

## Saffir-Simpson Tropical Cyclone Scale (STCS)

STCS is a scale that relates maximum tropical cyclone surface winds to potential damage and storm surge. A similar scale has been used in the Atlantic for three decades. Guard and Lander (1999) adapted the Atlantic scale to tropical regions and added a tropical storm scale. STCS considers: tropical building materials/practices; tropical vegetation/agriculture; weakening effects of termites, wood rot, salt spray; and effects of the coral reefs on storm surge.

Two tropical storm categories; five typhoon categories

Note: Categories are based on 1-min. average maximum sustained winds (MSW) and it's corresponding 1-3 second peak gust.

### Tropical Storm Categories

- 1) Tropical Storm Category A: "Weak Tropical Storm"  
MSW: 30-49 mph (26-43 kt)  
Peak Gust: 40-64 mph (33-56 kt)
- 2) Tropical Storm Category B: "Severe Tropical Storm"  
MSW: 50-73 mph (44-63 kt)  
Peak Gust: 65-94 mph (57-81 kt)

### Typhoon Categories

- 1) Typhoon Category 1: "Minimal Typhoon"  
MSW: 74-95 mph (64-82 kt)  
Peak Gust: 95-120 mph (82-105 kt)
- 2) Typhoon Category 2: "Moderate Typhoon"  
MSW: 96-110 mph (83-95 kt)  
Peak Gust: 121-139 mph (106-121 kt)
- 3) Typhoon Category 3: "Strong Typhoon"  
MSW: 111-129 mph (96-112 kt)  
Peak Gust: 140-164 mph (122-142 kt)
- 4) Typhoon Category 4: "Very Strong Typhoon"  
MSW: 130-156 mph (113-136 kt)  
Peak Gust: 165-198 mph (143- 173 kt)
- 5) Typhoon Category 5: "Devastating Typhoon"  
MSW: 157-194 mph (137-170 kt)  
Peak Gust: 199-246 mph (174-216 kt)

### Ingredients needed for a Tropical Storm or Typhoon

A pre-existing disturbance—large area of persistent, loosely organized thunderstorms.

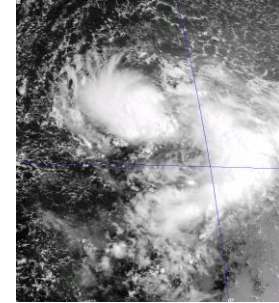
Warm ocean water—temp at least 80 degrees F down to a depth of 150 ft.

Light upper level winds—little or no vertical wind shear, which degrades the tropical cyclone structure.

## Examples of Satellite Imagery for Each Category

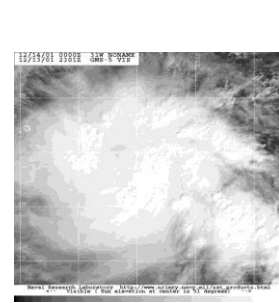
Tropical cyclone is a general term that refers to tropical depressions, tropical storms, and typhoons.

