DEPARTMENT OF STATE TROPICAL CYCLONE STRIKE, WIND AND STORM SURGE PROBABILITY WARNINGS

NAVENVPREDRSCHFAC DOCUMENT NO.
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USERS MANUAL

NAVAL
ENVIRONMENTAL
PREDICTION
RESEARCH
FACILITY

Naval Environmental Prediction Research Facility
Monterey, California 93940

Department of State Tropical Cyclone Strike, Wind and Storm Surge Probability Warnings

Users Manual

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Prepared for
Fleet Numerical Oceanography Center
Monterey, California 93940

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SPECIAL NOTICES

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ABSTRACT

The objective of this users manual for the Department of State, Office of Foreign Disaster Assistance, is to provide non-ADP personnel with the information necessary to effectively use the warning information.

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RECORD OF CHANGES

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1. Introduction

The tropical cyclone, a severe storm of tropical origin, represents one of the most destructive forces on earth. Referred to as typhoons, hurricanes, tropical storms or often just cyclones, severe storms of this type are known worldwide. They form in tropical waters a few degrees away from the equator in both hemispheres and generally move westward then often turn poleward and many times either strike land where they die or they die on an eventual eastward track in the mid latitudes. This tropical cyclone life cycle may take up to 2 weeks to complete. Their threat is great to shipping, but it is greatest to populated coastal areas. Because of the threat to shipping, the Department of Defense (DOD) (primarily the Navy) cooperating with the Department of Commerce has developed a worldwide capability to track and forecast these storms. Various other government agencies make use of this information for various purposes. In particular, the Department of State uses DOD forecasts along with other information as factors in describing the general world situation.

The DOD forecasts commonly used predict the track and maximum winds over the following three-day period. These deterministic forecasts represent the best estimate of the future, but by no means represent the only possible future for the storm. For this reason it is necessary to allow for other reasonable outcomes. This is beyond the capability of all but a handful of trained tropical meteorologists. The Navy, with the cooperation of the Office of Foreign Disaster Assistance, has developed a series of computer models which interpret the forecasts in terms of threat indices. The Navy will be running these models on a routine operational basis and will provide a summary of the threat indices to the State Operations Center.

This document is designed to introduce that information.

2. The Threat

The usual ways in which tropical cyclones impact populated areas are with winds, torrential rains causing flooding and wind induced abnormal tides called storm surge. Of these three impacts, storm surge is responsible for perhaps as high as 90-95% of cyclone related deaths. High winds and storm surge are a problem in coastal (including island) areas with storm surge confined to the tidal plains. Winds are a serious problem only for a zone within 50 to 100 miles of a coast. Heavy rains, on the other hand, can bring disastrous consequences such as landslides and flooded streams and lakes hundreds of miles inland along the narrow path of the storm as it dies overland.

All these impacts are higuly localized so that a small deviation from the forecast would translate to an all or nothing difference in the local impact. The threat models quantify the risk of disastrous phenomena by using probability. The messages which will be provided to the State Department consider the threat of hurricane force winds (winds over 74 mph or 63 kt) worldwide and the threat of storm surge of at least 2 meters above high tide in the Bay of Bengal. The accompanying threat of fresh water flooding is not addressed because the technology to do so with reasonable reliability has not yet been developed. This, as well as the storm surge threat for the remainder of the world, may be added piecemeal whenever possible.

3. Meaning of Threat Indices

The threat indices are color codes; green, yellow, orange and red for increasing levels of threat (higher probability) and decreasing lead time. These are most meaningful to officials responsible for taking actions which would reduce damage and loss of life. Since the threat will generally be to foreign soil this will apply to the State Department only in the limited sense relative to U.S. embassies, missions and consulates. Other State Department actions may include advising potential relief agencies of an imminent disaster or to some extent planning coordinated actions with other interested governments.

