pacific (PAC) Regions.

The content and order of elements in a SIGMET message for tropical cyclone shall be in accordance with WMO Technical Regulations [C.3.1]. The data type designator to be included in the WMO abbreviated header of such messages shall be T<sub>1</sub>T<sub>2</sub> = WC (WMO-No. 386, Manual on GTS refers).

The designated Tropical Cyclone Advisory Centre (TCAC) New Delhi shall monitor the development of tropical cyclones in its area of responsibility, in accordance with the ASIA/PAC ANP and issue advisory information concerning the positions of the centre of the cyclone, its direction and speed of movement, central pressure and maximum surface wind near the centre. These advisories are disseminated to the MWOs in the TCAC New Delhi area of responsibility, to be used in the preparation of the OUTLOOK appended to SIGMETs for tropical cyclones. In addition, the tropical cyclone advisories shall be disseminated to the other TCACs, whose areas of responsibility may be affected, to the world area forecast centers (WAFc) London and Washington and international OPMET data banks, and centres operating the satellite distribution systems (SADIS and ISCS).

[C.3.1]. The data type designator to be included in the WMO abbreviated header of such messages shall be T<sub>1</sub>T<sub>2</sub> = FK (WMO-No. 386, Manual on GTS, refers).

TCAC New Delhi is issuing Tropical Cyclone Advisories for its area of responsibility, for each tropical cyclone, as necessary, in the format specified by ICAO every six hours.

### TC ADVISORY

DTG:	20031213/1200Z
TCAC:	NEW DELHI
TC:	AGNI
NR:	01
PSN:	N0930 E08730
MOV:	MNW 04KT
C:	998HPA
Max Wind:	40KT
FCST PSN +12hrs:	140000 N1030 E08630
Max Wind +12hrs:	45KT
FCST PSN +18hrs:	140600 N1100 E08600
Max Wind +18hrs:	50KT
FCST PSN +24hrs:	141200 N1130 E08530
Max Wind +24hrs:	55KT
NEXT MSG:	200031213/1800 Z

**2.8 Tropical cyclone warnings for national purposes**

Information on tropical cyclone warnings provided nationally by Panel countries, including the port warning system, is given in Annex A to this Chapter.

Storm surge warnings will be the responsibility of the National Meteorological Services (see section 4.2).

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\* SIGMETs for tropical cyclones will only be issued for those tropical cyclones having a 10-minute mean surface wind\*\* speed of 63 km/h (34 kt) or more."

\*\* See 1.3 "Average wind speed"

## TROPICAL CYCLONE WARNING SYSTEMS IN THE PANEL COUNTRIES

### 2.1 Classification of systems

Existing classifications of low pressure systems (cyclonic disturbances) in the Panel countries are given below together with the WMO classifications.

#### ***Classification of low pressure systems (cyclonic disturbances) presently in use by Panel countries for national purposes***

<u>Country</u>	<u>Type of Disturbance</u>	<u>Corresponding Wind Speed</u>
<b>Bangladesh</b>	Low pressure area	Less than 17 knots (31 km/h)
	Well marked low	17 - 21 knots (31 - 40 km/h)
	Depression	22 - 27 knots (41 - 51 km/h)
	Deep Depression	28 - 33 knots (52 - 61 km/h)
	Cyclonic storm	34 - 47 knots (62 - 88 km/h)
	Severe cyclonic storm	48 - 63 knots (89 - 118 km/h)
	Severe cyclonic storm with a core of hurricane wind	64 - 119 knots (119-221 km/h)
	Super cyclonic storm	120 knots (222 kph) and above
<b>India</b>	Low pressure area	Less than 17 knots
	Depression	17 - 27 knots
	Deep Depression	28 - 33 knots
	Cyclonic storm	34 - 47 knots
	Severe cyclonic storm	48 - 63 knots
	Very severe cyclonic storm	64 - 119 knots
	Super cyclonic storm	120 knots and above
<b>Maldives</b>	Low pressure area	Less than 17 knots
	Depression	17 - 27 knots
	Deep Depression	28 - 33 knots
	Cyclonic storm	34 - 47 knots
	Severe cyclonic storm	48 - 63 knots
	Very severe cyclonic storm	64 - 119 knots
	Super cyclonic storm	120 knots and above
<b>Myanmar</b>	Low or low pressure area	Less than 17 knots
	Depression	17 - 33 knots
	Cyclonic storm	34 - 63 knots
	Severe cyclonic storm	64 knots or more
<b>Oman (Sultanate of)</b>	Low	Less than 17 knots
	Depression	17-28 knots
	Deep depression	28-33 knots
	Cyclonic storm	34-47 knots
	Severe cyclonic storm	48-63 knots
	Severe cyclonic storm of Hurricane intensity	64 knots or more

## ANNEX II-A-2

<u>Country</u>	<u>Type of Disturbance</u>	<u>Corresponding Wind Speed</u>
<b>Pakistan</b>	Depression	22 - 27 knots
	Deep Depression	28 - 33 knots
	Cyclonic storm	34 - 47 knots
	Severe cyclonic storm	48 - 63 knots
	Severe cyclonic storm of Hurricane Intensity	64 knots or more
<b>Sri Lanka</b>	Low pressure area	Less than 17 knots
	Depression	17 - 27 knots
	Deep Depression	28 - 33 knots
	Cyclonic storm	34 - 47 knots
	Severe cyclonic storm	48 - 63 knots
	Very severe cyclonic storm	64 - 119 knots
<b>Thailand</b>	Super cyclonic storm	120 knots and above
	Tropical depression	Up to 33 knots
	Tropical storm or Cyclonic storm	34 - 63 knots
<b>WMO</b> Classification (vide WMO-No. 471)	Typhoon or cyclone	64 knots or more
	Tropical depression	Winds up to 34 knots
	Moderate tropical storm	Winds 34 - 47 knots
	Severe tropical storm	Winds 48 - 63 knots
	Hurricane (or local synonym)	Winds 64 knots and more
	Tropical disturbance of unknown intensity	Wind speed uncertain

## **2.2 Tropical Cyclone Warning System in Bangladesh**

### **2.2.1 *Organization***

The Bangladesh Meteorological Department is responsible for providing tropical cyclone warnings to Bangladesh and its coastal areas and for a designated portion of the high seas in the Bay of Bengal. Warnings and forecasts are issued under the authority of the Director, Bangladesh Meteorological Department.

The tropical storm warnings are provided from the Storm Warning Centre, Agargaon, Dhaka-1207. This Centre is also responsible for issuing the weather warnings like "Nor'westers" (severe local storms) warning, etc.

### **2.2.2 *Tracking***

The tropical cyclones are tracked with the help of conventional observations, Doppler radar, NOAA & MTSAT satellite observations.

### **2.2.3 *Tropical cyclone warnings***

Tropical cyclone warnings are provided to:

- (i) The Honourable President
- (ii) The Honourable Prime Minister
- (iii) Control room, Ministry of Food and Disaster Management (MoFDM)
- (iv) The Sea Port Authorities at Chittagong, Mongla and Cox's Bazar

- (v) The Cyclone Preparedness Programme (CPP), Red Crescent Society
- (vi) The Armed Forces
- (vii) Inland river ports
- (viii) Airport authorities
- (ix) Concerned government officials
- (x) The general public (through mass-media, radio and television)
- (xi) Fishing boats and trawlers in the sea
- (xii) The NGOs

#### **2.2.4 Stages of warnings**

Warnings are issued in four stages for the government officials. The first stage called "Alert" is issued to all concerned whenever a disturbance is detected in the Bay as per Standing Orders for Disasters (SOD) of Bangladesh. In the second stage, cyclone warnings are issued in four stages as detailed below:

- (i) (a) Distant Cautionary Signal - issued if a ship might run into danger during its voyage after leaving the harbour.
- (b) Distant Warning Signal - issued when there is no immediate danger of the port but a ship might run into the storm after leaving the port.
- (ii) (a) Local Cautionary Signal – issued when port is threatened by squally weather from tropical disturbances or nor'westers.
- (b) Local Warning Signal - issued when the port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution. It is issued minimum 24 hours before the landfall.
- (iii) Danger Signal - issued when the port is likely to experience severe weather from a storm of slight or moderate intensity. The Signal is issued minimum 18 hours before the landfall.
- (iv) Great Danger Signal - issued when the port is likely to experience severe weather from a storm of great intensity. The signal is issued minimum 12 hours before the landfall.

#### **2.2.5 Format of the cyclone warning bulletin**

Cyclone warning bulletins contain the following information:

- (i) Name of the storm
- (ii) Position of the storm centre
- (iii) Direction and speed of movement in knots for international use and km/h for national use.
- (iv) Distance of the storm centre from the ports.
- (v) Maximum sustained wind within the radius of maximum wind of the disturbance.
- (vi) Signals for the maritime ports.
- (vii) Areas likely to be affected specifying Police Station (Thana) of sub-division as far as possible.

- (vii) Approximate time of commencement of gale winds (speed more than 51 km/ h).
- (viii) Storm surge height in meter and areas likely to be inundated.
- (ix) Advisory for fishing boats and trawlers over North Bay and Deep Sea.

#### **2.2.6 Tropical cyclone warnings for the high seas**

Tropical cyclone warnings for the high seas in Bangladesh are provided from the Storm Warning Centre at Dhaka and are broadcast from the coastal radio station at Chittagong (ASC). Warnings are issued for the Bay of Bengal region north of 18°N latitude.

#### **2.2.7 Warnings to ports**

In accordance with international procedure, ports are warned and advised to hoist "Signals" whenever adverse weather is expected over the ports for the oceanic areas in which it is located due to the tropical cyclone. However, regional difference exist. The warning messages normally contain information on the location, intensity, direction and speed of movement of the tropical cyclone and the expected weather over the port. The tropical cyclone signals used in Bangladesh ports along with their meaning are given in Attachment to Annex A.

#### **2.2.8 Dissemination**

Warnings are disseminated through high priority landline telegrams, telefax, telephone and teleprinter. In addition, warnings are also transmitted to Radio Bangladesh, Dhaka, Chittagong, Khulna, Rangpur, Rajshahi and Sylhet for broadcast. Alert messages are broadcast four to five times a day. "Warnings" are broadcast every hour and "Danger" and "Great Danger" messages are broadcast frequently.

### **2.3 Cyclone warning system in Myanmar**

#### **2.3.1 Organization**

Tropical cyclone warnings in Myanmar are provided by the Department of Meteorology and Hydrology, Myanmar. Tropical cyclone warnings are provided from the Central Forecasting Office at Yangon.

#### **2.3.2 Tracking and dissemination**

Conventional observations, such as surface and upper-air observations, ships' reports, and radar and satellite observations are utilized for observing, detecting and tracking tropical cyclones. Collection and dissemination of meteorological data and warnings are done with the co-ordination of Myanmar Posts and Telecommunications and Department of Civil Aviation point-to-point circuit. Some stations are equipped with SSB sets as a back-up system for the collection and dissemination of observations and warnings.

#### **2.3.3 Tropical cyclone warnings**

The Central Forecasting Office at Yangon is responsible for providing tropical cyclone and storm surge warnings to its coastal population, the ports along the Myanmar coast and for the designated area of the high seas in the Bay of Bengal. The area designated for Myanmar for providing warnings is the area of the Bay of Bengal east of 92°E and north of 10°N. Warnings are broadcast through the coastal radio station at Yangon (call sign XYR).

Port warning signals and their meanings used in the ports of Myanmar are given in Attachment A.

## **2.4 Cyclone warning system in India**

The India Meteorological Department is responsible for providing tropical cyclone warnings in India. The tropical cyclone warning service is one of the most important functions of the India Meteorological Department and it was the first service undertaken by the Department which is more than 125 years old.

### **2.4.1 *Organization***

Tropical cyclone warnings in India are provided through three Area Cyclone Warning Centres (ACWCs) located at Kolkata, Chennai and Mumbai and three Cyclone Warning Centres at Bhubaneswar, Visakhapatnam and Ahmedabad. The entire cyclone warning work is co-ordinated by the Deputy Director General of Meteorology (Weather Forecasting) at Pune and Deputy Director General of Meteorology (Cyclone Warning) at New Delhi. Tropical cyclone warnings from RSMC - tropical cyclones, New Delhi are provided to All India Radio, New Delhi and to Doordarshan, New Delhi for broadcast and telecast respectively.

### **2.4.2 *Tracking of tropical cyclones***

Tracking of the tropical cyclones in India is done with the help of:

- (i) Conventional surface and upper-air observations from inland and island stations and ships' observations;
- (ii) Cyclone detection radar including Doppler Weather Radar; and
- (iii) Satellite cloud pictures from the Polar orbiting meteorological satellites and the Geostationary Satellite (INSAT 3A & Kalpana-1).

More details on the observing system are provided in a separate chapter.

### **2.4.3 *Tropical cyclone warnings***

The bulletins and warnings issued in connection with tropical cyclones in India may be divided into the following broad categories:

- (i) Warning bulletins for shipping on the high seas.
- (ii) Warning bulletins for ships plying in the coastal waters.
- (iii) Port warnings.
- (iv) Fisheries warnings.
- (v) Four stage warnings for the State and Central Government officials.
- (vi) Warnings for recipients who are registered with the department (Designated/registered users).
- (vii) Aviation.
- (viii) Warnings for the general public through All India Radio, Doordarshan and the Press.
- (ix) Warning for Indian Navy.
- (ix) Bulletins for Print / Electronic media.



### 2.4.3.1 Bulletins for the high seas

These bulletins are for the shipping interests on the high seas. The area covered by these bulletins is the sea area between the Asian Coast and the line joining the points 24°N 68°E, 20°N 68°E, 20°N 60°E, 5°N 60°E, 5°N 95°E, 10°N 95°E, 10°N 94°E, 13°30'N 94°E, 13°30'N 92°E, 18°N 92°E and 18°N 94°30'E. The exact area of coverage is shown in Map A (Attachment A).

These bulletins are issued by the Area Cyclone Warning Centres at Mumbai and Kolkata and are broadcast by the Coastal Radio Stations of the Department of Telecommunication (DoT) at Mumbai (VWB), Kolkata (VWC) and Chennai (VWM) in morse code. The bulletins for the Arabian Sea broadcast from Mumbai Radio are issued by the Area Cyclone Warning Centre at Mumbai, whilst those for the Bay of Bengal, broadcast from Kolkata and Chennai Radio, are issued by the Area Cyclone Warning Centre at Kolkata. Under the new GMDSS programme of WMO/IMO, India is issuing GMDSS bulletins for met area VIII (N) daily at 0900 UTC and 1800 UTC with additional warning during cyclone period. These bulletins consist of six parts. They are:

- Part I : Tropical Cyclone Warning in plain language.
- Part II : Synopsis of weather conditions in the forecast area in plain language.
- Part III : Forecast in plain language.
- Part IV : Analysis of the surface synoptic chart in IAC Fleet Code.
- Part V : Data of observations from ships in WMO codes.
- Part VI : Data of observations from selected land stations and upper-air reports in WMO codes.

In normal undisturbed weather, two bulletins are broadcast at fixed hours known as "Daily" bulletins. In the event of disturbed weather (depression in the Bay of Bengal and the Arabian Sea), a third bulletin known as "Extra" bulletin is broadcast.

When a cyclonic storm has developed, three additional bulletins known as 'Storm' bulletins are broadcast. In addition to these six bulletins, if any unexpected development of weather warrants urgent communication to ships, a "Special" bulletin is issued which may be broadcast at any time. These bulletins are broadcast according to a schedule at fixed hours. Daily bulletins broadcast from Mumbai and Kolkata consist of all the above six parts, while those from Chennai consist only of Parts I, II and III. "Extra", "Storm" and "Special" bulletins contain only Part I. An example of a tropical cyclone warning bulletin for the high seas (Part I) is given below:

TTT CYCLONE WARNING BAY OF BENGAL 040300 UTC. SHIPS OBSERVATIONS ABSENT. BUT SATELLITE IMAGERIES INDICATE THAT CYCLONIC STORM WITH ESTIMATED CENTRAL PRESSURE 992 hPa LAY CENTERED AT 040300 UTC OVER WEST CENTRAL BAY CENTRED WITHIN HALF DEGREE LATITUDE FIFTEEN DEGREE NORTH LONGITUDE EIGHTY-EIGHT AND HALF DEGREES EAST MOVING NORTH-WEST AT EIGHT KNOTS. AFFECTING AN AREA EXTENDING TWO HUNDRED NAUTICAL MILES. WIND FORCE 37 KNOTS, OCCASIONALLY INCREASING TO 47 KNOTS IN CENTRAL BAY TO A DISTANCE OF 100 NAUTICAL MILES FROM CENTRE. LIKELY INTENSIFY FURTHER AND MOVE IN NORTH NORTHEAST DIRECTION AT 12 KNOTS AND CROSS BANGLADESH COAST BY EVENING/NIGHT OF TUESDAY THE 5<sup>TH</sup>.

### 2.4.3.2 Coastal bulletins

These bulletins give weather information in greater detail in the coastal areas for the benefit of ships plying mainly in coastal areas. For the purpose of these bulletins, the coastal area is defined as the sea area up to 75 km off the coastline.

As in the case of sea bulletins for merchant ships, the coastal bulletins are broadcast from Navtex, Chennai. In normal weather coastal bulletins are broadcast twice daily (Daily - One at 0630 UTC and Daily - Two at 1830 UTC respectively). These are known as "Daily" bulletins. Whenever a depression, tropical cyclone or some other phenomenon influences the weather of the coastal strip concerned "Extra", "Storm" and "Special" bulletins for the coastal strip are also broadcast in addition to "Daily" bulletins.

Each bulletin first gives the name of the coastal strip to which it pertains followed by the details of the weather system, if any, affecting the coastal area. It also includes a forecast of wind, weather, visibility and state of sea for the coastal strip. Information on storm surges/tidal waves and areas likely to be affected are given whenever necessary. The bulletins also give information regarding storm warning signals, if any, hoisted at the ports in the coastal strip concerned.

The coastal bulletins pertaining to Tamilnadu and Andhra coasts are being sent to Maritime telex (Navtex) at Chennai and they are sending by Narrow Band Direct Printing (NBDP) mode to the ships plying in the above coastal waters. Coastal weather bulletin in respect of Kerala coast is broadcast through Kochi radio and Karnataka coastal weather bulletin is broadcast through the maritime telex (Navtex) Mumbai.