TS CAT A



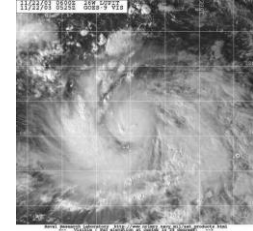
Tropical Depression  
30 mph

TS CAT B



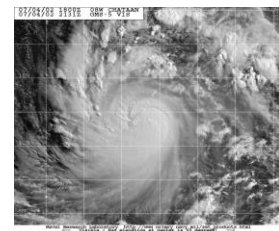
Tropical Storm Faxai  
Dec 2001 50 mph

TY CAT 1



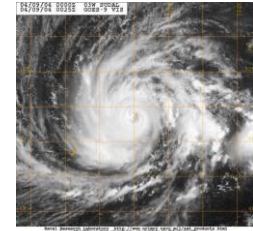
Typhoon Lupit  
Nov 2003 75 mph

TY CAT 2



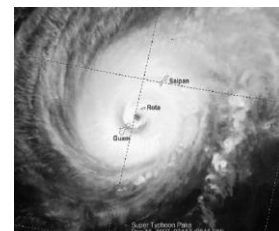
Typhoon Chata'an  
July 2002 100 mph

TY CAT 3



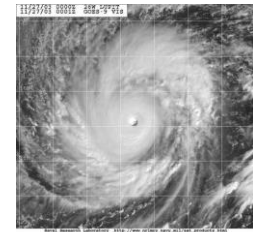
Typhoon Sudal  
Apr 2004 125 mph

TY CAT 4



Typhoon Paka  
Dec 1997 150 mph

TY CAT 5



Super Typhoon Lupit  
Nov 2003 165 mph

TY CAT 5 Eye



Eye of Super Typhoon  
Yuri Nov 1991 175 mph

The term "Super Typhoon", while not an official term, is commonly used to refer to typhoons with maximum sustained surface winds  $\geq 150$  mph ( $\geq 130$  kt).

## Potential Damages

(structures, infrastructure, and vegetation)

### Tropical Storm Category A

Damage only to the flimsiest lean-to type structure. Minor damage to banana and papaya trees.

### Tropical Storm Category B

Major damage to huts made of thatch or loosely attached corrugated sheet metal or plywood; sheet metal and plywood may become airborne. Minor damage to buildings of light materials. Moderate damage to banana and papaya trees.

### Typhoon Category 1

Corrugated metal and plywood stripped from poorly constructed or termite infested structures and may become airborne. Few wooden, non-reinforced power poles tilted and some rotten power poles broken. Less than 10% defoliation of trees/shrubs. Palm fronds begin to break.

### Typhoon Category 2

Damage to wooden and tin roofs and other structures of termite infested or rotted wood. Considerable damage to structures made of light materials. Several rotten wooden power poles snapped and many non-reinforced power poles tilted. Some secondary power lines down. 10-30% defoliation of trees/shrubs.

### Typhoon Category 3

Extensive damage to wooden structures weakened by termite infestation, wet and dry wood rot, and corroded roof straps. Structures made of light material may be destroyed. Some roof, window, and door damage to well-built, wooden and metal buildings. Air full of small flying debris. Few hollowed-spun concrete power poles broken or tilted and many non-reinforced wooden power poles blown down or broken. Many secondary power lines down. Palm trees begin to lose crowns; 30-50% defoliation of trees/shrubs.

### Typhoon Category 4

Many well-built wooden or tin homes damaged or destroyed and complete destruction of buildings made of light materials. Extensive damage to non-concrete roofs. Some reinforced hollow-spun concrete and many reinforced wooden power poles blown down with numerous secondary power lines downed. Trees/shrubs 50-90% defoliated; trees begin to lose bark.

### Typhoon Category 5

Total failure of non-concrete reinforced roofs. Extensive or total destruction to non-concrete residence and industrial buildings. Severe damage to some solid concrete poles, to numerous reinforced hollow-spun concrete power poles, to many steel towers and virtually all wooden poles. All secondary power lines, most primary power lines downed. Considerable glass failures due to flying debris and explosive pressure caused by extreme wind gusts; well constructed storm shutters fail. Trees devoid of all but largest stubby and sandblasted branches; up to 100% defoliation. Large airborne debris.

## Examples of Damage for Each Category

TS CAT B



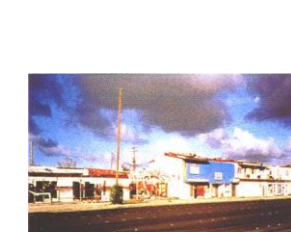
Damage to banana trees

TY CAT 1



Weakened, unguied wooden power poles can break

TY CAT 2



Weakened wood and tin roofs can fail

TY CAT 3



Palms can lose crowns at about 115mph (100kt)

TY CAT 3



Poorly reinforced hollow-block walls can topple

TY CAT 4



Cars in parking lots near buildings can be overturned

TY CAT 4



Tops of empty fuel storage tanks can be stripped away

TY CAT 4-5



Trees defoliated, stubby, with bark sandblasted



## Coastal Inundation and Wave Action

### Tropical Storm Category A

On windward coasts, sea level rise less than 2 ft. above normal in open bays and inlets. Breaking waves inside bays can reach 2-3 ft.; less than 1 ft. over reefs. Rough surf at reef margin with moderately strong along-shore (rip) currents inside reef.