When actions are taken based on either a probability or a forecast they may prove to have been either unnecessary or inadequate after the fact. For example, when a hurricane theatens, the U.S. National Weather Service typically covers a coastal area of about 300 miles with a hurricane warning when only about 100 miles of coast will actually receive hurricane force winds. Thus the probability of experiencing hurricane force winds for a single point within the warning area is about one-third (33%). Coastal points adjacent to the warning area are threatened but the probability of hurricane force wind is less. People in those areas face an acceptable risk from the Weather Service point of view. The concept of overwarning (300 miles were warned for 100 miles to be affected) is a necessary precaution in the face of uncertainty to insure adequate warning for those who will be affected.

Table 1 describes the four color codes in terms of lead time, probability level, overwarning factors and key words which describe types of actions generally appropriate to each threat level. The values selected for lead time and threat levels are based on an evolving body of knowledge including U.S. military experience with readiness conditions, relating the color codes to National Weather Service

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hurricane watches and warnings, and limited independent research. It is reasonable to expect some adjustment of these values will be required over time.

a. RED — The probability of the event (65 kt winds or greater, 2 meter or greater storm surge*) is at least 20% within the next 18 hours. Disaster potential is high and imminent. Preparations should be complete or nearing completion. These actions are expensive, and will not be done unnecessarily more than four times for each time they prove to have been necesssary. (Overwarning factor is less than 5.)

b. ORANGE — The probability of the event (65 kt winds or greater, 2 meter or greater storm surge*) is at least 10% within the next 24 hours. This is the time to order preparations of major cost: closing, evacuating, moving, etc. These actions are relatively expensive; they will prove necessary one of every 5 to 10 times they are ordered. (Overwarning factor is 5-10.)

c. YELLOW — The probability of the event (65 kt winds or greater, 2 meter or greater storm surge*) is at least 5% within the next 36 hours. Disaster potential over a broad area is moderate, but not imminent. This is the time to plan future actions and to preposition men and materials. These actions are relatively inexpensive and will prove necessary once for every 10 to 20 times they are ordered. (Overwarning factor is 10-20.)

d. GREEN — The probability of the event (65 kt winds or greater, 2 meter or greater storm surge*) is at least 2.5% within the next 48 hours. The disaster potential is low and distant in time. This is the time to review plans and establish communications with responsible parties. These actions are very inexpensive and will be performed 20 to 40 times for every one occasion of necessity. Stated another way, actions will prove necessary for only 2.5 to 5% of the area in which it is ordered. (Overwarning factor is 20 to 40.)

Table 1. Description of color codes.

* Storm surge probabilities apply to the Bay of Bengal only.

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4. Information Flow

During the summer and fall months in both the northern and southern hemisphere (all year) tropical cyclone formation is possible. Most of the time the cyclones are far out to sea and of little concern to interests other than shipping. The Navy's Fleet Numerical Oceanography Center (FNOC) in Monterey, CA routinely receives tropical cyclone warnings from units in Norfolk, VA, Pearl Harbor, HI and Guam which form a world-wide tropical cyclone forecasting network. These warnings are received at six or twelve hourly intervals during the life of the cyclone. Table 2 shows the normal issue times for warnings in various ocean basins.

	AGENCY	TIMES OF ISSUE
N.E. Pacific	NWOC Pearl Harbor (+WSFO San Fran)*	00,06,12,1800 GMT
N. Cent Pacific	NWOC Pearl Harbor (+WSFO Honolulu)*	00,06,12,1800 GMT
N.W. Pacific	NOCC/JTWC Guam	00,06,12,1800 GMT
S.E. Pacific	NWOC Pearl Harbor	03 and 1500 GMT
S.W. Pacific	NOCC/JTWC Guam	07 and 1900 GMT
Atlantic	NEOC Norfolk (+NHC Miami)*	04,10,16,2200 GMT
S. Indian	NOCC/JTWC Guam	02 and 1400 GMT
N. Indian	NOCC/JTWC Guam	04,10,16,2200 GMT

Table 2. Schedule issue times for warnings in various ocean basins. Agency abbreviations are WSFO (Weather Service Forecast Office), NWOC (Naval Western Oceanography Center), NOCC/JTWC (Naval Oceanography Command Center/Joint Typhoon Warning Center), NEOC (Naval Eastern Oceanography Center), and NHC (National Hurricane Center). *Where a Department of Commerce agency is involved, warnings are issued by DOC with DOD coordination. Special warnings may be issued at other than scheduled times as circumstances warrant.