#### **Example:**

"TTT SPECIAL BULLETIN FOR ANDAMAN NICOBAR COAST. LATEST OBSERVATIONS FROM SHIPS INDICATE THIS MORNING'S DEPRESSION NOW CYCLONIC STORM CENTRED AT 280900 UTC WITHIN HALF A DEGREE OF LATITUDE 13°N, LONGITUDE 94°E. LIKELY TO INTENSIFY FURTHER AND MOVE NORTHWARDS AT FIVE KNOTS. FORECAST VALID UNTIL 281700 UTC. NORTH OF LATITUDE ELEVEN DEGREES NORTH WIND NORTHWEST TO WEST SPEED FORTY TO FIFTY KNOTS. FAIRLY WIDESPREAD RAIN WITH FREQUENT RAIN SQUALLS. VISIBILITY GOOD REDUCING TO VERY POOR IN HEAVY RAIN. SEA HIGH. SOUTH OF LATITUDE ELEVEN DEGREES WIND MAINLY WESTERLY TWENTY TO THIRTY KNOTS. SCATTERED RAIN WITH A FEW SQUALLS. VISIBILITY TEN KILOMETRES BECOMING TWO KILOMETRES IN RAIN SEA ROUGH. LOCAL CAUTIONARY SIGNAL NUMBER THREE HOISTED AT PORT BLAIR."

Under the new GMDSS programme of IMO/WMO, India is issuing NAVTEX bulletins daily from the Area Cyclone Warning Centres at Mumbai and Chennai for the respective coastal areas.

### 2.4.3.3 Tropical cyclone bulletins to All India Radio (AIR) for broadcast

In general, weather bulletins are issued by the meteorological offices to the AIR stations for broadcast in the midday transmissions. These are based on 0300 UTC charts. The areas covered by the bulletins are the areas served by the respective AIR stations. These bulletins include:

- (i) a summary of the past weather;
- (ii) special weather warnings for public services such as the Public Works Department, Irrigation, DoT, Railways, etc.; and
- (iii) a general forecast including warnings.

## ANNEX II-A-8

Points (ii) and (iii) are valid until the morning of the second day. The summary of weather includes information about tropical storms and depressions affecting the area. The centre of the system is included with reference to the nearest well-known place and latitude and longitude. Warnings in bulletins once included are repeated in the subsequent daily bulletins also as long as adverse weather is anticipated. In addition, meteorological centres in the maritime states include suitable warnings for fishermen. These general bulletins are broadcast at a fixed time at midday by the AIR stations and are intended to meet the requirements of the public in general and the needs of various categories of officials in particular.

In addition, special AIR bulletins containing cyclone alert messages issued 48 hours prior to the commencement of the adverse weather and tropical cyclone warning messages issued 24 hours prior to the commencement of the adverse weather in the coastal areas due to an approaching tropical storm are broadcast. These broadcasts are meant to alert the agencies entrusted with the responsibility of carrying out cyclone preparedness works and also the general public.

(For framing the tropical storm warning bulletins to AIR and Doordarshan abbreviated terms like "cyclone" for cyclonic storm, "severe cyclone" for the severe cyclonic storm and "super cyclone" for super cyclonic storm are also used.)

The height of the storm surge is included in the bulletin in metres and it represents height above the normal tide level. The coastal districts likely to be affected by the storm are mentioned in the first sentence of the bulletins. The types of damage likely to be expected from systems of various intensities along with the suggested action are also included. For this purpose the following table is referred.

## ANNEX II-A-9

<b>System Intensity</b>	<b>Damage expected</b>	<b>Action Suggested</b>
<b>Deep Depression (28-33 Kts or 52-61Kmph)</b>	Minor damage to loose and unsecured structures	Fishermen advised not to venture into the open seas.
<b>Cyclonic Storm (34-47kts or 62-88 kmph)</b>	Damage to thatched huts. Breaking of tree branches causing minor damage to power and communication lines	Total suspension of fishing operations.
<b>Severe Cyclonic Storm (48-63 kts or 89-118 kmph)</b>	Extensive damage to thatched roofs and huts. Minor damage to power and communication lines due to uprooting of large avenue trees. Flooding of escape routes.	Total suspension of fishing operations. Coastal hutment dwellers to be moved to safer places. People in affected areas to remain indoors.
<b>Very Severe Cyclonic Storm (64-90 kts or 119-167 kmph)</b>	Extensive damage to kutcha houses. Partial disruption of power and communication line. Minor disruption of rail and road traffic. Potential threat from flying debris. Flooding of escape routes.	Total suspension of fishing operations. Mobilise evacuation from coastal areas. Judicious regulation of rail and road traffic. People in affected areas to remain indoors.
<b>Very Severe Cyclonic Storm ( 91-119 kts or 168- 221 kmph )</b>	Extensive damage to kutcha houses. Some damage to old buildings. Large-scale disruption of power and communication lines. Disruption of rail and road traffic due to extensive flooding. Potential threat from flying debris.	Total suspension of fishing operations. Extensive evacuation from coastal areas. Diversion or suspension of rail and road traffic. People in affected areas to remain indoors.
<b>Super Cyclone (120kts or more or 222 kmph or more)</b>	Extensive structural damage to residential and industrial buildings. Total disruption of communication and power supply. Extensive damage to bridges causing large-scale disruption of rail and road traffic. Large-scale flooding and inundation of sea water. Air full of flying debris.	Total suspension of fishing operations. Large-scale evacuation of coastal population. Total suspension of rail and road traffic in vulnerable areas. People in affected areas to remain indoors.

**Example:**

VERY SEVERE CYCLONIC STORM SITUATED AT 181200 UTC OF DECEMBER 2003 ABOUT 250 KM SOUTH EAST OF MACHILIPATNAM LIKELY TO STRIKE COAST BETWEEN ONGOLE AND MACHILIPATNAM IN THE NEXT 12 TO 24 HOURS.

**CYCLONE WARNING:**

Cyclone Warning Bulletin No. 06 issued by Area Cyclone Warning Centre, Chennai at 1900 Hrs. IST on 18th December 2003 for repeated broadcast at hourly/half hourly intervals. Warning for Nellore, Prakasam, Guntur, Krishna, West and East Godavari and Visakhapatnam districts. Mornings Very Severe Cyclonic storm over west-central Bay of Bengal moved northwestward and lay centred at 1730 hrs. IST of 18<sup>th</sup> about 250kms. southeast of Machilipatnam. The system expected to intensify further and move in a northwesterly direction and cross south Andhra Pradesh coast between Ongole and Machilipatnam by mid-day of 19<sup>th</sup> December.

Under its Influence heavy to very heavy rain commencing from early morning of 19<sup>th</sup> December likely cause floods in Nellore, Prakasam, Guntur, Krishna, West and East Godavari and Visakhapatnam districts. Gales speed reaching 140-150 kmph commencing from early morning of 19<sup>th</sup> December in Prakasam, Guntur, Krishna, West and East Godavari districts. Gale force winds reaching 100-110 kmph likely Nellore and Visakhapatnam districts.

Tidal wave of five metres likely inundates low-lying areas of Prakasam, Guntur, and Krishna districts at the time of storm crossing coast.

**DAMAGE EXPECTED:**

The system may cause extensive damage to kutchha houses, partial disruption of power and communication line, minor disruption of rail and road traffic, potential threat from flying debris, flooding of escape routes in Prakasam, Guntur, Krishna, West and East Godavari districts. And also extensive damage to thatched roofs and huts, minor damage to power and communication lines due to uprooting of large avenue trees, flooding of escape routes in Nellore and Visakhapatnam districts.

**ACTION SUGGESTED:**

Total suspension of fishing operations. Mobilise evacuation from coastal areas. Judicious regulation of rail and road traffic. People in affected areas to remain indoors.

**STORM WARNING SIGNALS:**  
(to be appended)

These bulletins are generally issued at the time of each sea area bulletin. The frequency of the bulletin can be raised when the tropical storm is tracked with the help of radar and previous warnings issued needs modification.

A third set of bulletins issued to AIR is the coastal weather bulletins. Whenever a cyclonic storm is likely to affect the Indian coastal areas, coastal weather bulletins issued by the India Meteorological Department are broadcast in the All India News Cycles of All India Radio from New Delhi in English, Hindi and in the regional language of the area affected. These bulletins contain information on the following:

- 1) Time of issue of bulletin in IST
- 2) Coastal strip for which bulletin issued and period of validity
- 3) Position, intensity and movement of cyclonic storm
- 4) Forecast point and time of landfall

- 5) Signals hoisted at the ports in the coastal strip
- 6) Information of storm surges/tidal waves

These bulletins are issued three times a day.

#### 2.4.3.4 Tropical storm warnings to government officials (Four-stage warnings)

A "pre-cyclone watch" bulletin is issued by DGM himself soon after the formation of a depression informing senior central government officials including chief secretary of coastal maritime States about likely development of a cyclonic storm, its movements, coastal belt of India likely to experience adverse weather. No fixed format is used.

At the second stage, a "cyclone alert" is issued 48 hours in advance of the expected commencement of adverse weather in association with the cyclonic storm over the coastal area. The third stage of the warning, known as "cyclone warning" is issued 24 hours in advance of commencement of severe weather. The last stage of warning covering the post-landfall scenario is included in the cyclone warnings issued just before landfall and is continued till the cyclonic wind force is maintained in the core area of the cyclonic storm over land. Formats for "cyclone alert" and "cyclone warning" bulletins are given below:

##### **Example (CYCLONE ALERT):**

**The depression has intensified into a deep depression lay centred at 170300 UTC of December,2003 about 300 km south east of Machilipatnam likely to intensify further and move in a northwesterly direction.**

Cyclone Alert No. 03 issued by Area Cyclone Warning Centre, Chennai at 1000 Hrs. IST on 17<sup>th</sup> December 2003. The depression over west-central Bay has concentrated into a deep depression this morning and lay centred at 0830 hrs. 1ST of 17<sup>th</sup> about 300kms. southeast of Machilipatnam. It is likely to intensify further and move in a northwesterly direction.

Under its influence widespread rain with scatted heavy to very heavy rain commencing from evening of 17<sup>th</sup> December in the districts of north Tamilnadu and south Andhra Pradesh coasts. Squally winds speed reaching 50-60 likely to commence from the evening of 17<sup>th</sup> in the districts mentioned above.

Fishermen along north Tamilnadu –south Andhra Pradesh coasts are advised not to venture into sea.

##### **Example (CYCLONE WARNING):**

**Very severe cyclonic storm situated at 181200 UTC of December, 2003 about 250 km southeast of Machilipatnam likely to strike coast between Ongole and Machilipatnam in the next 12 to 24 hours.**

Cyclone Warning Bulletin No. 06 issued by Area Cyclone Warning Centre, Chennai at 2030 Hrs. IST on 18<sup>th</sup> December 2003 for repeated broadcast at hourly/half hourly intervals. Warning for Nellore, Prakasam, Guntur, Krishna, West and East Godavari and Visakhapatnam districts. Mornings Very Severe Cyclonic storm over west-central Bay of Bengal moved northwestward and lay centred at 1730 hrs.1ST of 18<sup>th</sup> about 250kms. southeast of Machilipatnam. The system expected to intensify further and move in a northwesterly direction and cross south Andhra Pradesh coast between Ongole and Machilipatnam by mid-day of 19<sup>th</sup> December.

Under its Influence heavy to very heavy rain commencing from early morning of 19<sup>th</sup> December likely cause floods in Nellore, Prakasam, Guntur, Krishna, West and East Godavari and Visakhapatnam districts. Gales speed reaching 140-150 kmph commencing from early morning of 19<sup>th</sup> December in Prakasam, Guntur, Krishna, West and East Godavari districts. Gale force winds reaching 100 -110 kmph likely Nellore and Visakhapatnam districts.

Tidal wave of five metres likely inundate low lying areas of Prakasam, Guntur, and Krishna districts at the time of storm crossing coast.

**DAMAGE EXPECTED:**

The system may cause extensive damage to kutcha houses, partial disruption of power and communication line, minor disruption of rail and road traffic, potential threat from flying debris, flooding of escape routes in Prakasam, Guntur, Krishna, West and East Godavari districts. And also extensive damage to thatched roofs and huts, minor damage to power and communication lines due to uprooting of large avenue trees, flooding of escape routes in Nellore and Visakhapatnam districts.

**ACTION SUGGESTED:**

Total suspension of fishing operations. Mobilise evacuation from coastal areas. Judicious regulation of rail and road traffic. People in affected areas to remain indoors.

**STORM WARNING SIGNALS:**

(to be appended)

**2.4.3.5 Storm warnings to ports**

A visual storm warning signal system for the Bay of Bengal ports, chiefly for the port of Kolkata, has been in existence since 1865. A similar system for the ports on the west coast was started in 1880. A uniform system applicable to all Indian ports was introduced in 1898.

The India Meteorological Department issues storm warnings to port officers whose ports are likely to be affected by adverse weather. They are also advised to hoist visual storm warning signals for the benefit of ships at the port and those out at sea. The information is, in most cases, conveyed by very high priority telegrams.

The storm warning signals, which are displayed prominently on masts in ports, are in the form of cones and cylinders for day signals and red and white lamps for night signals. In addition to hoisting signals, port officers have, in most cases, arrangements for disseminating the information and warnings received by them to country crafts and sailing vessels in the harbour.

The meaning of the signals used in Indian ports is given in Attachment A.

**2.4.3.6 Facsimile broadcast**

HF Facsimile broadcast of weather charts from RTH New Delhi has been discontinued.

**2.4.3.7 Dissemination of tropical cyclone warnings**

The modes of telecommunication used for the dissemination of tropical cyclone warnings in India are:

- (i) high priority telegram----- to be discontinued shortly
- (ii) teleprinter

- (iii) Automatic Message Switching System (AMSS)
- (iv) telephones
- (v) W/T (especially police W/T)
- (vi) All India Radio
- (vii) television
- (viii) microwave link of the railways
- (ix) Cyclone Warning Dissemination System (CWDS), Digital Cyclone Warning Dissemination System (DCWDS) - one way communication system
- (x) GMDSS
- (xi) Internet by keeping information on IMD website (<http://www.imd.ernet.in>)

When one type of communication channel fails, the alternate channel is used.

## **2.5 Storm warning system in Maldives**

The Department of Meteorology Maldives (DMM) issue tropical cyclone and severe weather warning to the public and travellers across the country. Apart from severe weather and tropical cyclone warning, tsunami warnings received through GTS were also despatched. The National Meteorological Centre has established the following means of communication for the dissemination of the warning.

- (i) Hotlines ( dedicated telephone)
- (ii) Local TV ( Television Maldives)
- (iii) Local Radio ( Voice of Maldives)
- (iv) Coast-Guard Service
- (v) Internet (<http://www.meteorology.gov.mv>)
- (vi) Facsimile

## **2.6 Tropical Cyclone Warning System in Oman**

### **2.6.1 *Organization***

Tropical cyclone warnings in Oman are provided by the Department of Meteorology under the Directorate General of Civil Aviation and Meteorology which falls under the Ministry of Transport and Communication.

Tropical cyclone warnings are provided from the Central Forecasting Office at Seeb International Airport.

### **2.6.2 *Tracking***

The tropical cyclones are tracked with the help of conventional surface and upper air observations, satellite observations particularly the METEOSAT-5 and aircraft reports.

### **2.6.3 *Tropical Cyclone Warning***

Tropical cyclone warnings are provided for:

- (i) The high seas
- (ii) Coastal waters



- (iii) Ports
- (iv) Civilian and military aviation
- (v) Governmental officials
- (vi) General public including fishermen
- (vii) Recipients registered with the DGCAM

#### **2.6.4 Warning Procedures**

The Central Forecasting Office will issue tropical cyclone advices, warnings and amendments every 12 hours or more frequently if required by changing conditions. The storm advice and warnings will contain the following information:

- (i) Advice Number
- (ii) Date and time
- (iii) Name of Storm
- (iv) Position of storm centre
- (v) Intensity
- (vi) Central pressure
- (vii) Movement
- (viii) Remarks

In the event the cyclone is expected to approach the coast of Oman, the following conditions will be appended to the above bulletins:

- CONDITION IV - Sustained winds of 50 knots or higher expected within 72 hours.
- This conditions will serve as a preliminary alert during which all responsible agencies should review action plans relative to evacuation of area subject to flooding or storm surges.
- CONDITION III - Sustained winds of 50 knots or higher expected within 48 hours.
- STANDBY ALERT
- CONDITION II - Sustained winds of 50 knots or higher expected within 24 hours.
- STANDBY ALERT
- Remote area should be warned.  
Pubic should be alerted.
- CONDITION I - Sustained winds of 50 knots or higher expected within 12 hours.
- Evacuation plans in effect in areas deemed necessary.
- EXAMPLE - SEEB MET ADVICE NBR 3
- AT 200600 GMT CYCLONIC STORM ARB 8501 0612 POSITIONED WITHIN A DEGREE OF LAT 20DEG N LONG 64DEG E ABOUT 300 NM ESE MASIRAH ISLAND. ESTIMATED MAX WIND OF 65 KNOTS AND CENTRAL PRESSURE OF 980 hPa. TO CONTINUE MOVING WEST AT 12 KNOT FOR NEXT 12 HOURS. CONDITION IV DUQM AND MASIRAH ISLAND.

#### **2.6.5 Bulletins for the High Seas**

Tropical cyclone warnings for the high seas in Oman are provided by the Central Forecasting Office located at Seeb International Airport and are broadcast from the Muscat Coastal Radio Station at Muscat, whose call sign is A4M.

#### **2.6.6 Warnings to Ports**

The Central Forecasting Office of the Meteorological Department issues storm warnings to ports whenever adverse weather is expected to affect them.

The main Ports are:

- (i) Mina Sultan Qaboos in Muscat
- (ii) Mina Salalah
- (iii) Wudam Naval Base
- (iv) Khasab
- (v) Sohar
- (vi) Qalhat

#### **2.6.7 Dissemination of Tropical Cyclone Warnings**

The modes of telecommunication used for the dissemination of tropical cyclone warnings and advisories to different categories of recipients are:

- (i) Telephones
- (ii) Telefax
- (iii) Voice Mail Pager System
- (iv) Oman Radio
- (v) Oman Television
- (vi) Muscat Radio Coastal Station
- (vii) Web site: [www.met.gov.om](http://www.met.gov.om)
- (viii) E-mail

### **2.7 Tropical cyclone warning system in Pakistan**

The Pakistan Meteorological Department is responsible for providing tropical cyclone warnings in the country, as one of the most important functions of the Department.