### Tropical Storm Category B

On windward coasts, sea level rise of 2-4 ft. above normal in open bays and inlets. Breaking waves inside bays can reach 3-5 ft.; 1-2 ft. additional water over reefs. Waves can inundate low-lying coastal areas below 2 ft. on windward locations where reefs are narrow. Very rough surf at reef margin with strong along-shore rip currents inside reefs.

### Typhoon Category 1

On windward coasts, sea level rise of 4-6 ft above normal in open bays and inlets. Breaking waves inside bays can reach 5-7 ft; 2-3 ft. Additional water across reef. Waves may inundate low-lying coastal roads below 2-4 ft on windward locations where reefs are narrow. Minor pier damage and small craft in exposed anchorages break moorings.

### Typhoon Category 2

On windward coasts, sea level rise of 6-8 ft above normal in open bays and inlets. Breaking waves inside bays can reach 7-10 ft; water is about 3-5 ft. above normal across reef flats. Waves will inundate low lying coastal roads below 4-6 ft on windward locations where reefs are narrow. Some erosion of beach areas, some moderate pier damage and some large boats torn from moorings.

### Typhoon Category 3

On windward coasts, sea level rise of 8-12 ft above normal in open bays and inlets. Breaking waves inside bay can reach 10-15 ft; water is about 5-8 ft above normal across reef flats. Waves may inundate low-lying coastal roads below 6-10 ft of elevation on windward locations where reefs are narrow. Considerable beach erosions and many large boats and some large ships torn from moorings.

### Typhoon Category 4

On windward coasts, sea level rise of 12-18 ft above normal in open bays and inlets. Breaking waves inside bays can reach 15-25 ft; water is about 8-13 ft above normal across reef flats. Waves may inundate coastal areas below 10-15 ft elevation. Large boulders carried inland with waves. Severe beach erosions and severe damage to port facilities including some loading derricks/gantry cranes. Most ships torn from moorings.

### Typhoon Category 5

On windward coasts, sea level rise of 18-30+ ft above normal in open bays and inlets. Breaking waves inside bays can be 25-35+ ft; water is about 12-20+ ft above normal reef flats. Serious inundation likely for windward coastal areas below 15-28+ ft. Very large boulders carried inland with waves. Extensive beach erosion. Extensive damage to port facilities including most loading derricks/gantry cranes. Virtually all ships, regardless of size, torn from moorings.

**Note:** Monsoon-generated swells, if present, can add 2-4 feet to inundation levels for developing tropical storms and Category 1 typhoons. In addition, high tide values must be added to determine actual inundation levels or actual **storm tide**. **Always plan for high tide!**

## Examples of Storm Surge for Each Category

Storm surge is the rise in water level above the normal tide level due to a combination of: waves and swells caused by stress from the strong winds; and, reduced weight of the atmosphere pushing down on the ocean caused by the low pressure of the typhoon.

### TS CAT B



Some near-coastal erosion at high tide

### TY CAT 1-2



Coastal erosion undermining inland rocks

### TY CAT 4



Boat torn from mooring during Paka Dec 1997

### TY CAT 4-5



Extensive coastal erosion

### TS CAT B-TY CAT 1



Waves breaking across coral reef flats

### TY CAT 2-3



Coastal damage at Yap from Ty Sudal 2003

### TY CAT 4



Constricted bay--Rota Ty Pongsona Dec 2002

### TY CAT 4-5



Incoming surf combined with reflected waves

**Damaging winds:** Sustained winds  $\geq$  39 mph (34 kt).

**Destructive winds:** Sustained winds  $\geq$  58 mph (50 kt).

**Typhoon-force winds:** Sustained winds  $\geq$  74 mph (63 kt).

## *Conditions of Readiness vs Watches and Warnings*

*Set by Local Government*

*Set by National Weather Service*

<b>Condition 4:</b> damaging winds possible within (w/i) 72 hours	-----
<b>Condition 3:</b> damaging winds possible w/i 48 hours	<b>Watch:</b> damaging winds possible w/i 48 hours; tropical storm or typhoon
<b>Condition 2:</b> damaging winds expected w/i 24 hours	<b>Warning:</b> damaging winds expected w/i 24 hours; tropical storm or typhoon
<b>Condition 1:</b> damaging winds expected w/i 12 hours or are occurring	-----