These warnings are received in a machine-readable format at FNOC. The receipt of the warning triggers the execution of a series of programs. Within several of these programs is a call to a routine which creates the State Department message. These products are shown in figure 1 (Bay of Bengal only) and figure 2 (World Oceans except Bay of Bengal).

Appendix A lists the cities for which threats are evaluated. For the most part these cities are those in

tropical cyclone prone areas with populations greater than 250,000. Several lesser cities are included when they are key cities politically, for example, a capital city or the main city of an island group. With the exception of U.S. Territories, all the cities are foreign.

5. No Threat Message

Because of the confined space in the Bay of Bengal, the existence of a cyclone is sufficient to indicate a significant threat to life. In the broad expanse of other ocean areas this is not the case. Consequently a threat message will be generated for each Bay of Bengal warning received, but this is not a reasonable procedure for other world oceans. When none of the cities listed in Appendix A are significantly threatened, no message at all will be generated. This leaves open the possibility of ambiguity between the following situations:

a) One or more storms exist but are not threatening listed cities;
b) No storms exist, or
c) There is a breakdown in the system at some point.

Once the procedures are well established, a breakdown should rarely occur. With the virtual elimination of breakdowns, the ambiguity is of little consequence.

Figure 1

FROM: FLENUMOCEANCEN MONTEREY CA
TO: SECSTATE WASHINGTON DC //OPS CENTER//
(others to be determined)
INFO: (Various Defense or Navy staff and Navy Oceanography Command activities some of which will be included only during or after checkout period)
(Various State Department or other agencies with interest in the Bay of Bengal)

BT
UNCLAS //N03140//
SUBJ: BAY OF BENGAL CYCLONE THREAT
1. CYCLONE 31-38 LOCATED AT 18.4N 86.5E AT 12092000Z WITH 70KT CENTER WINDS CONSTITUTES THE FOLLOWING THREAT AS DETERMINED BY AN OFDA AUTOMATED THREAT MODEL USING A DOD FORECAST FROM JTWC GUAM (REFER TO USERS MAN NO. XX).
A. THREAT OF HURRICANE FORCE WINDS ON COASTAL AND ISLAND LOCATIONS

THREAT LEVEL	SECTION OF COASTLINE
DANGER (RED)	19.2N 84.7E (INDIA) TO 20.5N 86.3E (INDIA)
ALERT (ORANGE)	18.5N 83.9E (INDIA) TO 22.0N 89.8E (B DESH)
CAUTION (YELLOW)	18.5N 83.9E (INDIA) TO 22.3N 91.7E (B DESH)
WATCH (GREEN)	17.8N 83.1E (INDIA) TO 21.5N 92.3E (B DESH)

B. THREAT OF STORM SURGE OF AT LEAST 2 METERS ABOVE HIGH TIDE

THREAT LEVEL	SECTION OF COASTLINE
DANGER (RED)	THRESHOLD NOT EXCEEDED AT ANY POINT
ALERT (ORANGE)	21.8N 87.8E (INDIA) TO 22.4N 90.8E (B DESH)
CAUTION (YELLOW)	21.2N 87.0E (INDIA) TO 22.4N 90.8E (B DESH)
WATCH (GREEN)	21.2N 87.0E (INDIA) TO 22.3N 91.7E (B DESH)

BT

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Figure 2

FROM: FLENUMOCEANCEN MONTEREY CA

TO: SECSTATE WASHINGTON DC // OPS CENTER //
(Others to be determined)