#### **2.7.1 Tracking of the tropical cyclones**

Tracking of the tropical cyclone in Pakistan is done with the help of:

- (i) conventional surface and upper-air observations from inland stations and ships' observations;
- (ii) cyclone detection radar; and
- (iii) satellite cloud pictures from the polar orbiting meteorological satellites.

#### **2.7.2 Tropical cyclone warnings**

The bulletins and warnings issued in connection with tropical cyclones in Pakistan may be divided into the following broad categories:

- (i) warning bulletins for shipping on the high seas;
- (ii) warning bulletins for ships plying in the coastal waters;

- (iii) port warnings;
- (iv) fisheries warnings;
- (v) warnings for Government officials;
- (vi) warnings for recipients who are registered with the Department;
- (vii) warnings for aviation;
- (viii) warnings for the general public through Radio Pakistan, television and the press.

### **2.7.3 *Bulletins for the high seas***

These bulletins are for the shipping interests on the high seas. The area covered includes the North Arabian Sea (north of 20°N). Coverage is shown in Map A (Attachment A).

These bulletins are issued by the Main Meteorological Office, Karachi and are broadcast by the Coastal Radio Stations. These bulletins consist of three parts. They are:

- Part I : Tropical Cyclone Warning in plain language.
- Part II : Synopsis of weather conditions in the forecast area in plain language.
- Part III : Forecast in plain language.

During normal undisturbed weather, two bulletins are broadcast at fixed hours known as "Daily" bulletins. In the event of disturbed weather additional bulletins are issued.

### **2.7.4 *Storm warnings to ports***

Pakistan Meteorological Department issues warnings to port officers whose parts are likely to be affected by adverse weather. They are also advised to hoist visual storm warning signals for the benefit of ships at the port and those out at sea. The information is, in most cases, conveyed by very high priority telegrams and by telephone. The meaning of the port warning signals used in Pakistan ports is given in Attachment A.

### **2.7.5 *Dissemination of tropical cyclone warnings***

The modes of telecommunication used for the dissemination of tropical cyclone warnings in Pakistan are:

- (i) high priority telegram
- (ii) teleprinter
- (iii) telephones
- (iv) W/T
- (v) Radio Pakistan
- (vi) Pakistan television
- (vii) telex/telex
- (viii) Internet (web site)

The mode of telecommunication differs for different types of messages. When one type of communication channel fails, the alternate channel is used.

## **2.8 Cyclone warning system in Sri Lanka**

### **2.8.1 *Organization***

The responsibility of the cyclone warning in Sri Lanka rests with the Department of Meteorology, Sri Lanka. Tropical cyclone warnings are provided from the National Meteorological Centre (NMC) Colombo.

### **2.8.2 Tracking**

Tropical cyclones are tracked with the help of conventional observations, radar, satellite observations and aircraft reports. These are dealt with in more detail in a separate chapter.

### **2.8.3 Tropical cyclone warnings**

#### **Tropical cyclone warnings/alert advisories are issued in three key stages**

- (i) When a depression or a cyclonic storm is about 550 km off the coast.

In addition to distance of storm centre from coast, this bulletin indicates forecast conditions on the (a) speed and direction of movement and (b) maximum surface wind speed likely. This bulletin is issued every twelve (12) hours and wherever imperative.

- (ii) When the cyclonic storm is 300 km off the coast.

In addition to above contents, information on areas likely to be affected are provided. This bulletin is issued every six (6) hours and wherever imperative. and

- (iii) When the cyclonic storm is 200 km off the coast and if landfall is indicated, a bulletin is issued every three (3) hour and wherever imperative. This bulletin includes additional information on point of landfall, storm surges and areas likely to be inundated.

#### **2.8.3.1 Tropical cyclone warnings for different users**

Relevant Government Officials including HE President & Prime Minister  
Disaster Management Centre (DMC)  
General Public  
Media  
The Armed Services & Police  
Local Administrations of relevant districts and  
Irrigation, Highways etc.

#### **Specific users**

Coastal fishing  
Shipping and  
Aviation

#### **2.8.3.2 Tropical cyclonic warnings for the high seas**

For the high seas, the tropical cyclone warnings are provided from NMC Colombo and broadcast through the coastal radio station Colombo Radio (4PB). The area covered by the warnings is the Indian Ocean, Arabian Sea and the Bay of Bengal from the equator to 10°N between 60°E and 95°E.

#### **3.8.3.3 Dissemination of tropical cyclone warnings**

The warnings/bulletins for the high seas are disseminated through Colombo (4PB). Other general modes are:

- State and Private Radio

- State and Private Television
- Press/Print Media
- Telephones/Pager/SMS
- Police Communication
- Teleprinter
- Telefax
- Internet SLMD website ( <http://www.meteo.slt.lk>)

## **2.9 Tropical cyclone warnings in Thailand**

### **2.9.1 *Organization***

Tropical cyclone warnings in Thailand are provided by the Meteorological Department, Thailand, from the Meteorological Office at Bangkok.

### **2.9.2 *Tracking***

Tropical cyclones are tracked with the help of conventional observations, radar, satellite observations and aircraft reports. These are dealt with in more detail in a separate chapter.

### **2.9.3 *Tropical cyclone warning system***

Tropical cyclone warnings for the high seas are issued from the Meteorological Office at Bangkok through the Bangkok coastal radio stations (HSA, HSS) for the areas covered by the Gulf of Thailand, west of Southern Thailand, Straight of Malacca and the South China Sea.

Port warnings issued in Thailand have been simplified. Three signals are used to indicate different stages of tropical storms, viz., tropical depression with wind speed up to 33 kts, tropical storm with wind speed 34 to 63 kts and typhoon or cyclone or storm with wind speed 64 kts or more. Four signals are used for the four different areas of responsibility. Port warning signals used in Thailand Port are given in Attachment A.

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Day Signals*	Specifications	Night Signals*	Remarks
<b>Bangladesh</b> (8.XI.1976)			
<b>Signals Meant for Maritime Ports</b>			
16a	I. <u>Distant Cautionary Signal Number One</u>	3b	)
	There is a region of squally weather in which a storm may be forming (well marked low or depression with surface winds up to 61 km/h. (33 knots))	)	) These signals indicate that ships may be exposed to danger after leaving the harbour
10a	II. <u>Distant Warning Signal Number Two</u>	2b	)
	A storm has formed (cyclonic storm with surface winds 62-88 km/h. (34-47 knots))	)	)
3a	III. <u>Local Cautionary Signal Number Three</u>	5b	)
	The port is threatened by squally weather (cyclonic circulation with surface winds 41-51 km/h. (22-27 knots)) or squalls due to Nor'westers)	)	) These signals indicate that the port itself and the ships in it are in danger
2a	IV. <u>Local Warning Signal Number Four</u>	4b	)
	The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution (cyclonic circulation with surface winds 52-61 km/h. (28-33 knots))	)	)
17a	V. <u>Danger Signal Number Five</u>	16b	)
	The port will experience severe weather from a storm of slight or moderate intensity, that is expected to cross the coast to the south of the port (to the east of the port in the case of Mongla) (cyclonic storm with surface winds 62-88 km/h. (34-47 knots))	)	) These signals indicate that the port itself and the ships in it are in danger

\* The national systems of visual storm warning signals (day signals and night signals) are reproduced in WMO Publication - WMO-No. 9, TD. 4, Volume D, Part D - Visual Storm Warning Signals Annexes II and III respectively.

Day Signals*	Specifications	Night Signals*	Remarks
<b>Bangladesh</b> - continued			
18a	VI. <u>Danger Signal Number Six</u>	17b	)
	The port will experience severe weather from a storm, of slight or moderate intensity that is expected to cross the coast to the north of the port (to the west of the port in the case of Mongla) (wind speed same as in Signal No. V)	)	)
19a	VII. <u>Danger Signal Number Seven</u>	18b	)
	The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross over or near to the port (wind speed as in Signal No. V)	)	)
20a	VIII. <u>Great Danger Signal Number Eight</u>	19b	)
	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port (to the east of the port in the case of Mongla) (severe cyclonic storm with surface winds 89-118 km/h. (48-63 knots) or severe cyclonic storm of hurricane intensity with winds 119 km/h. (64 knots) or above)	)	) These signals indicate that the port itself and the ships in it are in danger
21a	IX. <u>Great Danger Signal Number Nine</u>	20b	)
	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port (to the west of the port in the case of Mongla) (wind speed same as in Signal No. VIII)	)	)

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\* See footnote on page 1

Day Signals*	Specifications	Night Signals*	Remarks
<b>Bangladesh</b> - continued			
22a	X. <u>Great Danger Signal Number Ten</u>	21b	)
	The port will experience severe weather from a storm of great intensity that is expected to cross the coast over or near to the port (wind speed same as in Signal No. VIII)		) These signals indicate ) that the port itself and ) the ships in it are in ) danger
23a	XI. <u>Failure of Communications</u>	7b	)
	Communications with the Storm Warning Centre have broken down and the local officer considers that there is danger of bad weather. This signal is now inoperative.		) ) )

#### Signals Meant for River Ports

24a	I. <u>Cautionary Signal Number One</u>	5b	)
	Your area is threatened by squally winds of transient nature (Nor'westers squall of wind speed not exceeding 61 km/h. (33 knots)). Look out for further development		) These signals are used ) for the river ports, river ) and police stations in ) Bangladesh
1a	II. <u>Warning Signal Number Two</u>	7b	)
	A storm (of depression intensity, associated sustained winds not more than 38 mph. (33 knots)) or Nor'wester squall (of wind speed exceeding 61 km/h. (33 knots)) is likely to strike you (vessels of 65 feet and under in length are to seek shelter immediately)		) These signals are ) used for the river ) ports, river and ) police stations in ) Bangladesh ) ) )
2a	III. <u>Danger Signal Number Three</u>	2b	)
	A storm (of gale force, associated sustained winds 62-88 km/h. (34-47 knots)) will soon strike you. All vessels are to seek shelter immediately		) ) ) )

\* See footnote on page 1



Day Signals*	Specifications	Night Signals*	Remarks
<b>Bangladesh</b> - continued			
10a	IV. <u>Great Danger Signal Number Four</u>  A violent storm (of whole gale force and above, associated sustained wind speed exceeding 88 km/h. (47 knots)) will soon strike you. All vessels continue taking shelter immediately.	31b	) ) ) ) ) ) ) )
<b>India</b> <b>Radio warnings largely used</b>			
16a	I. <u>Distant cautionary signal number One</u>  There is a region of squally weather in which a storm may be forming	3b	) These signals indicate ) that ships may be exposed ) to danger after leaving the ) harbour
10a	II. <u>Distant warning signal number Two</u>  A storm has formed	2b	) These signals indicate ) that ships may be exposed ) to danger after leaving the ) harbour
3a*	III. <u>Local cautionary signal number Three</u>  Port is threatened by squally weather	5b	) Squally weather is ) meant to cover occasional ) or frequent squalls with ) rain or persistent type of ) strong gusty wind
2a*	IV. <u>Local warning signal number Four</u>  The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution.	4b	) (mean wind speed not ) less than 20 knots) ) accompanied by rain. ) Such conditions are associated ) with low pressure systems or ) onset and strengthening ) of monsoon. Mean wind ) speeds exceeding 33 knots ) associated with cyclonic ) storms are generally covered ) by signals higher than 3a

\* See footnote on page 1

Day Signals*	Specifications	Night Signals*	Remarks
<b>India</b> - continued			
17a	V. <u>Danger signal number Five</u>  Port will experience severe weather from a cyclone expected to move keeping the port to the left of its track	16b	) These signals indicate that the ) port itself and the ships in it ) are in danger )
18a	VI. <u>Danger signal number Six</u>  Port will experience severe weather from a cyclone expected to move keeping the port to the right of its track	17b	) These signals indicate ) that the port itself ) and the ships in it are ) in danger
19a*	VII. <u>Danger signal number Seven</u>  Port will experience severe weather from a cyclone expected to move over or close to the port	18b	) This signal is also hoisted when ) a storm is expected to skirt ) the coast without (actually) ) crossing it
20a	VIII. <u>Great Danger Signal number Eight</u>  Port will experience severe weather from a severe cyclone expected to move keeping the port to the left of its track	19b	) These signals indicate ) that the port itself ) and the ships in it are ) in danger
21a	IX. <u>Great Danger Signal number Nine</u>  Port will experience severe weather from a severe cyclone expected to move keeping the port to the right of its track	20b	) These signals indicate ) that the port itself ) and the ships in it are ) in danger
22a*	X. <u>Great Danger Signal number Ten</u>  Port will experience severe weather from a severe cyclone expected to move over or close to the port	21b	) This signal is also hoisted when ) a storm is expected to skirt the ) coast without (actually) crossing it
23a*	XI. <u>Failure of Communication</u>  Communications with the meteorological warning centre have broken down, and the local office considers there is a danger of bad weather	7b	) ) ) )

\* See footnote on page 1

**India** - continued

Brief System

- \* In the brief system only one of the five signals marked by an asterisk of the general system is hoisted, and the Port Officers are kept informed of the prospects of local bad weather associated with any disturbance in the sea, for the general information of shipping.

Extended System

Special section signals, in addition to those of the general system, are exhibited at certain ports in the Bay of Bengal belonging to the extended system.

If the port itself is threatened, the appropriate local signals of the general system are hoisted. But, if there is an area of squally weather or a storm that does not threaten the port, the distant cautionary or distant warning signal of the general system is hoisted, and one or more of the locality signals (described in the next paragraph) are hoisted under the distant signals, to indicate the position of the disturbance in the Bay.

The following shapes, when hung below a distant cautionary or warning signal, become locality signals, indicating the six divisions into which the Bay of Bengal has been divided for this purpose<sup>1)</sup>. If, however, the centre of the storm is near the boundary of a division, the hoisting of two locality signals is requested, the first indicating the division in which the centre is thought to be situated and the second the division nearest to the first.

In the event of a storm centre being near the corner where three divisions meet, the hoisting of three locality signals is requested, the first indicating the division in which the storm is estimated to be centred, the second the nearest adjoining division, and the third the remaining division.

Signal	3a	10a	24a	16a	2a	23a
Section						

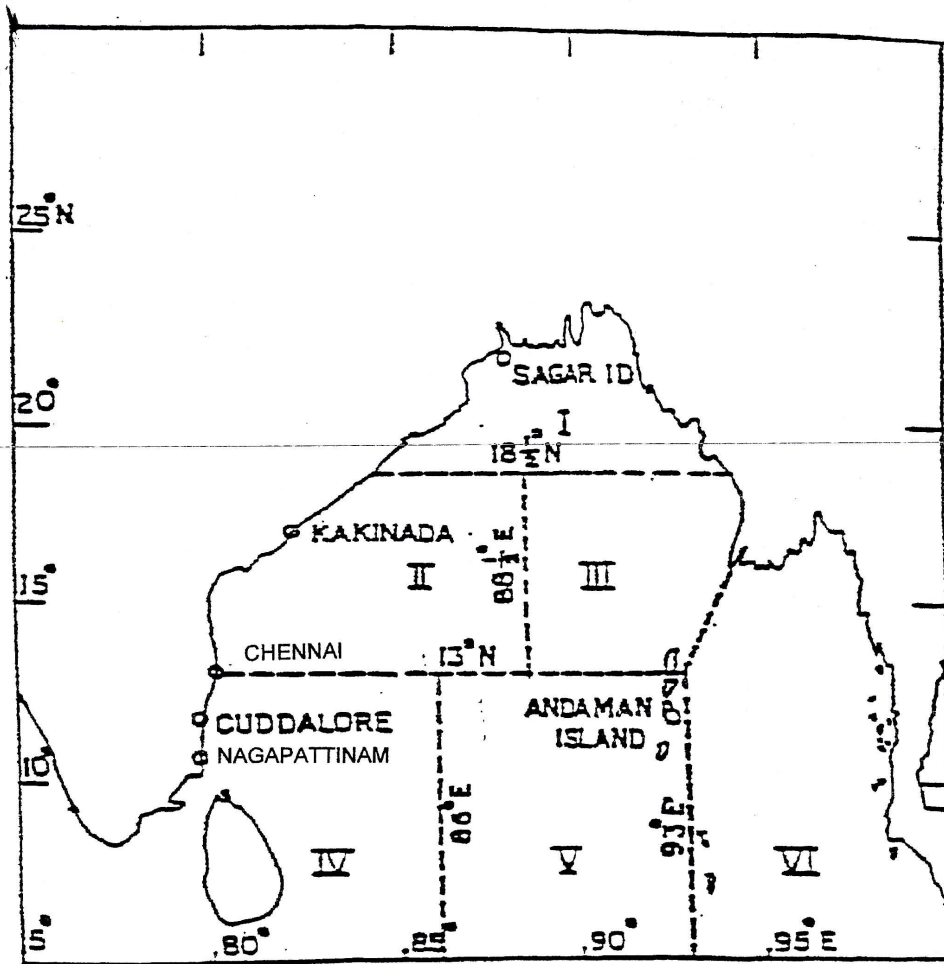
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1) The divisions are as indicated on the chart given on page II A-7. Thus, if there is squally weather in Section I of the Bay, the signal 25a would be hoisted at the various ports, and if a storm has formed in Section II, the signal 11a would be hoisted at all ports which were not directly threatened. As already stated, the ports directly threatened would hoist one or other of the local signals. The Meteorological Department endeavours to keep the number of locality signals on each hoist as small as possible, and generally the number of only that section in which the centre of the storm is situated is given in the Warning Telegram.

**VISUAL STORM WARNING SIGNALS**

**REGION II**

**India** - continued



Day Signals*	Specifications	Night Signals*	Remarks
<b>Myanmar</b> (21.II.1977)			
<u>General System</u>			
16a	There is a region of squally weather in which a storm may be forming	3b	Distant cautionary signal
10a	A storm has formed	2b	Distant warning signal
3a	The port is threatened by squally weather	5b*	Local cautionary signal
2a*	The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution	4b*	Local warning signal. The existence of a storm can often of motion can be fixed. In this case all those ports which the storm could possibly strike are warned by this signal
17a	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross the coast to the south of the port (or to the east in the case of Yangon, Pathein and Diamond Island)	16b	Local danger signal
18a	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross the coast to the north of the port (or to the west in the case of Yangon and Moulmein)	17b	Local danger signal
19a*	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross over or near to the port	18b*	Local danger signal

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\* See footnote on page 1

Day Signals*	Specifications	Night Signals*	Remarks
<b>Myanmar</b> - continued			
20a	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port (or to the east in the case of Yangon, Pathein and Diamond Island)	19b	Local great danger signal
21a	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port (or to the west in the case of Yangon and Moulmein)	20b	Local great danger signal
22a*	The port will experience severe weather from a storm of great intensity that is expected to cross over or near to the port	21b*	Local great danger signal
23a*	Communications with the meteorological warning centre have broken down, and the local officer considers that there is a danger of bad weather	7b*	Local failure of communications signal

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\* See footnote on page 1

**Myanmar** - continued

Brief System

In the brief system only one of the five signals marked by an asterisk of the general system is hoisted, and the Port Officers are kept informed of the prospects of local bad weather associated with any disturbance in the sea, for the general information of shipping.