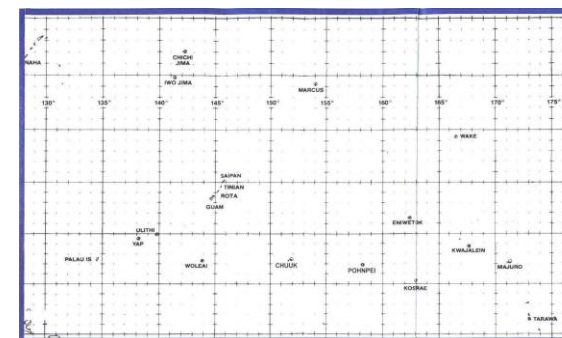
### How to prepare for a storm

1. Fill cars up with fuel.
2. Clean yard of potential debris.
3. Stock up on non-perishable foods and drinking water.
4. Obtain batteries, flashlights, and battery-operated radios.
5. Secure windows; put up or close shutters.
6. Remove or secure window air conditioners.
7. Adjust freezer and refrigerator to high and avoid opening in order to preserve perishable foods.
8. Attain enough fuel for lamps, stoves, and generators.
9. Fill containers with several days of water.
10. Have rags ready for slow leaks of wind driven water.
11. Park cars in protected area.

### What to do during a storm

1. Stay indoors.
2. Stay away from windows and sliding glass doors.
3. Minimize usage of telephone.
4. Listen to the local media or NOAA Weather Radio for the latest weather bulletins.
5. Do not touch loose or tangling wires after storm.
6. Do not drive around until the all clear is given.

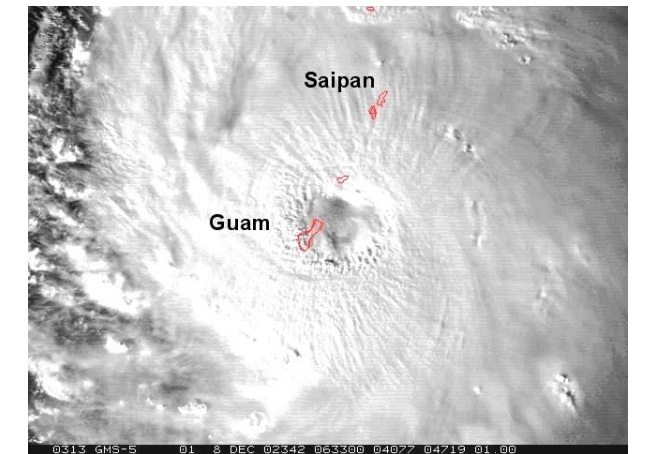
### Storm Tracking Chart



For a larger image visit our website at: [weather.gov/gum](http://weather.gov/gum)

## *Are You Prepared for a Typhoon?*

**Reading this will help!**



Super Typhoon Pongsona over Guam with 150-mph (130-kt) winds



**NATIONAL WEATHER SERVICE  
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3232 HUENEME ROAD  
BARRIGADA, GUAM 96913**

**National Oceanic and Atmospheric Administration  
U.S. Department of Commerce**

**Website: [weather.gov/gum](http://weather.gov/gum)  
Phone number: (671) 472-0900**

*(Updated 15 Aug 2014)*

**Extracted primarily from:** Guard, C.P., and M.A. Lander, 1999: *A Scale Relating Tropical Cyclone Wind Speed to Potential Damage for the Pacific Ocean Region-A User's Manual*. WERI Technical Report 86. Water and Environmental Research Institute, University of Guam, Mangilao, Guam 96910, pp. 60.