INFO: (Various Defense or Navy staff and Navy Oceanography Command activities some of which will be included only during or after checkout period)
(Various State Department or other agencies with interest on an area basis)

BT

UNCLAS //N03140//

SUBJ: TROPICAL CYCLONE WIND THREAT

1. TYPHOON CLARA SEP 18, 1981 1200 GMT LOCATED IN NORTH WEST PACIFIC AT 15.2N 127.1E WITH CENTER WINDS OF 75 KTS. ESTIMATE OF THREAT OF HURRICANE FORCE WINDS FOLLOW:

OFDA SELECTED POINTS	THREAT LEVEL
MANILA ROP	CAUTION (YELLOW)
HONGKONG BCC	CAUTION (YELLOW)
TAINAN ROC	DANGER (RED)
KAOSIUNG ROC	DANGER (RED)
TAIPEI ROC	ALERT (ORANGE)
HANGZHOW PRC	CAUTION (YELLOW)
SHANGHAI PRC	WATCH (GREEN)

2. THREAT TO ALL OTHER OFDA POINTS BELOW WATCH (GREEN) THREAT THRESHOLD FROM THIS STORM.

BT

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APPENDIX A

Office of Foreign Disaster Assistance
List of Cities
for Tropical Cyclone Threat Analysis

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ARABIAN SEA (14)

	LAT	LONG
INDIA (8)		
Trivandrum	8:28N	76:57E
Calicut	11:15N	75:46E
Bombay	18:58N	72:50E
Surat	21:10N	72:50E
Baroda	22:18N	73:12E
Mangalore	12:52N	74:52E
Bhaunagar	21:46N	72:09E
Jamnagar	22:28N	70:04E
PAKISTAN (1)		
Karachi	24:52N	67:03E
IRAN (1)		
Abadan	30:20N	48:16E
IRAQ (1)		
Al-Basrah	30:30N	47:47E
S. YEMEN (1)		
Aden	12:45N	45:12E
UAE (1)		
Dubayy	25:18N	55:18E
OMAN (1)		
Masqat	23:37N	58:35E

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NORTH PACIFIC (53)

	LAT	LONG
THAILAND (1)		
Bangkok	13:45N	100:31E
VIETNAM (4)		
Ho Chi Minh	10:45N	106:40E
Da Nang	16:04N	108:13E
Hue	16:28N	107:36E
Haiphong	20:52N	106:41E
HONG KONG (1)	22:15N	114:10E
CHINA (9)		
Shantou	23:23N	116:41E
Xiamen	24:28N	118:07E
Fuzhou	26:06N	119:17E
Ning-Bo	29:52N	121:31E
Hangzhou	30:15N	120:10E
Shanghai	31:14N	121:28E
Tsingtao/Qingdao	36:06N	120:19E
Tientsin/Tianjin	39:08N	117:12E
Luda	38:53N	121:35E
TAIWAN (3)		
Kaohsiung	22:38N	120:17E
Tainan	23:00N	120:11E
Taipei	25:03N	121:30E
S. KOREA (3)		
Inchon/Seoul	37:28N	126:38E
Kwangju	35:09N	126:54E
Pusan	35:06N	129:03E

JAPAN (22)

	LAT	LONG
Naha, Okinawa	26:13N	127:40E
Kagoshima	31:36N	130:33E
Kumamoto	32:48N	130:43E
Nagasaki	32:48N	129:55E
Fukuoka	33:35N	130:24E
Kitakyushu	33:53N	130:50E
Hiroshima	34:24N	132:27E
Matsuyama	33:50N	132:45E
Kurashiki	34:35N	133:46E
Okayama	34:39N	133:55E
Himeji	34:49N	134:42E
Kobe	34:41N	135:10E
Osaka	34:40N	135:30E
Nagoya	35:10N	136:55E
Hamamatsu	34:42N	137:44E
Shizuoka	34:58N	138:23E
Yokosuka	35:18N	139:40E
Yokohama	35:27N	139:39E
Tokyo	35:42N	139:46E
Chiba	35:36N	140:07E
Niigata	37:55N	139:03E
Sendai	38:15N	140:53E