Extended System

Special signals, in addition to those of the general system, are exhibited at certain ports in the Bay of Bengal belonging to the extended system.

If the port itself is threatened, the appropriate local signals of the general system are hoisted. But, if there is an area of squally weather or a storm that does not threaten the port, the distant cautionary or distant warning signal of the general system is hoisted, and one or more of the locality signals (described in the next paragraph) are hoisted under the distant signals, to indicate the position of the disturbance in the Bay.

The following shapes, when hung below a distant cautionary or warning signal, become locality signals, indicating the six divisions into which the Bay of Bengal has been divided for this purpose<sup>1)</sup>. If, however, the centre of the storm is near the boundary of a division, the hoisting of two locality signals is requested, the first indicating the division in which the centre is thought to be situated and the second the division nearest to the first.

In the event of a storm centre being near the corner where three divisions meet, the hoisting of three locality signals is requested, the first indicating the division in which the storm is estimated to be centred, the second the nearest adjoining division, and the third the remaining division.

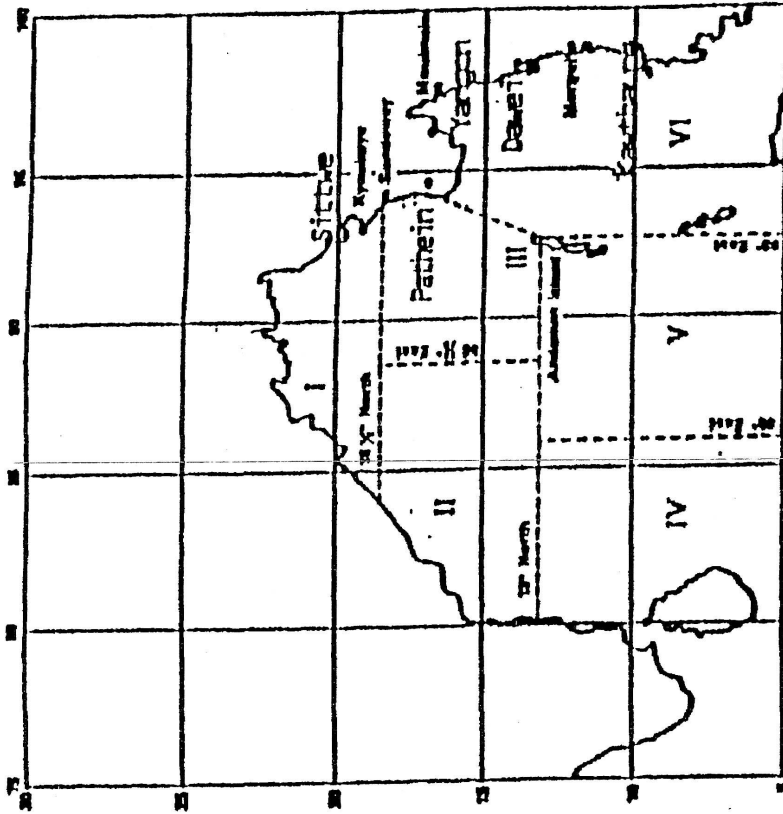
Signal	3a	10a	24a	16a	2a	23a
Section						

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1) The divisions are as indicated on the chart given on page 11. Thus, if there is squally weather in Section I of the Bay, the signal 25a would be hoisted at the various ports, and if a storm has formed in Section II, the signal 11a would be hoisted at all ports which were not directly threatened. As already stated, the ports directly threatened would hoist one or other of the local signals. The Department of Meteorology and Hydrology endeavours to keep the number of locality signals on each hoist as small as possible, and generally the number of only that section in which the centre of the storm is situated is given in the Warning Telegram.



Myanmar - continued



2007 Edition

2007 Edition

Day Signals*	Specifications	Night Signals*	Remarks
<b>Pakistan - (10.VI.1984)</b>		<b>Radio warnings largely used</b>	
16a	There is a region of squally weather in which a storm may be forming	3b )	) ) ) These signals ) indicate that ) ships may be ) exposed to danger ) after leaving the ) harbour
10a	A storm has formed	2b )	)
3a	Port is threatened by squally weather	5b )	) These signals ) indicate that the ) port itself and ) the ships in it ) are in danger
2a	Port is threatened by a storm, but it does not appear that danger justifies extreme measures of precaution	4b )	) ) )
17a	Severe weather from a storm of slight or moderate intensity, expected to cross the coast to south or east of port	16b )	) ) )
18a	Severe weather from a storm of slight or moderate intensity, expected to cross the coast to north or west of port	17b )	) These signals ) indicate that the ) port itself and ) the ships in it ) are in danger
19a	Severe weather from a storm of slight or moderate intensity, expected to cross over or near to the port	18b )	) ) )
20a	Severe weather from a storm of great intensity, expected to cross the coast to south or east of port	19b )	) ) )

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\* See footnote on page 1

Day Signals*	Specifications	Night Signals*	Remarks
<b><u>Pakistan</u></b> - continued			
21a	Severe weather from a storm of great intensity, expected to cross the coast to north or west of port	20b ) ) ) ) )	These signals indicate that the port itself and the ships in it are in danger
22a	Severe weather from a storm of great intensity, expected to cross over or near to the port	21b ) ) )	
23a	Communications with the meteorological warning centre have broken down, and the local office considers there is a danger of bad weather	7b ) ) ) )	These signals indicate that the port itself and the ships in it are in danger

**Sri Lanka** (20.II.1978)

53a			Hoisted at the Colombo Pilot Station
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**Thailand** (11.IV.1984)**Signals indicating the intensity of storms**

35a	Tropical depression or storm with wind speeds near centre not exceeding 33 kt	1.	Signals indicating the occurrence of storms in the Gulf of Thailand and adjacent seas to be displayed at Port Area (Bangkok) and at Bangkok Harbour Limit I (Pong Pachjarnit Fort, Pagklongsarn, Dhonburi)
36a	Tropical storm or storm with wind speeds near centre from 34 kt and over but not exceeding 63 kt		
56a	Typhoon or cyclone or storm with wind speeds near centre 64 kt or more	2.	Signals indicating the intensity and locality of storms will be hoisted on the same yard-arm with the pennant indicating the intensity and the flag indicating the locality of the storm. The flag is always hoisted below the pennant

\* See footnote on page 1

Day Signals*	Specifications	Night Signals*	Remarks
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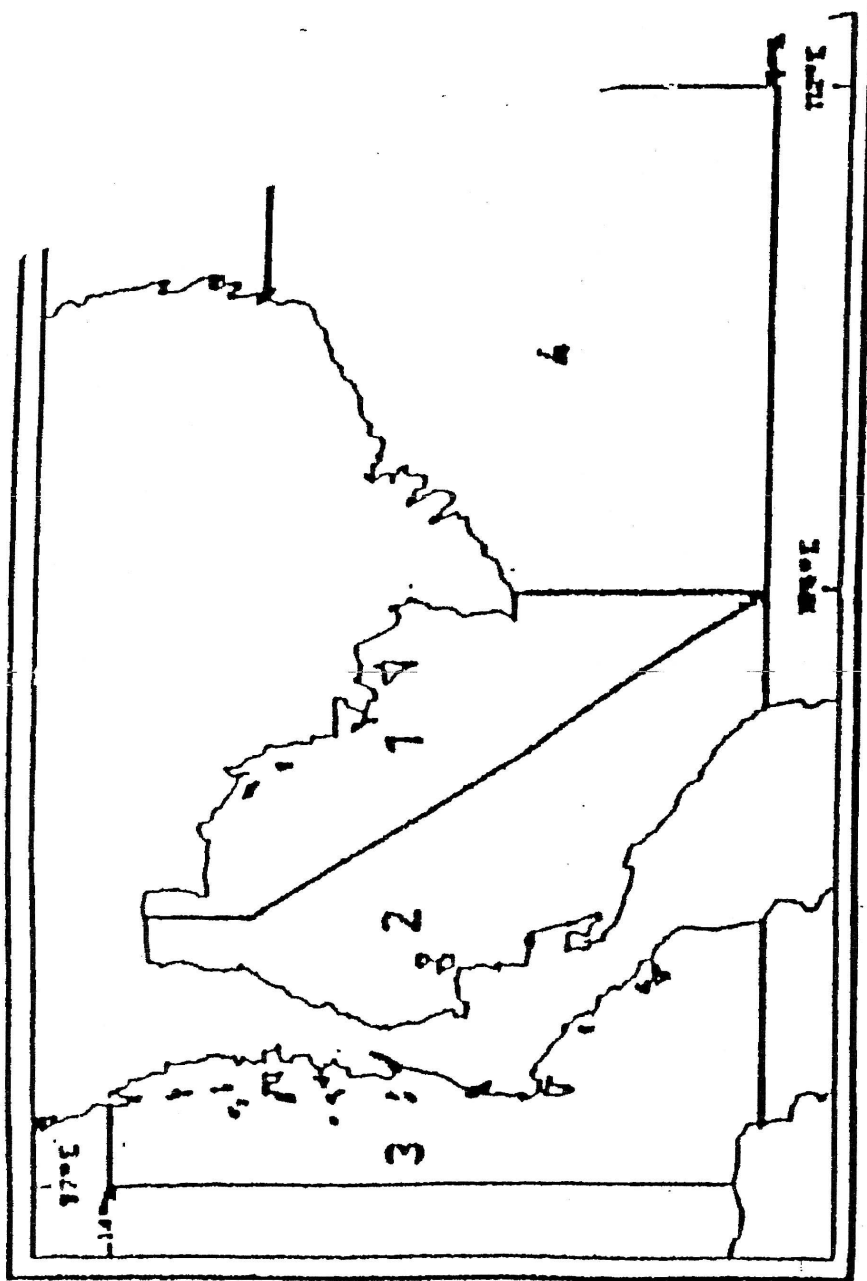
**Thailand** - continued**Signals indicating the locality of storms**

- 37a Area 1 : Gulf of Thailand east coast to Lat. 5°N and Long. 105°E
- 38a Area 2 : Gulf of Thailand west coast to Lat. 5°N
- 43a Area 3 : Andaman Sea bounded by west coast of southern Burma, west coast of southern Thailand, Long. 97°E, Lat. 5°N and Lat. 14°N
- 51a Area 4 : South China Sea bounded by southern Viet Nam coast, Lat. 12°N, Lat. 5°N, Long. 105°E and Long. 112°E

**Note:** In normal weather conditions (no tropical depression, storm or typhoon) the white pennant with red circle (52a) will be displayed at the upper yard-arm at Bangkok Harbour Limit I (Pong Pachjarnit Fort, Pagklongsarn, Dhonburi).

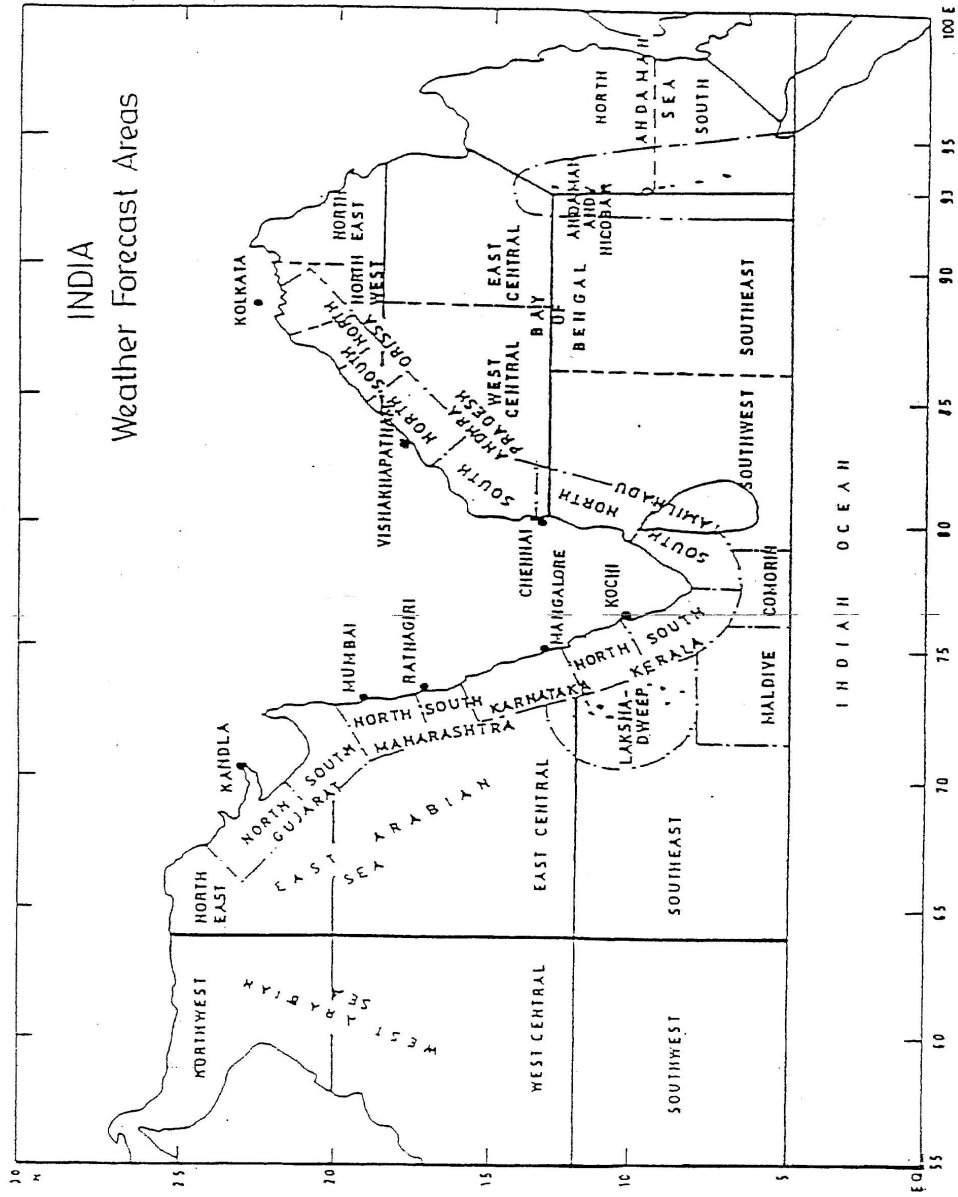
\* See footnote on page 1

**Thailand** - continued



Map showing the areas of responsibility of Thailand

MAP A: BOUNDARIES OF AREAS USED IN WEATHER BULLETINS FOR MERCHANT SHIPPING AND COASTAL WEATHER



2007 Edition

2007 Edition

**CHAPTER III****THE OBSERVING SYSTEM AND OBSERVING PROGRAMME****3.1 Networks of surface and upper-air stations****3.1.1 *Observations from basic network***

The list of implemented regional basic synoptic networks of surface and upper-air stations of the Panel countries is given in Table III-1. The network of stations adopted for regional exchange by the World Weather Watch is considered adequate for routine tracking of weather systems. However, in the cyclone season, particularly when a tropical depression or storm exists in the region, special efforts will be made by the national meteorological services to improve the collection and distribution of surface synoptic reports from the coastal stations.

**3.1.2 *Special observations from the WWW network***

National meteorological services will endeavour to arrange for additional observations in areas coming within the circulation of a tropical cyclone. These stations will make round-the-clock three-hourly or hourly observations when the system is of tropical storm intensity and close to the coast and the observations will be passed on real-time to the Panel countries.

**3.1.3 *Special observations from stations other than those of the regional basic synoptic network***

National Meteorological Services (NMS) have established a large number of meteorological observing stations, in addition to those in the regional basic synoptic network, observations from which are received by the NMS. When there is a tropical cyclone in the Bay of Bengal or in the Arabian Sea, observations from these stations, particularly from coastal stations, will be exchanged on real-time basis on priority. If the observations are not received during a tropical cyclone situation a request for them could be sent to the NMC concerned. A list of these stations is given in Table III-2.

**TABLE III-1: List of implemented regional basic synoptic network stations**

Name of Station Radiosonde	Surface								Radiowind					
	1	2				3				4				
	00	03	06	09	12	15	18	21	00	06	12	18	00	12
41240 KHASAB		X	X	X	X	X	X							
242 DIBA*	X	X	X	X	X	X	X	X						
244 BURAIMI	X	X	X	X	X	X	X	X						
246 SOHAR MAJIS	X	X	X	X	X	X	X	X						
253 RUSTAQ	X	X	X	X	X	X	X	X						
254 SAIQ		X	X	X	X									
255 NIZWA*			X	X	X									
256 SEEB INT. AIRPORT	X	X	X	X	X	X	X	X	X					
257 SAMAIL	X	X	X	X	X	X	X	X						
258 MINA SULTAN QABOOS	X	X	X	X	X	X	X	X						
262 FAHUD	X	X	X	X	X	X	X	X						
263 BAHLA	X	X	X	X	X	X	X	X						
264 ADAM	X	X	X	X	X	X	X	X						
265 IBRA	X	X	X	X	X	X	X	X						
267 QALHAT	X	X	X	X	X	X	X	X						
268 SUR	X	X	X	X	X	X	X	X						
275 QARN ALAM	X	X	X	X	X	X	X	X						
288 MASIRAH	X	X	X	X	X	X	X	X						
304 MARMUL	X	X	X	X	X	X	X	X						
312 MINA SALALAH	X	X	X	X	X	X	X	X						
314 THUMRAIT	X	X	X	X	X	X	X	X						
315 QAIROON HAIRITI		X	X	X	X	X	X	X	X					
316 SALALAH	X	X	X	X	X	X	X	X	X					
515 DROSH		X	X	X	X	X	X	X	X					
530 PESHAWAR	X	X	X	X	X	X	X	X	X	X				X
560 PARACHINAR	X	X	X	X	X	X	X	X						
571 ISLAMABAD AIRPORT	X	X	X	X	X	X	X	X						
594 SARGODHA	X	X	X	X	X	X	X	X	X	X				X
598 JHELUM	X	X	X	X	X	X	X	X	X	X				
620 ZHOB	X	X	X	X	X	X	X	X						
624 DERA ISMAIL KHAN	X	X	X	X	X	X	X	X	X	X				
640 LAHORE CITY	X	X	X	X	X	X	X	X	X	X				
660 QUETTA AIRPORT		X	X	X	X	X	X	X	X					
661 QUETTA (SHEIKH MANDA)									X	X	X	X		X
675 MULTAN	X	X	X	X	X	X	X	X	X	X	X	X		X
685 BAR KHAN	X	X	X	X	X	X	X	X	X	X				
710 NOKKUNDI		X	X	X	X	X	X	X	X					
712 DAL BANDIN	X	X	X	X	X	X	X	X	X	X				
715 JACOBABAD	X	X	X	X	X	X	X	X	X	X				
718 KHANPUR	X	X	X	X	X	X	X	X						
739 PANJGUR	X	X	X	X	X	X	X	X						X
744 KHUZDAR	X	X	X	X	X	X	X	X	X	X				
749 NAWABSHAH	X	X	X	X	X	X	X	X	X	X				
756 JIWANI	X	X	X	X	X	X	X	X	X	X				
765 HYDERABAD	X	X	X	X	X	X	X	X	X	X				
768 CHHOR		X	X	X	X	X	X	X	X	X			X	
780 KARACHI AIRPORT	X	X	X	X	X	X	X	X	X	X				X

\* During the period of tropical cyclone



Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
41859	RANGPUR	X	X	X	X	X	X	X	X	X	X	X	X		
883	BOGRA	X	X	X	X	X	X	X	X	X	X	X	X	X	
891	SYLHET	X	X	X	X	X	X	X	X	X	X	X	X		
907	ISHURDI	X	X	X	X	X	X	X	X	X	X	X	X		
923	DHAKA	X	X	X	X	X	X	X	X	X	X	X	X	X	
936	JESSORE	X	X	X	X	X	X	X	X	X	X	X	X		
977	CHITTAGONG (AMBAGAN)	X	X	X	X	X	X	X	X	X	X	X	X	X	
978	CHITTAGONG (PATENGA)	X	X	X	X	X	X	X	X						
992	COX'S BAZAR	X	X	X	X	X	X	X	X	X	X	X	X		
950	BARISAL	X	X	X	X	X	X	X	X	X	X	X	X		
943	FENI	X	X	X	X	X	X	X	X	X	X	X	X		
42027	SRINAGAR	X	X	X	X	X	X	X	X		X			X	X
071	AMRITSAR	X	X	X	X	X	X	X	X						
101	PATIALA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
111	DEHRADUN	X	X	X	X	X	X	X	X						
131	HISSAR		X	X	X	X	X	X	X	X					
165	BIKANER	X	X	X	X	X	X	X	X						
182	NEW DELHI/ SAFDARJUNG	X	X	X	X	X	X	X	X	X	X	X	X	X	X
189	BAREILLY	X	X	X	X	X	X	X	X						
260	AGRA	X	X	X	X	X	X	X	X						
309	NORTH LAKHIMPUR	X	X	X	X	X	X	X	X						
314	DIBRUGARH/ MOHANBARI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
328	JAISALMER	X	X	X	X	X	X	X	X						
339	JODHPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
348	JAIPUR/SANGANER	X	X	X	X	X	X	X	X						
361	GWALIOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
369	LUCKNOW/AMAUSI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
379	GORAKHPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
397	SILIGURI									X		X		X	X
42410	GUWAHATI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
415	TEZPUR	X	X	X	X	X	X	X	X						
452	KOTA AERODROME	X	X	X	X	X	X	X	X						
475	ALLAHABAD/ BAMHRAULI	X	X	X	X	X	X	X	X						
492	PATNA	X	X	X	X	X	X	X	X	X		X		X	X
559	GUNA	X	X	X	X	X	X	X	X						
571	SATNA	X	X	X	X	X	X	X	X						
591	GAYA	X	X	X	X	X	X	X	X	X		X			
623	IMPHAL TULIHAL	X		X		X		X		X	X	X	X		
634	BHUJ-RUDRAMATA	X	X	X	X	X	X	X	X						
647	AHMEDABAD	X	X	X	X	X	X	X	X	X	X	X	X	X	X
667	BHOPAL/BAIRAGARH	X	X	X	X	X	X	X	X	X	X	X	X	X	X
675	JABALPUR	X	X	X	X	X	X	X	X						

Name of Station		Surface							Radiowind				Radiosonde		
1		2							3				4		
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
701	RANCHI	X	X	X	X	X	X	X	X	X		X		X	X
707	BANKURA	X	X	X	X	X	X	X	X						
724	AGARTALA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
737	RAJKOT	X	X	X	X	X	X	X	X						
754	INDORE	X	X	X	X	X	X	X	X						
779	PENDRA	X	X	X	X	X	X	X	X						
798	JAMSHEDPUR	X	X	X	X	X	X	X	X	X		X			
809	KOLKATA / DUMDUM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
840	SURAT	X	X	X	X	X	X	X	X						
867	NAGPUR /SONEGAON	X	X	X	X	X	X	X	X	X	X	X	X	X	X
875	RAIPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
886	JHARSUGUDA	X	X	X	X	X	X	X	X	X		X			
895	BALASORE	X	X	X	X	X	X	X	X	X		X			
42909	VERAVAL	X	X	X	X	X	X	X	X						
934	AKOLA	X	X	X	X	X	X	X	X						
971	BHUBANESWAR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
977	SANDHEADS		X			X									
43003	MUMBAI (SANTACRUZ)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
014	AURANGABAD	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	CHIKALTHANA														
041	JAGDALPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
063	PUNE	X	X	X	X	X	X	X	X						
086	RAMGUNDAM	X	X	X	X	X	X	X	X	X					
110	RATNAGIRI	X	X	X	X	X	X	X	X						
117	SHOLAPUR		X	X	X	X	X	X	X	X		X			
128	HYDERABAD AIRPORT	X	X	X	X	X	X	X	X	X	X	X	X	X	X
150	VISHAKHAPATNAM/ WALTAIR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
185	MACHILIPATNAM (FRANCHPET)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
189	KAKINADA	X	X	X	X	X	X	X	X						
192	GOA/PANJIM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
198	BELGAUM/SAMBRE	X	X	X	X	X	X	X	X						
201	GADAG			X	X	X	X	X	X	X					
213	KURNOOL	X	X	X	X	X	X	X	X						
233	CHITRADURGA	X	X	X	X	X	X	X	X						
237	ANANTAPUR	X	X	X	X	X	X	X	X						
245	NELLORE	X	X	X	X	X	X	X	X						
279	CHENNAI/MEENAMBAKKAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
284	MANGALORE/BAJPE	X	X	X	X	X	X	X	X						
285	MANGALORE/PANAMBUR									X	X	X	X	X	X
295	BANGALORE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43311	AMINI DIVI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
314	KOZHICODE	X	X	X	X	X	X	X	X						
321	COIMBATORE/PEELAMEDU	X	X	X	X	X	X	X	X						
329	CUDDALORE	X	X	X	X	X	X	X	X						

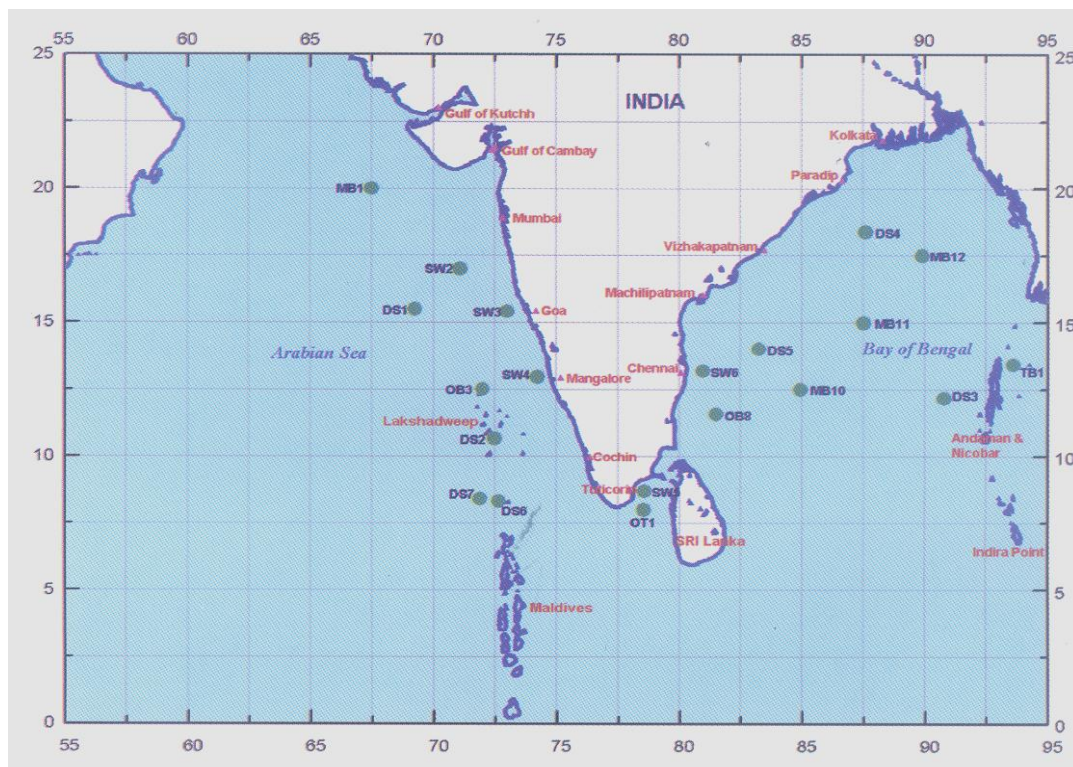
Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
333	PORT BLAIR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
344	TIRUCHIRAPALLI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
346	KARAIKAL	X	X	X	X	X	X	X	X	X	X	X	X	X	X
353	KOCHI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
369	MINICOY	X	X	X	X	X	X	X	X	X	X	X	X	X	X
371	TIRUVANANTHAPURAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
418	TRINCOMALEE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
421	ANURADHAPURA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
424	PUTTALAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
436	BATTICALOA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
450	KATUNAYAKE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
466	COLOMBO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
473	NUWARA ELIYA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
486	RATNAPURA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
495	GALLE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
497	HAMBANTOTA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
533	HANIMADHOO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
555	MALE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
577	KADHDHOO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
588	KADEHDHOO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
599	GAN	X	X	X	X	X	X	X	X	X	X	X	X	X	X
48001	PUTAO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
004	HKAMTI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
008	HYITKYINA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
010	HOMALIN	X	X	X	X	X	X	X	X	X	X	X	X	X	X
018	KATHA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
019	BHAMO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
020	MAWLAIK	X	X	X	X	X	X	X	X	X	X	X	X	X	X
025	KALEWA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
035	LASHIO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
037	MONYWA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
042	MANDALAY	X	X	X	X	X	X	X	X	X	X	X	X	X	X
045	MINDAT	X	X	X	X	X	X	X	X	X	X	X	X	X	X
048	NYUNG-U	X	X	X	X	X	X	X	X	X	X	X	X	X	X
053	MEIKTILA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
057	TAUNGGYI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
060	KENGTUNG	X	X	X	X	X	X	X	X	X	X	X	X	X	X
062	SITTWE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
071	KYAUKPYU	X	X	X	X	X	X	X	X	X	X	X	X	X	X
077	PROME	X	X	X	X	X	X	X	X	X	X	X	X	X	X
078	TOUNGOO	X	X	X	X	X	X	X	X	X	X	X	X	X	X
080	SANDOWAY	X	X	X	X	X	X	X	X	X	X	X	X	X	X
094	PATHEIN	X	X	X	X	X	X	X	X	X	X	X	X	X	X
097	YANGON	X	X	X	X	X	X	X	X	X	X	X	X	X	X
108	DAWEI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
109	COCO ISLAND	X	X	X	X	X	X	X	X	X	X	X	X	X	X
110	MERGUI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
112	KAWTHAUNG	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
48300	MAE HONG SON	X	X	X	X	X	X	X	X						
303	CHIANG RAI	X	X	X	X	X	X	X	X						
327	CHIANG MAI	X	X	X	X	X	X	X	X	X	X	X			X
328	LAMPANG	X	X	X	X	X	X	X	X						
330	PHRAE	X	X	X	X	X	X	X	X						
331	NAN	X	X	X	X	X	X	X	X						
351	UTTARADIT	X	X	X	X	X	X	X	X						
353	LOEI	X	X	X	X	X	X	X	X						
354	UDON THANI	X	X	X	X	X	X	X	X						
356	SAKON NAKHON	X	X	X	X	X	X	X	X						
375	MAE SOT	X	X	X	X	X	X	X	X						
376	TAK	X	X	X	X	X	X	X	X						
377	BHUMIBOL DAM	X	X	X	X	X	X	X	X						
378	PHITSANULOK	X	X	X	X	X	X	X	X						
379	PHETCHABUN		X	X	X	X	X	X	X	X					
381	KHON KAEN	X	X	X	X	X	X	X	X						
400	NAKHON SAWAN	X	X	X	X	X	X	X	X						
407	UBON RATCHATHANI	X	X	X	X	X	X	X	X	X	X	X			X
431	NAKHON RATCHASIMA	X	X	X	X	X	X	X	X						
432	SURIN	X	X	X	X	X	X	X	X						
455	BANGKOK	X	X	X	X	X	X	X	X	X	X	X			X
456	DON MUANG	X	X	X	X	X	X	X	X						
462	ARANYAPRATHET	X	X	X	X	X	X	X	X						
475	HUA HIN	X	X	X	X	X	X	X	X						
477	SATTAHIP	X	X	X	X	X	X	X	X						
480	CHANTHABURI	X	X	X	X	X	X	X	X	X		X			
48500	PRACHUAP KHIRIKHAN	X	X	X	X	X	X	X	X	X		X	X		
517	CHUMPHON	X	X	X	X	X	X	X	X						
532	RANONG	X	X	X	X	X	X	X	X						
551	SURAT THANI	X	X	X	X	X	X	X	X	X		X			
565	PHUKET AIRPORT		X	X	X	X	X	X	X	X	X				X
567	TRANG	X	X	X	X	X	X	X	X						
568	SONGKHLA	.	.	.	.	.	.	.	.	.	.	X	X	X	X
569	HAT YAI	X	X	X	X	X	X	X	X	X					
583	NARATHIWAT	X	X	X	X	X	X	X	X						

**TABLE III-2: List of stations other than those in the WWW network from which special observations are available in cyclone situations**

Country: <u>Bangladesh</u>		Surface								Radiowind				Radiosonde	
1	Name of Station	2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
41863	DINAJPUR	X	X	X	X	X	X	X	X						
858	SAIDPUR	X	X	X	X	X	X	X	X						
886	MYMENSINGH	X	X	X	X	X	X	X	X	X					
895	RAJSHAHI	X	X	X	X	X	X	X	X						
909	TANGAIL	X	X	X	X	X	X	X	X						
915	SRIMANGAL	X	X	X	X	X	X	X	X						
926	CHUADANGA	X	X	X	X	X	X	X	X						
929	FARIDPUR	X	X	X	X	X	X	X	X						
933	COMILLA	X	X	X	X	X	X	X	X						
939	MADARIPUR	X	X	X	X	X	X	X	X						
941	CHANDPUR	X	X	X	X	X	X	X	X						
943	FENI	X	X	X	X	X	X	X	X	X	X	X	X		
946	SATKHIRA	X	X	X	X	X	X	X	X						
947	KHULNA	X	X	X	X	X	X	X	X						
950	BARISAL	X	X	X	X	X	X	X	X	X	X	X	X		
951	BHOLA	X	X	X	X	X	X	X	X						
953	MAIJDICOURT	X	X	X	X	X	X	X	X	X					
958	MONGLA	X	X	X	X	X	X	X	X						
960	PATUAKHALI	X	X	X	X	X	X	X	X						
965	SITAKUNDA	X	X	X	X	X	X	X	X						
963	HATIYA	X	X	X	X	X	X	X	X						
964	SANDWIP	X	X	X	X	X	X	X	X						
966	RANGAMATI	X	X	X	X	X	X	X	X						
984	KHEPUPARA	X	X	X	X	X	X	X	X						
989	KUTUBDIA	X	X	X	X	X	X	X	X						
998	TEKNAF	X	X	X	X	X	X	X	X						
Country: <u>India</u>															
42830	PORBANDAR	X	X	X	X	X	X	X	X						
43049	GOPALPUR	X	X	X	X	X	X	X	X	X		X	X		
43221	ONGOLE	X	X	X	X	X	X	X	X						
43348	ADIRAMPATTINAM		X				X								
Country: <u>Sri Lanka</u>															
413	MANNAR	X	X	X	X	X	X	X	X						
475	POTTUVIL	X	X	X	X	X	X	X	X						

DETAILS OF BUOYS AND LOCATIONS AS ON OCTOBER 2003



SW –Shallow water DS - Deep sea OT-Thermal buoy MB- Meteorological buoy

Country: Oman

Name of Station	Surface								Radiowind				Radiosonde	
	1		2						3				4	
	00	03	06	09	12	15	18	21	00	06	12	18	00	12
23051 BOUY (MINA SULTAN QABOOS)		X	X	X	X	X	X	X	X					
052 BOUY (SUR) <sup>1</sup>	X	X	X	X	X	X	X	X						
053 BOUY (MINA SALALA) <sup>1</sup>	X	X	X	X	X	X	X	X						
055 BOUY (SOHAR)	X	X	X	X	X	X	X	X						

<sup>1</sup> Temporarily discontinued

### **3.1.4 Upper-air stations**

Additional upper wind observations will be made as appropriate whenever a tropical cyclone is centred within 500 nautical miles of the station. The minimum required is two observations per day, but for a better understanding of the ambient wind field three or even four flights on some days will be made when possible. All these additional upper-air observations will be distributed among the Panel countries.

### **3.2 Observations from mobile ships**

Efforts will be made to obtain the maximum number of ships' observations from the cyclone field by the NMSs and to pass on these observations to RSMC New Delhi. Whenever there is a tropical cyclone in the Bay of Bengal or in the Arabian Sea, additional ships' reports at frequent intervals will be requested by the storm warning centre/meteorological office concerned.