PHILIPPINES (4)

Manila	14:35N	121:00E
Cebu	10:20N	123:40E
Davao	7:04N	125:36E
Bacolod/Lloilo	10:40N	122:57E

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PACIFIC ISLANDS (6)	LAT	LONG
Agana, Guam	13:28N	144:45E
Truk	7:25N	151:47E
Palau	7:30N	134:30E
Saipan/Tinian	15:12N	145:45E
Yap	9:31N	138:06E
Ponape	6:55N	158:15E

SOUTH PACIFIC (24)

AUSTRALIA (7)		
Brisbane	27:28S	153:02E
Darwin	12:28S	130:50E
Perth	31:56S	115:50E
Cairns	16:55S	145:46E
Newcastle	32:56S	151:46E
Sydney	33:52S	151:13E
Norfolk Island	29:02S	167:57E

NEW ZEALAND (4)		
Auckland	36:52S	174:46E
Manukau	37:02S	174:54E
Wellington	41:18S	174:47E
Whangarei	35:43S	174:19E

AFRICA (2)		
Durban, S. Africa	29:55S	30:56E
East London, S. Africa	33:00S	27:55E

ISLANDS (13)

	LAT	LONG
Madagascar		
Tulear	23:21S	43:40E
Diego Suarez	12:16S	49:17E
Fiji		
Nandi	17:48S	177:25E
Suva	18:08S	178:25E
Port Louis	20:10S	57:30E
Mauritius		
Noumea, New Caledonia	22:16S	166:27E
Nukualofa, Tonga Is.	21:08S	175:12W
Easter Is.	27:07S	109:22W
Niue Is.	19:02S	169:52W
Apia, Somoa	13:50S	171:44W
Pago Pago, Am Somoa	14:16S	170:42W
Rarotonga Is.	21:14S	159:46W
Saint-Denis, Reunion	20:52S	55:28E

NORTH ATLANTIC (29)

Nassau, Bahamas	25:05N	77:21W
Hamilton, Bermuda	32:17N	64:46W
St. Johns, Antigua	17:06N	61:51W
Roseau, Dominica	15:18N	61:24W
Fort-de-France, Martinique	14:36N	61:05W
Castries, St. Lucia	14:01N	61:01W

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NORTH ATLANTIC (continued)

	LAT	LONG
Bridgetown, Barbados	13:06N	59:37W
Kingstown, St. Vincent	13:09N	61:14W
St. Georges, Grenada	12:03N	61:45W
PUERTO RICO (2)		
San Juan	18:28N	66:07W
Ponce	18:01N	66:37W
VIRGIN ISLANDS (2)		
St. Thomas	18:21N	64:55W
St. Croix	17:45N	64:45W
Pointe-a-Pitre, Guadalupe	16:14N	61:32W
Port of Spain, Trinidad & Tobago	10:39N	61:31W
Willemstad, Netherlands Antilles	12:06N	68:56W
CUBA (2)		
Santiago de Cuba	20:01N	75:49W
Havana	23:08N	82:22W
Kingston, Jamaica	18:00N	76:48W
Santo Domingo Dominican Republic	18:28N	69:54W
San Salvador, El Salvador	13:42N	89:12W
Barranquilla, Colombia	10:59N	74:48W

VENEZUELA (2)

	LAT	LONG
Maracaibo	10:40N	71:37W
Caracas	10:30N	66:56W

MEXICO (3)

Tampico	22:13N	97:51W
Vera Cruz	19:12N	96:08W
Matamoros	25:53N	97:30W

Belize, Belize	17:30N	88:12W
Port-au-Prince, Haiti	18:32N	72:20W

EASTERN PACIFIC (2)

MEXICO

Mazatlan	23:13N	106:25W
Acapulco	16:51N	99:55W