### **3.3 Aircraft reports**

All reports from aircraft in flight in the area will be passed on real-time to RMC New Delhi and to other Panel countries. In case the national meteorological service collecting the report deems it to be of interest in the analysis or forecasting of a tropical cyclone situation, it will be prefixed with an agreed high priority symbol.

### **3.4 Radar observations**

As long as a tropical cyclone remains within range of one of the cyclone detection radars in the region, the meteorological centre concerned will keep the system under continuous surveillance and will transmit the radar observations through GTS to RMC New Delhi and other Panel countries. These reports will be made in accordance with a pre-established schedule, preferably on a regular three-hourly basis.

The report will be in the RADOB code (FM20-V RADOB) or the code given in Annex III-A and will be transmitted twice to ensure reception of the complete message.

In case the report is in plain language, the full range of information available at the radar station will be given. The message will therefore include, where available, the confirmation of the determination of the centre; the shape, definition, size and character tendency of the eye; the distance between the end of the outermost band and the centre of the cyclone and the direction and speed of movement with a statement of the interval of time over which the movement was calculated.

A list of the cyclone detection radar stations in the Panel area is given in Table III-3 below.

TABLE III-3

**WEATHER RADAR STATIONS KEEPING WATCH  
OVER THE ARABIAN SEA AND THE BAY OF BENGAL**

Country	Station	N	E	Type	Op. since
Bangladesh	41992 Cox's Bazar	21°20'	92°17'	10 cm (Doppler)	1970
	41984 Khepupara	21°59'	90°14'	10 cm	1982
	41923 Dhaka	23°46'	90°23'	10 cm	1970
	41859 Rangpur			10 cm	1999
India	42807 Kolkata	22°36'	88°21'	10 cm / DWR	1973 / 2002
	42976 Paradip	20°16'	86°41'	10 cm	1973
	43149 Visakhapatnam	17°41'	83°17'	10 cm	1970
	43185 Machilipatnam	16°11'	81°08'	10 cm/ DWR	1981 2004
	----- Sriharikota	13°40'	80°14'	DWR	2002
	43278 Chennai	13°05'	80°17'	10 cm DWR	1973 / 2003
	43346 Karaikal	10°55'	79°51'	10 cm	1979
	43353 Kochi	09°57'	76°17'	10 cm	1987
	43192 Goa	15°27'	73°48'	10 cm	1978
	43057 Mumbai	18°54'	72°48'	10 cm	1975
	42634 Bhuj	23°14'	69°39'	10 cm	1987
	Myanmar	48071 Kyaukpyu	19°23'	93°33'	10 cm
Pakistan	41780 Karachi	24°54'	67°08'	5.6 cm	1991
Sri Lanka	43418 Trincomalee	08°35'	81°15'	10 cm	1982
Thailand	48455 Bangkok	13°44'	100°34'	10 cm (Doppler)	1992
	48517 Chumphon	10°29'	99°11'	5.6 cm	1985
	48565 Phuket	08°07'	98°19'	10 cm (Doppler)	1990
	48551 Surat Thani	09°07'	99°21'	10 cm (Doppler)	1993
	48475 Hau Hin	12°35'	99°57'	10 cm (Doppler)	1994

### 3.5 Satellite observations

Although the same images are obtained at all cyclone warning centres, it is essential that meteorological authorities compare with each other the conclusions reached on the intensity, position and development characteristics shown by the images.

When a depression or tropical cyclone is in existence in the Panel region, meteorological services will transmit to RSMC - tropical cyclones New Delhi, as soon as is feasible, bulletins of satellite observations. RSMC New Delhi is incorporating the satellite derived information in their bulletins which are disseminated for use in the Panel countries.

As soon as a tropical cyclone is observed over the Panel region, RSMC - tropical cyclones New Delhi will receive a satellite bulletin based on INSAT / Kalpana-1 pictures every hour to the extent possible. Information from this bulletin will be included in the tropical cyclone advisories which will be issued from RSMC - tropical cyclones New Delhi eight times a day when a tropical cyclone is in the Panel region.



Satellite bulletins will generally contain the following information in plain language:

1. Identification of issuing station, date and time of origin.
2. Time of picture, identification of satellite.
3. Position of centre and whether eye discernible.
4. Intensity: T-number, maximum sustained wind and central pressure estimated.
5. Other characteristics deduced from picture, e.g., organization, size of CDO, diameter and definition of eye and estimated extent of winds of specified speeds.
6. Past movement.
7. Development characteristics.

## CODE FOR REPORTING RADAR OBSERVATIONS RELATING TO CYCLONIC DISTURBANCES

Part "A" (to be reported when centre of the storm can be determined).

CYREP FFAA STATION Iliii YYGGg 4R<sub>w</sub>L<sub>a</sub>L<sub>a</sub>L<sub>a</sub> 1L<sub>o</sub>L<sub>o</sub>L<sub>o</sub>L<sub>o</sub> EYE or SPIRAL  
6CSDT Pd<sub>s</sub>d<sub>s</sub>f<sub>s</sub>f<sub>s</sub>

Explanatory Notes

CYREP FFAA	:	Radar Report giving centre of a cyclone
STATION	:	Name of station in plain language
Iliii	:	Station Index Number
YY	:	UTC date
GGg	:	Time of observation in hours and tens of minutes UTC
4	:	Indicator figure
1	:	Quadrant of globe _____ '1' for our area as per WMO definition
R <sub>w</sub>	:	Wavelength of radar 3 for 3 cm radar, 5 for 5.6 cm radar, 8 for 10 cm radar
L <sub>a</sub> L <sub>a</sub> L <sub>a</sub>	:	Latitude } In tenths of a degree. Tenths are } obtained by dividing the
number of minutes L <sub>o</sub> L <sub>o</sub> L <sub>o</sub> L <sub>o</sub> remainder.	:	Longitude } by six and discarding the
EYE or SPIRAL	:	Either the word "EYE" or the word "SPIRAL" will be reported, but not both.  The word "EYE" will be reported if a partial or complete eye is seen by the radar.  If a double walled eye is seen "DOUBLE EYE" will be reported instead of "EYE".  If the storm centre is estimated using only spiral bands the word "SPIRAL" will be reported.
6	:	Indicator figure to show that eye characteristics and/or confidence of fix follow.
C	:	Confidence of fix (Vide Table 1).
S	:	Shape of eye and length of arc of eyewall seen (Vide Table 2).
D	:	Diameter or length of major axis of the eye (Vide Table 3).
T	:	Tendency of the eye determined over the period since the last observation (Vide Table 4).

ANNEX III-A-2

**NOTE:** S, D and T will be reported as solidus (/) if the storm centre is fixed from spiral bands only.

- P : Period over which the movement of the storm centre has been determined (Vide Table 5).
- $d_s d_s$  : Direction in tens of degree towards which the storm centre is moving.
- $f_s f_s$  : Speed of movement of storm centre in kilometres per hour.

If movement over a period of 3 hours or more cannot be estimated, the group  $pd_s d_s f_s f_s$  will be dropped.

**NOTE:** The radar meteorologist may at his discretion add any other operationally useful information not covered above, in plain language at the end of Part A of the message.

**TABLE 1**

**Confidence of Fix (C)**

Code Figure	Category	Radar echo pattern	Likely accuracy about
1.	Very poor	Spiral bands, ill-defined or too few or too short	100 km
2.	Poor	Centre estimated from well- defined spiral bands ----eye not visible	50 km
3.	Fair	Partial eye wall seen	30 km
4.	Good	Closed or nearly closed eye whose geometric centres can be located with confidence	10 km

**NOTE:** The accuracy and criteria as given above are only illustrative and not definitive.

**TABLE 2**

**Shape of eye and length of arc of eyewall seen (S)**

Code Figure	Length of arc	Shape
0	----	Ill-defined
1	Less than 180°	{ Shape other than circular or elliptical
2	More than 180°	
3	Closed	
4	Less than 180°	{ Elliptical
5	More than 180°	
6	Closed	
7	Less than 180°	{ Circular
8	More than 180°	
9	Closed	

**TABLE 3****D - Diameter or length of major axis of the eye of the tropical cyclone**

<b>Code Figure</b>		<b>Code Figure</b>	
0	less than 10 km	6	60 to 69 km
1	10 to 19 km	7	70 to 79 km
2	20 to 29 km	8	80 to 89 km
3	30 to 39 km	9	90 km and greater
4	40 to 49 km	/	undetermined
5	50 to 59 km		

**TABLE 4****T - Tendency of the eye, determined over the period since the last observation**

<b>Code Figure</b>	
0	Eye has first become visible since the last observation.
1	No significant change in the characteristics or size of the eye.
2	Eye has become smaller with no other significant change in characteristics.
3	Eye has become larger with no other significant change in characteristics.
4	Eye has become less distinct with no significant change in size.
5	Eye has become less distinct and decreased in size.
6	Eye has become less distinct and increased in size.
7	Eye has become more distinct with no significant change in size.
8	Eye has become more distinct and decreased in size.
9	Eye has become more distinct and increased in size.
/	Change in character and size of eye cannot be determined.

**TABLE 5****P - Period over which the movement of the storm centre has been determined**

<b>Code Figure</b>	<b>Period</b>
7	During the preceding 3 hours
8	During the preceding 6 hours
9	During a period of more than 6 hours

(to be reported whenever any radar echo is seen)

RAREP FFBB Iliii YYGGg CHARACTER (b<sub>1</sub>b<sub>1</sub>b<sub>1</sub>/r<sub>1</sub>r<sub>1</sub>r<sub>1</sub> ----- b<sub>n</sub>b<sub>n</sub>b<sub>n</sub>/r<sub>n</sub>r<sub>n</sub>r<sub>n</sub>) INTENSITY TENDENCY  
d<sub>s</sub>d<sub>s</sub>f<sub>s</sub>f<sub>s</sub> ALTD (bbb/H<sub>t</sub>H<sub>t</sub>/rrr)

- NOTE:**
1. Part B will normally be reported only at synoptic hours. In the case of any break in observations or rapid development, additional Part B messages may be transmitted as necessary.
  2. Part A messages are to be prepared and transmitted as close to the observation time as possible. Part B can be transmitted separately, after Part A has been sent. When Part A and Part B are transmitted together, the code groups RAREP, Iliii, YYGGg need not be included in Part B.

**Character:**

- EYE : An echo identified definitely as the eyewall of a tropical cyclone.
- SPRL BND : A continuous or broken curved line of echoes recognizable as a spiral band associated with a cyclonic system.
- SQL LN : This pattern should normally have a length to width ratio of about 10 to 1 and length about 60 km or more.
- BRKN LN : A broken line of echoes.
- SLD : An area fully covered with echoes.
- BRKN : An area 4/8 to 7/8 covered with echoes.
- SCT : An area 1/8 to 4/8 covered with echoes.
- WDLY SCT : An area less than 1/8 covered with echoes.
- ISLTD : Isolated solid mass of echo.
- ECHO ALDFT : Echo seen only at elevations higher than half the beam width.
- bbb : Azimuth in three digits (degrees) of points on the periphery of an echo area.
- rrr : Range (three digits) in units of kilometres.

**NOTE:**

- (1) The groups within the brackets ( ) may be reported as many times as necessary.
- (2) In the case of line echoes, in spiral bands and eyewall, as many bbb/rrr points along the line as necessary may be given to define the shape of the line. The points should preferably be given along the line in the anti-clockwise direction.
- (3) In the case of areas, as many bbb/rrr points as necessary to define the shape may preferably be given in the anti-clockwise order starting from the northernmost point. The first point should be repeated as the last point to indicate that it is a closed area.
- (4) In any one RAREP message, the character of echoes ..... will be reported in the order given in the group description above.
- (5) If an echo system with a distinct characteristic is partly or wholly embedded in another, the two systems should be reported in separate groups. For example, a SPRL BND, or BRKN LN (which may be distinguished as such by using the attenuator or isoecho system) embedded in a larger area of echoes will be reported as SPRL BND or BRKN LN in addition to the area reported separately.
- (6) The number of features or groups should be as few as possible, and should be just sufficient to convey an overall picture of the system.

**Intensity:****For radars having facility for quantitative measurement**

Code	dBZ	Approximate rainfall rate mm/hr	Other radars
WK	23 to 32	less than 4	Qualitatively determined as in Weather Radar Manual
MDT	33 to 42	4 to 15	
STG	43 to 52	16 to 63	
VRY STG	53 or more	64 and above	

- NOTE:**
- (1) The intensity of the strongest echo in the group is to be reported.
  - (2) The rainfall rates indicated are based on the relationship  $Z = 200R^{1.6}$  and may be taken only as a rough guide.
  - (3) Intensity is to be reported only of echoes within 200 km range

**Tendency:**

INCG	:	Increasing
DCG	:	Decreasing
NO CHG	:	No change

In view of the difficulties in finding out the tendency of echoes of large areal extent as in a depression or cyclone, tendency should be reported only in case of isolated cells or groups of cells or a line mainly for aviation purposes. The radar meteorologist will take into consideration the change in height, area, length and intensity of echoes over a period of time in judging the tendency.

$d_s d_s$  : Direction in tens of degrees towards which the echo or group of echoes is moving.

$f_s f_s$  : Speed in kilometres per hour of the echo or group of echoes.

ANNEX III-A-6

NOTE: (1) In case of a group of echoes or of a line, only the overall movement of the group of echoes will be reported.

(2) The movement will be observed over a period of, say 30 to 60 minutes.

ALTD : Indicator for echo height information.

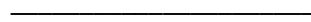
H<sub>t</sub>H<sub>t</sub> : Height of top of echo above mean sea level in kilometres.

NOTE: (1) Reports of heights should be restricted to a maximum range of 200 km from the station.

(2) In the case of echoes of large areas, the height group may be repeated as necessary for including a number of prominent echoes.

The radar meteorologist will have discretion to report any other special phenomena such as Bright Band and Anomalous Propagation in plain language at the end of the message.

Parts A and B both shall be used whenever the echo pattern observed is recognized as relating to tropical cyclone. Part B only will be used for reporting echoes other than connected with tropical cyclone.



## SATELLITE CLOUD IMAGERY MONITORING FACILITIES IN THE PANEL COUNTRIES

### Bangladesh

Bangladesh Meteorological Department (BMD) has at its office premises satellite picture receiving ground stations which monitor satellite cloud imageries (HRPT) from the polar-orbiting (NOAA) and Geostationary (MTSAT) weather satellites. In addition, a separate organization in Bangladesh, known as SPARRSO (acronym), receives cloud imageries from the polar-orbiting US weather satellites and GMS. BMD also receives INSAT, Meteosat imageries from internet.

### India

An exclusive meteorological satellite KALPANA-I was launched on 12 Sept 2002. It gives satellite Imagery in three channels, i.e. Visible, Infrared and Water Vapour. The VHRR resolution of this satellite is 2.0 Km in Visible and 8 Km in Infrared and Water Vapour channels. Data from this satellite are being received and processed at IMD New Delhi. KALPANA-I is located at 74.0 deg. E longitude.

Another Satellite INSAT-3A was launched on 10 April 2003. It is also utilized operationally at IMD. It has three VHRR channels identical to KALPANA-I VHRR and in addition has three channels of CCD. It is located at 93.5 deg E. The three channels of CCD give Imagery in three channels namely visible, Near Infrared and Short wave Infrared. The resolution of CCD payload in all three channels is 1 Km..

The HRPT data from U.S. polar orbiting satellites (NOAA series) are received by a ground reception and processing system at IMD, New Delhi. Imagery and the products are derived from the AVHRR data of HRPT stream. Vertical profiles of temperature and humidity are retrieved from TIP data. All these are good tools of weather forecasting and climate studies.

Another HRPT data receiving system is operating at Chennai for reception and processing of AVHRR and TOVS data from some of the NOAA series of US satellites.

IMD also receives lower resolution processed data of METEOSAT-5 through a Primary Data Utilization system (PDUS).

The satellite imageries of all channels are updated every hour on IMD website. The images displayed are full frame, Asia Mercator Sector and Northwest sector. Recently animation of last 24 hours/ 72 hours/ Infrared images are also put on IMD website ([www.imd.ernet.in](http://www.imd.ernet.in) and [www.imd.gov.in](http://www.imd.gov.in)) for users and public.

### Satellite Derived Products

The computer system (IMDPS) commissioned on 22nd September 1992, is used for processing data from INSAT series of satellite. Apart from generating cloud imagery, the following products are being derived from satellite data; and the same are also archived.

- (i) Cloud Motion Vector ( CMVs ) based on three consecutive KALPANA-I images at 00 UTC, 0730 UTC and 1200 UTC are being disseminated over the GTS .
- (ii) Sea Surface Temperature ( SSTs ) eight times a day as well as, daily mean for each  $1^{\circ} \times 1^{\circ}$  latitude/ longitude grid ( free from cloud contamination) using KALPANA-I data.
- (iii) Outgoing Long wave Radiation ( OLR ) on daily / weekly / monthly basis over  $1^{\circ} \times 1^{\circ}$  latitude/longitude grid .
- (iv) Quantitative Precipitation Estimates ( QPE ) on daily / weekly / monthly basis over  $1^{\circ} \times 1^{\circ}$  latitude/longitude grid, using the standard temperature threshold technique of Arkin.
- (v) Vertical Temperature Profiles from NOAA & ATOV's data.



- (vi) The cloud motion vectors derived from INSAT satellites are displayed on IMD website daily. In addition to this QPE, OLR and SST are also displayed on IMD website daily.

#### Cyclone Warning Dissemination System ( CWDS ) through INSAT

Cyclone Warning Dissemination System (CWDS) is a dependable scheme for transmission of cyclone alert/warning message directly to the area likely to be affected by the cyclone using the S-band broadcast capabilities on board the Indian National Satellite (INSAT). The system enables the cyclone warning center of IMD to directly and selectively address a particular area likely to be affected by cyclones. 250 Analogue CWDS receiver and 100 Digital CWDS receivers have already been installed in the coastal areas on India. The effectiveness and performance of the CWDS system has been monitored during the past cyclones and it has been found to be good. The network of 100 Digital CWDS receivers is installed in the Andhra Pradesh during 2003 and it has been working satisfactorily. There is a plan to increase present network to 400 receivers of Digital technology by 2007.

#### Meteorological Data Dissemination (MDD)

Under this scheme, processed satellite imagery is being multiplexed with meteorological data and up linked to INSAT in the C-band for reception at ground stations in the S-band. 35 MDD stations have been installed and they are operational, including one in the Maldives and one in Colombo, Sri Lanka. PC-based image processing workstations are available at 35 Analogue MDD stations. The present MDD stations are under replacement by Digital MDD receivers, HRIT/LRIT data reception and work stations.

#### Automatic Weather Stations (AWS)

IMD is in the process of replacing old 100 – Automatic Weather Stations (AWS) using latest state of the art AWS by 2006. Another 25-AWS shall also be deployed with above system to increase the network to 125. At present 16 – AWS are operational and data is being received at New Delhi and Pune. A new ground reception and processing centre is also proposed to be established at Pune for 125 – AWS stations and 500 – ARG stations in next 1-2 years.

#### Automatic Rain gauge Stations (ARs)

IMD is in the process of procurement and deployment of 500 – Automatic Rain gauge Stations (ARS) to work with INSAT – 3A / Kalpana – 1 Satellite DRT. This is likely to be completed by 2006. After successful commissioning of above, the network is likely to be extended further to cover all the part time Raingauges and part time observations at far flung station/areas.

#### Future plans

INSAT -3D is scheduled to be launched in the first quarter of 2007, which will have 6 – channel imager as well as 19 channel sounder as Meteorological payloads.

Digital Meteorological Data Dissemination (DMDD) with LLRIT / HRIT data format is to be introduced in the year 2006 – 07 replacing analog MDD Broadcast.

A network of 5 GPS station is being set up for estimation of Integrated Precipitable Water Vapour (IPWV) in the year 2005 – 06.

“**National** Satellite Data Centre” with its website is being setup at IMD, New Delhi for making satellite data available to various users.

A L- Band transmission for Digital MDD for satellite imageries & weather data shall be commissioned by 2007 with Global coverage.

**INSAT derived cloud motion vectors**

Sector – 3	Type of information	Observation time ( UTC )	Satellite	Area
1.	Cloud motion wind at Different level	00	KALPANA- 1	F
2.	Cloud motion wind at Different level	07	KALPANA- 1	F
3.	Cloud motion wind at Different level	12	INSAT-3A	F

Area:-F: 45<sup>0</sup> from Sub Satellite point  
 KALPANA –1 SSP- 74<sup>0</sup> E ; INSAT- 3A SSP- 93.5<sup>0</sup> E

**Maldives**

The Department of Meteorology receives imagery from INSAT/KALPANA and METEOSAT satellites through internet.

**Myanmar**

The Department of Meteorology and Hydrology in Myanmar is receiving satellite imageries from GMS and US polar-orbiting satellites (NOAA series of the USA) and less regularly from METEOR-series of the USSR.

**Oman (Sultanate of)**

The Meteorological Department has the following satellite ground receiving stations:

- (i) APT and WEFAX system based at Seeb International Airport.
- (ii) APT and WEFAX system based at Salalah Airport.
- (iii) HRPT system at Seeb International Airport.
- (iv) PDUS at Seeb International Airport.
- (v) S-VISSR at Seeb International Airport.

All the above mentioned systems receive their data from the EUMETSAT Geostationary Satellite and NOAA Polar Orbiting Satellites.

Apart from generating cloud imagery, several products are derived from the satellite data. Some of these products are:

- (i) Sounding based on TOVS [on experimental basis]
- (ii) Sea surface temperature
- (iii) Precipitation estimates
- (iv) Cloud tops
- (v) Fire detection [on experimental basis]
- (vi) Pollution [on experimental basis]
- (vii) Vegetation Index - NDVI [on experimental basis]

**Pakistan**

Pakistan Meteorological Department (PMD) operates a network of nine APT stations at Islamabad, Karachi, Lahore, Multan, Gilgit, and Skardu, besides HRPT stations at Quetta and Islamabad. APT pictures are regularly received from US polar-orbiting satellites (NOAA Series) amid other geo-stationary satellites in the region. One SADIS equipment has recently been installed at the Met. Office Karachi Airport which is functioning since December 2000.

**Sri Lanka**

AVHRR data of HRPT satellite cloud imageries and derived products from the NOAA series are received through the ground station at NMC Colombo. METEOSAT-5/IODC imageries are also accessed through Internet hourly, regularly.

**Thailand**

The Meteorological Department in Thailand is receiving satellite imagery from NOAA and GOES-9 satellites.

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## CHAPTER IV

### TROPICAL CYCLONE FORECASTING

#### 4.1 Forecasting development and movement of tropical cyclones

The final responsibility for analysis and forecasting development and movement of tropical cyclones in the region will be with the National Meteorological Service of each of the Members. However, in addition to the exchange of observational data needed for analysis and forecasting, the following special arrangements for the exchange of processed products and advisories have been made.

- (i) (a) Processed products will be provided by RSMC - tropical cyclones New Delhi. A list of output products broadcast from RSMC - tropical cyclones New Delhi for international purposes is given in Table IV-1. A list of other products broadcast through facsimile from RSMC - tropical cyclones New Delhi for national purposes is given in Annex IV-A.
- (b) RSMC -tropical cyclones New Delhi will issue a tropical weather outlook once daily throughout the year for the benefit of the Member countries. It is being transmitted on the GTS at 06 UTC. The outlook covering the Bay of Bengal and the Arabian Sea indicates possible development of tropical depressions over the sea. An additional outlook will be transmitted again over the GTS at 1700 UTC when a Depression is located and expected to intensify into a cyclonic storm.
- (ii) In case there is a tropical cyclone in the Panel region, RSMC - tropical cyclones New Delhi will also issue the following:
  - (a) Tropical cyclone advisories, details of which have been given in earlier chapters.
  - (b) Tropical Cyclone Advisory Centre (TCAC)-New Delhi will issue Tropical Cyclone Advisory bulletins for the international air navigation to Meteorological Watch Offices (MWOs) in area of responsibility at least for every six hours.
- (iii) The satellite tropical disturbance summary issued from Washington will be exchanged through the GTS.
- (iv) National Meteorological Services may like to use climatological charts of average vector motions for the track prediction. The track prediction based on climatological charts are usually most useful (minimum error) when tropical storms are to the south of sub-tropical anti-cyclones. Such charts for the region for each month and for each season are available\*.

#### 4.2 Storm surge forecasting

Storm surge forecasting will be the responsibility of the National Meteorological Services.

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\* Reference: Mandal, G.S. 1991, Tropical Cyclones and their Forecasting and Warning System in the North Indian Ocean, WMO TCP Report No. 28.

TABLE IV-1

## Processed products transmitted by RSMC - Tropical Cyclones New Delhi for international purposes

Section-1	Description of product	Reference time (UTC)	Area
1.	Sea level analysis	0000 0600 1200 1800	A A A A
2.	850 hPa	0000 1200	AA AA
3.	700 hPa	0000 1200	AA AA
4.	500 hPa	0000 1200	AA AA
5.	300 hPa	0000 1200	AA AA
6.	200 hPa	1200	A
7.	INSAT I-D full frame INFRARED cloud picture	0000	

Area: A: 25°S-45°N, 30°E-125°E

Scale: 1:20 Mercator Projection

## Computer output products

Section-2	Type of information	Observation time (UTC)	Area
1.	RAFC New Delhi Winds and Temp. forecast (24 hours) 500 hPa	0000 1200	H H
2	RAFC New Delhi Winds and Temp. forecast (24 hours) 300 hPa	0000 1200	H H
3.	RAFC New Delhi Winds and Temp. forecast (24 hours) 200 hPa	0000 1200	H H

Area: H: 20°S-60°N, 30°E-145°E

Scale: 1:20 Mercator Projection

**INSAT derived cloud motion vectors**

Section-3	Type of information	Observation time (UTC)	Area
1.	Cloud motion winds, different levels	0600	F
2.	Bay of Bengal	0000	G
3.	Arabian Sea	1200	G
4.	Indian Ocean (part)		

Area: E: 30°S-30°N, 53°E-113°E  
G: 40°S-40°N, 43°E-123°E

Scale: 1:20 Mercator Projection

**Computer output products transmitted by RSMC - Tropical Cyclones New Delhi  
For national purposes**

Section	Type of information	Observation time (UTC)	Area
1.	500 hPa contour chart (ECMWF) forecast valid for 48 hours	1200	G
2.	200 hPa wind chart (ECMWF) 48 hours	1200	E
3.	Seven days mean sea-surface temperature	-	D
4.	850 hPa Relative Vorticity	0000	C
5.	500 hPa Relative Vorticity	0000	C
6.	300 hPa Relative Vorticity	1200	C
7.	24 hours F/C Rainfall	0000 1200	B B

Area: B: 00-40°N, 60°E-105°E  
C: 00-40°N, 50°E-120°E  
D: 00-25°N, 55°E-100°E  
E: 35°S-35°N, 00-180°E  
G: 20°N-90°N, 00-180°E

Scale: 1:20 Mercator Projection

## CHAPTER V

### COMMUNICATIONS

#### 5.1 **General**

The basic communication network for the exchange of data, forecast, warnings and observations will be the Global Telecommunication System (GTS). Tropical cyclone advisories and warnings (SIGMETs) for aviation shall be transmitted by means of the Aeronautical Fixed Service (AFS), according to the provision of ICAO Annex 3/WMO-No. 49, Technical Regulations [C.3.1], and ICAO ASIA/PAC and MID ANP FASIDs.

Processed products of RSMC - tropical cyclones New Delhi will be broadcast in chart form through facsimile broadcast from RTH New Delhi.

In the GTS a regional arrangement exists for the exchange of raw and processed data, forecasts, warnings and addressed messages. Normally message-switching computers in GTS transmit the data on a first in-first out basis. However, priority can be assigned to certain messages on the basis of abbreviated headings. Such messages are given preference over other messages in transmission on the circuits.

The messages for which high priorities are to be assigned are:

- (i) all radar observations in cyclonic storm situations;
- (ii) composite ships' surface and upper-air observations from the tropical cyclone field;
- (iii) tropical cyclone warnings;
- (iv) tropical weather outlook;
- (v) tropical cyclone advisories; and
- (vi) satellite bulletins from RSMC - tropical cyclones New Delhi.

To exchange these messages on priority basis among the Panel countries the abbreviated headings as decided in consultation with RTH New Delhi will be used.

#### 5.2 **Procedures to be followed**

WMO headings.

Station location indicators.

International block and station index numbers will be used to send surface and upper-air observations.

##### ***5.2.1 Tropical cyclone warning headings***

The headings used for the exchange of tropical cyclone warnings by the Panel countries are given in Table V-1. Member countries will request RTH New Delhi to assign priority to these headings if not already provided.

##### ***5.2.2 Telecommunication headings for the exchange of radar observations***

The telecommunication headings used for the exchange of radar observations are listed in Table V-2.

### 5.2.3 **Telecommunication headings for the exchange of other messages**

The telecommunication headings (which will be the priority headings) for the exchange of tropical weather outlook, tropical storm advisories and satellite bulletins as decided in consultation with the RTH New Delhi are listed in Table V-3.

### 5.2.4 **Telecommunication headings for the exchange of tropical cyclone advisories and warnings for aviation**

The telecommunication headings for the exchange of tropical cyclone advisories and warnings for aviation are given in Table V-4.

### 5.3 **Existing GTS circuits among the Panel countries**

- |                                    |  |
|------------------------------------|--|
| 1. New Delhi - Bangkok             | Upgrading to 64 Kbps or via internet under progress  |
| 2. New Delhi - Colombo (Sri Lanka) | Upgrading to 64 Kbps or via internet under progress  |
| 3. New Delhi - Dhaka (Bangladesh)  | 64 kbps TCP/IP WMO Socket circuit, satellite (since March 2007)  |
| 4. New Delhi - Karachi (Pakistan)  | 50 baud satellite circuit has been up-graded to a high speed 64kbps leased data circuit using TCP/IP Protocol and made operational w.e.f.14-10-2002. |
| 5. New Delhi - Malé (Maldives)     | Upgraded to 128 Kbps through Internet. w.e.f. February,2004.   |
| 6. New Delhi - Yangon (Myanmar)    | 50 baud circuit, satellite. Yangon has been requested to intimate the availability of Internet and TCP/IP Socket communication. Response is awaited. |
| 7. Bangkok - Yangon (Myanmar)      | 50 baud circuit, satellite   |
| 8. Muscat - Jeddah                 | 9600 bps circuit, satellite since 1993   |

### 5.4 **List of important telephone numbers and addresses connected with tropical cyclone warnings in the Panel countries**

A list containing addresses of the tropical cyclone warning centres of the Panel countries, together with their telephone numbers, is given in Annex V-A.

### 5.5 **GMDSS**

GMDSS is a satellite based broadcast system intended for the benefit of ships at high seas. EGC (Enhanced Group Call) Safety Net System of the INMARSAT (International Maritime Satellite Organisation) together with NAVTEX and MSI (Maritime Safety Information) broadcast form integral parts of the GMDSS. Under this ocean going vessels would receive:

- a) Meteorological forecasts and warnings;
- b) Navigational aid and warnings; and
- c) Helps in search and rescue operations. WMO has suggested date of full implementation of the system as 1 February 1999. IMD is broadcasting two GMDSS bulletins at 0900 and 1800 UTC everyday with effect from 1 October 1998 and additional warnings during the cyclone season.



5.6 India Meteorological Department started Digital Data Broadcast service via Satellite from 1<sup>st</sup> July, 2003 using World Space "Asia Star" Satellite. This is replacement of the HF Broadcast System. The Meteorological data presently being broadcast are:

- (i) Indian Satellite images such as three hourly Visible, Infrared, Colour and Water Vapour images.
- (ii) GTS data ( SYNOP, PILOT, TEMP, METAR, TAF etc. ) of India and its neighbouring countries.
- (iii) Weather Charts and Model outputs.

The Broadcast covers large areas of Middle – East and South East Asia at a downlink frequency of 1467-1492 MHZ. at a speed of 128 Kbps.

5.7 India Meteorological Department is hosting its own website [www.imd.ernet.in](http://www.imd.ernet.in) which also provides information pertaining to WX Charts, Forecasts, Warnings, Satellite Imageries, Hydrological and Seismological and other weather related topics are updated on regular basis.

5.8 Regional Meteorological Centres located at Delhi, Chennai, Nagpur and Mumbai have hosting their own websites.

**TABLE V-1**

**ABBREVIATED HEADINGS FOR EXCHANGE OF  
TROPICAL CYCLONE WARNINGS FOR THE HIGH SEAS**

	<u>Country</u>	<u>GTS Abbreviated Headings</u>	<u>Priority</u>
1.	Bangladesh	WTBW20 VGDC	Highest
2.	India	WTIN20 DEMS	Highest
3.	Maldives	WTMV20 VRMM	Highest
4.	Myanmar	WTBM20 and WOBM20 VBRR	Highest
5.	Oman (Sultanate of)	WTOM20 and WSOM20 OOMS	Highest
6.	Pakistan	WWPK20 OPKC	Highest
7.	Sri Lanka	WTSB40 VCCC	Highest
8.	Thailand	WTTH20 VTBB	Highest

**TABLE V-2****COMMUNICATION HEADINGS FOR THE EXCHANGE OF RADAR OBSERVATIONS**

	<u>Country</u>	<u>Abbreviated heading</u>
1.	Bangladesh	SDBW20 VGDC
2.	India	SDIN VABB ) (Mumbai-Karachi) SDIN VECC ) (Kolkata-Dhaka and Bangkok) SDIN VOMM ) (Chennai-Bangkok, Dhaka and Colombo)
3.	Maldives	SDMV20 VRMM
4.	Myanmar	SDBM20 VBRR
5.	Pakistan	SDPK20 OPKC SDPK40 OPKC
6.	Thailand	SDTH20 VTBB

**TABLE V-3****GTS HEADINGS FOR THE EXCHANGE OF TROPICAL WEATHER OUTLOOK,  
TROPICAL STORM ADVISORY AND SATELLITE BULLETIN**

<u>Country</u>	<u>Abbreviated heading</u>	
	<u>Tropical weather outlook</u>	<u>Tropical storm advisory</u>
Bangladesh	WWBW20 VGDC, WOBW20 VGDC WTIN 20 DEMS WWPK 20 OPKC	BMAA01 VGDC DEMS
India		BMAA01VBRR DEMS
Pakistan		BMAA01 OPKC DEMS
		BMAA01 VCCC DEMS
		BMAA01 VTBB DEMS
		BMAA01 VRMM DEMS
		BMAA01 OOMS DEMS

Satellite bulletins generated by RTH, New Delhi

TCIN 20 DEMS (Sat bulletins based on INSAT pictures)  
 TCIN 50 DEMS (Sat bulletins based on INSAT pictures)  
 TCIN 51 DEMS (Intense precipitation advisory bulletins)  
 ATIN 50 DEMS (For all CDRs during cyclone period)

INSAT Satellite wind bulletins generated by RTH, New Delhi

TWIO01 DEMS	TWIO06 DEMS
TWIO02 DEMS	TWIO07 DEMS
TWIO03 DEMS	TWIO08 DEMS
TWIO04 DEMS	TWIO09 DEMS
TWIO05 DEMS	TWIO10 DEMS

TABLE V-4

**WMO HEADINGS FOR THE EXCHANGE OF TROPICAL  
CYCLONE ADVISORIES FOR AVIATION AND SIGMETS**

**I. TC Advisories**

<u>Country</u>	<u>Abbreviated heading</u>	<u>Area</u>
1. India	FKIN21 VIDP FKIN20 VIDP	Bay of Bengal Arabian Sea

**II. SIGMETs for tropical cyclones**

<u>Country</u>	<u>Abbreviated heading</u>	<u>Area</u>
1. Bangladesh	WCBWxx VGDC	Dhaka
2. India	WCINxx VECC WCINxx VOMM WCINxx VABB	Kolkata Chennai Mumbai
3. Maldives	WCMV31 VRMM	Malé
4. Myanmar	WCBMxx VYYY	Yangon
5. Oman (Sultanate of)	WCOMxx OOMS	Muscat
6. Pakistan	WCPKxx OPKC	Karachi
7. Sri Lanka	WCSB31 VCCC	Colombo
8. Thailand	WCTHxx VTBB	Bangkok

**Notes:**

1. *TCAC New Delhi shall send the TC advisories to the MWOs through AFTN. In addition to the MWOs listed above, the advisories shall be sent to all MWOs in the area of responsibility of TCAC New Delhi according to ICAO ASIA/PAC and MID Regions FASIDs.*
2. *TCAC New Delhi shall send the TC advisories to Singapore OPMET Data Bank – AFTN address WSSSYMYX.*
3. *The MWOs listed above shall send their SIGMETs for tropical cyclones through AFTN to the MWOs responsible for the adjacent FIRs and to Singapore OPMET Data Bank – AFTN address WSSSYMYX.*

## ANNEX V-A-1

**LIST OF IMPORTANT ADDRESSES AND TELEPHONE NUMBERS CONNECTED  
WITH TROPICAL CYCLONE WARNINGS IN THE PANEL COUNTRIES**

<b><u>Bangladesh</u></b>	Director Bangladesh Meteorological Department Meteorological Complex Agargaon Dhaka-1207	Phone: Off: (880) 2-8116634, (880) 2-8119832 (direct) Fax: (880) 2-8118230/ (880) 2-8119832 E-mail: directorbmd2005@yahoo.com Home page:
	Deputy Director Storm Warning Centre Dhaka	Phone: Off: (880) 2-9114388 Res: (880) 2-8126257 E-mail: swcbmd@yahoo.com
	Duty Forecasting Officer Storm Warning Centre Dhaka	Phone: (880) 2-8113071 (880) 2-9135742 (880) 2-9111015 (880) 2-9112439 Fax: (880) 2-8118230
<b><u>India</u></b>	Director General of Meteorology India Meteorological Department (IMD) Regional Telecommunication Hub Mausam Bhavan, Lodi Road New Delhi 110003	Phone: Off: (91) 11-24611842 Fax (91) 11-24611792 Res: (91) 11-24629770 Fax: (91) 11-24699216 (91) 11-24623220 E-mail: sks@imd.ernet.in Home page: <a href="http://www.imd.ernet.in">http://www.imd.ernet.in</a>
	Duty Officer	Phone: (91) 11-24631913 (24 hrs)
	Deputy Director General RSMC New Delhi	Phone: Off: (91) 11-24611068 Res: (91) 11-24619844 E-mail: subramanian@imd.ernet.in
<b><u>Maldives</u></b>	Permanent Representative of Maldives with WMO Director, Department of Meteorology Ghazee Building Malé 20-05	Phone: Off: (960) 3323303  960) 3325766 Res: (960) 3320778 Fax: (960) 3320021
	Duty Forecaster, National Meteorological Centre	Phone: Off: (960) 3323084 Fax: (960) 3315509
<b><u>Myanmar</u></b>	Director-General Department of Meteorology and Hydrology Mayangon Post Office 11061, Yangon	Phone: Off: (951) 665669 (951) 660823 (951) 660824 (951) 660827 (951) 660525 (951) 660176 Res: (951) 513362 Fax: (951) 665944

## ANNEX V-A-2

<b><u>Oman</u></b> <b><u>(Sultanate of)</u></b>	Director	Phone:	Off: (968) 519360
	Oman Meteorological Department		(968) 519364 (24 hours)
	Directorate General of Civil Aviation and Meteorology, Seeb International Airport		Res: (968) 9705897
	P.O. Box 1, P.C. 111	Fax:	(968) 519363 (24 hours)
	Muscat	E-mail:	a.alharthy@metgov.om
		Home page:	http://www.met.gov.om
<b><u>Pakistan</u></b>	Director-General	Phone:	Off: (92) 51-9257314
	Pakistan Meteorological Department	Telefax:	(92) 51-4432588
	P.O. Box # 1214, Sector H-8/2	E-mail:	qamarc@hotmail.com
	Islamabad		pmisba@isb.paknet.com.pk
		Home page:	http://met.gov.pk http://www.pakmet.com
	Senior Meteorologist	Phone:	Off: +(92) 21-45791300 / 45791302
	Jinnah International Airport		(24 hours)
	Karachi	Home page:	http://www.met.gov.pk http://www.pakmet.com
		E-mail:	pmisba@isb.paknet.com.pk
<b><u>Sri Lanka</u></b>	Director-General	Phone:	Off: (94) 11-2694104
	Department of Meteorology	Fax	(94) 11-2698311
	Bauddhaloka Mawatha	E-mail:	meteo1@slt.net.lk
	Colombo-7		
	Deputy Director, NMC, Colombo	Phone/Fax	(94) 11-2691443
		E-mail:	sbaladev_24@yahoo.com
	Duty Meteorologist, NMC, Colombo	Phone	(94) 11-2684746
	Duty Meteorologist, Met office	Phone	(94) 11-2252721
	International Airport, Katunayake	Fax:	(94) 11-2252319
		E-mail:	meteo@slt.lk meteo1@slt.net.lk meteo2@slt.net.lk
	Disaster Prevention and Preparedness		
	Director General	Phone	(94) 11-2252721
	Disaster Management Centre	Fax:	(94) 11-2252319
	Ministry of Disaster Management and Human Rights, Colombo-7	E-mail:	dmcs@slt.net.lk, dgdmcsl@gmail.com
<b><u>Thailand</u></b>	Senior Meteorologist	Phone:	(66) 2-3989830
	Central Weather Forecast Division		(66) 2-3994433
	Meteorological Department		(24 hours)
	4353 Sukumvit Road	Fax:	(66) 2-3989816
	Bang-Na		(24 hours)
	Bangkok 10260	E-mail:	tmd@metnet.tmd.go.th
		Home page:	http://www.thaimet.tmd.go.th

ANNEX V-A-3

**TSU**

WMO/ESCAP Panel on Tropical Cyclones  
Technical Support Unit (TSU)  
c/o Pakistan Meteorological Department  
pmisba@isb.paknet.com.pk  
P.O. Box # 1214, Sector H-8/2  
Islamabad  
Pakistan

Phone: (92) 51-9257314  
Telefax: (92) 51-4432588  
E-mail:

Home page: [tsupmd@hotmail.com](mailto:tsupmd@hotmail.com)  
<http://www.tsuptc.org>

**CHAPTER VI****MONITORING AND QUALITY CONTROL OF DATA****6.1 Monitoring of data**

It will be the responsibility of the National Meteorological Services to monitor the data, advisories and forecasts received by them in accordance with the specified arrangements. Each tropical cyclone warning centre will review from time to time the inflow of data to the centre and also the transmission to neighbouring services of the messages they are responsible for sending out.

To be sure of reception of important data in the case of cyclonic storm situations, cyclone warning centres of the Member countries will transmit addressed messages to RSMC - tropical cyclones New Delhi four times a day which will include important surface, upper-air and ships' observations.

The National Meteorological Services will inform RSMC - tropical cyclones New Delhi of any shortcomings in the flow of data (raw and processed) and also indicate any requirements over and above those already agreed upon for tropical cyclone warning purposes.

**6.2 Quality control**

National Meteorological Services will make extra efforts to make sure that all observational data passed on GTS, particularly during disturbed weather, have been checked for errors and that corrections are made if needed. They will impress upon their observing stations the need for accuracy of data, particularly in tropical cyclone situations and the difficulties that may be caused in the decision process by an incorrectly recorded or transmitted observation.

In case of doubt as to the correctness of any observation or part thereof, an addressed message will be sent to the national service and to RSMC - tropical cyclones New Delhi requesting confirmation.

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## CHAPTER VII

### ARCHIVAL OF DATA

#### 7.1 Necessity for data archival

In view of the development of computer facilities in the region, it is expected that the research efforts on tropical cyclones will substantially increase. In addition to dynamic modelling of tropical cyclones on the new generation computer being acquired by national authorities, it is expected that the synoptic oriented investigations and research as well as verification programmes will be undertaken in the region.

It is, therefore, necessary to create data sets as detailed and as complete as possible for all the future cyclones.

#### 7.2 Tropical cyclone data on landfall

There is a dearth of information on actual conditions of tropical cyclones and an endeavour is therefore required to be made to utilize whatever information is obtained to the maximum extent possible. In particular, the Panel countries are interested in verifying forecast and estimated conditions against the actual.

Panel countries will take appropriate steps to ensure that after a tropical cyclone makes a landfall all the available data pertaining to that tropical cyclone are collected and archived. Data on the actual condition of winds, storm surge, surface pressure and rainfall from stations near the point of landfall will be sent to RSMC - tropical cyclones New Delhi. If the landfall is in a country other than India, its meteorological service will send a brief summary of information to RSMC - tropical cyclones New Delhi for inclusion in the RSMC - New Delhi tropical cyclone report.

In the case of a tropical cyclone making a landfall on the coast of a country, which is not a member of the Panel, RSMC - Tropical Cyclones, New Delhi will collect the information for inclusion in the RSMC - New Delhi tropical cyclones report.

#### 7.3 Role of RSMC - tropical cyclones New Delhi in data archiving

For each tropical cyclone occurrence in the area, initially RSMC - tropical cyclones New Delhi will compile the following data sets:

- (i) Microfilms of daily synoptic charts covering the area 45°N to 30°S and 30°E to 120°E for the surface and upper-air charts for the levels 700, 500 and 200 hpa for 00 UTC and 12 UTC.
- (ii) Magnetic tapes or microfilm copies of all upper-air data from stations within 15 degrees of the tropical cyclone field.
- (iii) The tracks of tropical cyclones for the Panel regions prepared by the India Meteorological Department.

For the purpose of making these archives the National Meteorological Services will supply New Delhi with relevant information requested by RSMC - tropical cyclones New Delhi. On request by a Panel country, the RSMC - tropical cyclones New Delhi will make arrangements to supply these data sets to the Panel Member concerned on a copying cost basis.

In accordance with the directive of the WMO Executive Council (EC-XLV), Geneva, July 1993) an international format for the archiving of tropical cyclone data is to be used by all RSMCs with activity specialization in tropical cyclones.

The Tropical Cyclone Programme (TCP) office of the WMO Secretariat has the responsibility for the maintenance of the format, including assignment of the source codes to appropriate organizations, and authorizing additions and changes.



In the international format given below, the Dvorak T-number (Position 35-36) and Dvorak CI-number (position 37-38) will be the ones determined at the centre submitting the data, in the case of the Panel on Tropical Cyclones, by RSMC New Delhi.

Complete historic data in the format given in Annex VII-A will be made available for research applications. RSMC New Delhi will provide such data, to the Director of the National Climatic Data Centre (NCDC), USA in this format.

## GLOBAL TROPICAL CYCLONE TRACK AND INTENSITY DATA SET - REPORT FORMAT

Position	Content
1- 9	Cyclone identification code composed by 2 digit numbers in order within the cyclone season, area code and year code. 01 SWI2000 shows the 1st system observed in South-West Indian Ocean basin during the 2000/2001 season. Area codes are as follows: ARB = Arabian Sea ATL = Atlantic Ocean AUB = Australian Region (Brisbane) AUD = Australian Region (Darwin) AUP = Australian Region (Perth) BOB = Bay of Bengal CNP = Central North Pacific Ocean ENP = Eastern North Pacific Ocean ZEA = New Zealand Region SWI = South-West Indian Ocean SWP = South-West Pacific Ocean WNP = Western North Pacific Ocean and South China Sea
10-19	Storm Name
20-23	Year
24-25	Month (01-12)
26-27	Day (01-31)
28-29	Hour- universal time (at least every 6 hourly position - 00Z, 06Z, 12Z and 18Z)
30	Latitude indicator: 1 =North latitude; 2=South latitude
31-33	Latitude (degrees and tenths)
34-35	Check sum (sum of all digits in the latitude)
36	Longitude indicator: 1 =West longitude; 2=East longitude
37-40	Longitude (degrees and tenths)
41-42	Check sum (sum of all digits in the longitude)
43	position confidence* 1 = good (<30nm; <55km) 2 = fair (30-60nm; 55-110 km) 3 = poor (>60nm; >110km) 9 = unknown
Note*	Confidence in the center position: Degree of confidence in the center position of a tropical cyclone expressed as the radius of the smallest circle within which the center may be located by the analysis. "position good" implies a radius of less than 30 nm, 55 km; "position fair", a radius of 30 to 60 nm, 55 to 110km; and "position poor", radius of greater than 60 nm, 110km.
44-45	Dvorak T -number (99 for no report)
46-47	Dvorak CI-number (99 for no report)
48-50	Maximum average wind speed (whole values) (999 for no report).
51	Units 1 =kt, 2=m/s, 3=km per hour.
52-53	Time interval for averaging wind speed (minutes for measured or derived wind speed, 99 if unknown or estimated).
54-56	Maximum Wind Gust (999 for no report)
57	Gust Period (seconds, 9 for unknown)
58	Quality code for wind reports: 1 =Aircraft or Dropsonde observation 2=Over water observation (e.g. buoy) 3=Over land observation 4=Dvorak estimate 5=Other
59-62	Central pressure (nearest hectopascal) (9999 if unknown or unavailable)
63	Quality code for pressure report (same code as for winds)

ANNEX VII-A-2

64	Units of length: 1 =nm, 2=km
65-67	Radius of maximum winds (999 for no report)
68	Quality code for RMW: 1 =Aircraft observation 2=Radars with well-defined eye 3=Satellite with well-defined eye 4=Radars or satellite, poorly-defined eye 5=Other estimate
69-71	Threshold value for wind speed (gale force preferred, 999 for no report)
72- 75	Radius in Sector 1: 315 - _45
76-79	Radius in Sector 2: 45 - _135
80-83	Radius in Sector 3: 135 - _225
84-87	Radius in Sector 4: 225 - _315
88	Quality code for wind threshold 1=Aircraft observations 2=Surface observations 3=Estimate from outer closed isobar 4=Other estimate
89-91	Second threshold value for wind speed (999 for no report)
92-95	Radius in Sector 1: 315 - 45
96-99	Radius in Sector 2: 45_ - 135
100-103	Radius in Sector 3: 135 - 225
104-107	Radius in Sector 4: 225 - 315
108	Quality code for wind threshold (code as for row 88)
109-110	Cyclone type: 01 = tropics; disturbance ( no closed isobars) 02= <34 knot winds, <17m/s winds and at least one closed isobar 03= 34-63 knots, 17 -32m/s 04= >63 knots, >32m/s 05= extratropical 06= dissipating 07= subtropical cyclone (nonfrontal, low pressure system that comprises I initially baroclinic circulation developing over subtropical water) 08= overland 09= unknown
111-112	Source code (2 -digit code to represent the country or organization that provided the data to NCDC USA. WMO Secretariat is authorized to assign number to additional participating centers, organizations) 01 RSMC Miami-Hurricane Center 02 RSMCTokyo-TyphoonCenter 03 RSMC-tropical cyclones New Delhi 04 RSMC La Reunion-Tropical Cyclone Centre 05 Australian Bureau of Meteorology 06 Meteorological Service of New Zealand Ltd. 07 RSMC Nadi- Tropical Cyclone Centre 08** J9int Typhoon Warning Center, Honolulu 09** Madagascar Meteorological Service 10 ** Mauritius Meteorological Service 11 ** Meteorological Service, New Caledonia 12 Central Pacific Hurricane Center, Honolulu  Note**: no longer used
Headings	1-19 Cyclone identification code and name; 20-29 Date time group; 30-43 Best track positions; 44-110 Intensity, Size and Type; 111-112 Source code.

## ANNEX VII-A-3

LOCATIONS	NDBP	WMO ID	LAT ( <sup>0</sup> N)	LONG ( <sup>0</sup> E)
Pipavav Port	SW 1	23091	20.875 <sup>0</sup> 20 <sup>0</sup> 52' 30"	71.492 <sup>0</sup> 71 <sup>0</sup> 29' 31"
Off Ratnagiri	SW 2	23092	16.999 <sup>0</sup> 16 <sup>0</sup> 59' 51"	72.490 <sup>0</sup> 72 <sup>0</sup> 29' 37"
Goa Port	SW 3	23093	15.400 <sup>0</sup> 15 <sup>0</sup> 24' 00"	73.751 <sup>0</sup> 73 <sup>0</sup> 45' 36"
Mangalore Port	SW 4	23094	12.942 12 56' 34"	74.732 <sup>0</sup> 74 <sup>0</sup> 43' 55"
Tuticorin Port	SW 5	23095	08.801 <sup>0</sup> 08 <sup>0</sup> 47' 24"	78.329 <sup>0</sup> 78 <sup>0</sup> 21' 00"
Ennore Port	SW 6	23096	13.190 <sup>0</sup> 13 <sup>0</sup> 11' 12"	80.380 <sup>0</sup> 80 <sup>0</sup> 23' 30"
Off Goa	DS 1	23097	15.560 <sup>0</sup> 15 <sup>0</sup> 33' 58"	69.178 <sup>0</sup> 69 <sup>0</sup> 10' 56"
Off Lakshadweep	DS 2	23098	10.625 <sup>0</sup> 10 <sup>0</sup> 37' 55"	72.510 <sup>0</sup> 72 <sup>0</sup> 30' 02"
Off Chennai	DS 3	23099	12.135 <sup>0</sup> 12 <sup>0</sup> 08' 03"	90.760 <sup>0</sup> 90 <sup>0</sup> 46' 22"
Off Paradip	DS 4	23100	18.475 <sup>0</sup> 18 <sup>0</sup> 26' 58"	87.556 <sup>0</sup> 87 <sup>0</sup> 35' 14"
Off Machilipatnam	DS 5	23101	13.995 <sup>0</sup> 13 <sup>0</sup> 59' 41"	83.274 <sup>0</sup> 83 <sup>0</sup> 16' 27"
Off Minicoy	DS 6	-----	08.300 <sup>0</sup> 08 <sup>0</sup> 18' 00"	72.760 <sup>0</sup> 72 <sup>0</sup> 45' 36"
Off Minicoy	DS 7	-----	08.315 <sup>0</sup> 08 <sup>0</sup> 19' 19"	72.664 <sup>0</sup> 72 <sup>0</sup> 39' 51"
OTEC Site	OT 1	23102	08.208 <sup>0</sup> 08 <sup>0</sup> 12' 36"	78.569 <sup>0</sup> 78 <sup>0</sup> 34' 12"
Off Cuddalore	OB 8	-----	11.503 <sup>0</sup> 11 <sup>0</sup> 30' 09"	81.473 <sup>0</sup> 81 <sup>0</sup> 28' 24"
Off Mahabalipuram	MB 10	23167	12.513 <sup>0</sup> 12 <sup>0</sup> 31' 02"	84.983 <sup>0</sup> 84 <sup>0</sup> 58' 36"
Off Ramaypatnam	MB 11	23168	14.997 <sup>0</sup> 14 <sup>0</sup> 59' 50"	87.504 <sup>0</sup> 87 <sup>0</sup> 30' 14"
Off Visakhapatnam	MB 12	23169	17.492 <sup>0</sup> 17 <sup>0</sup> 29' 30"	89.924 <sup>0</sup> 89 <sup>0</sup> 55' 26"

**SW –Shallow water DS - Deep sea OT-Thermal buoy MB- Meteorological buoy**