

# CHEMICAL RELEASES ASSOCIATED WITH CYCLONES



This leaflet provides brief information about Natech and other chemical releases caused directly or indirectly by cyclones. It is an extract from the WHO publication *Chemical releases caused by natural hazard events and disasters – information for public health authorities*. The full document provides additional information on the roles of the health sector in prevention, preparedness, response and recovery in relation to Natech events.



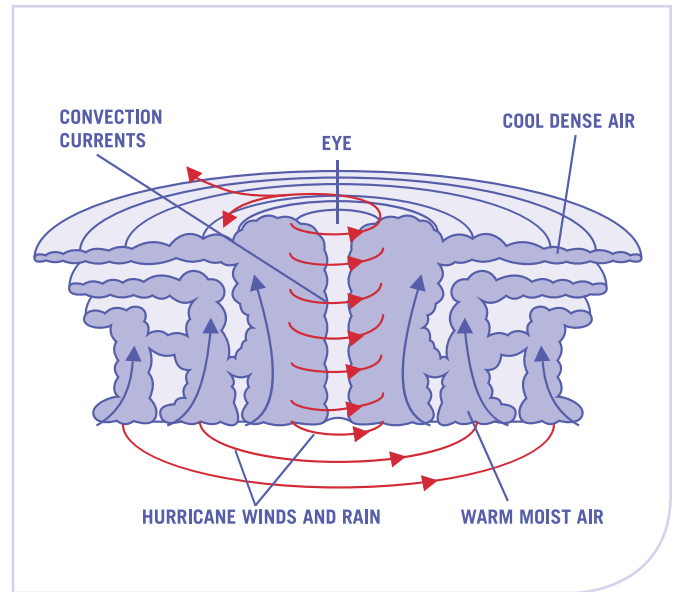
**World Health  
Organization**

# WHAT IS A CYCLONE?

Cyclone, hurricane and typhoon are regionally specific names for a low-pressure weather system over tropical or subtropical waters characterized by thunderstorms, torrential rain and high wind speeds (1, 2). Cyclone intensity is predicted to increase as a consequence of climate change (3).

Cyclones are further classified according to wind speed and location (1, 2):

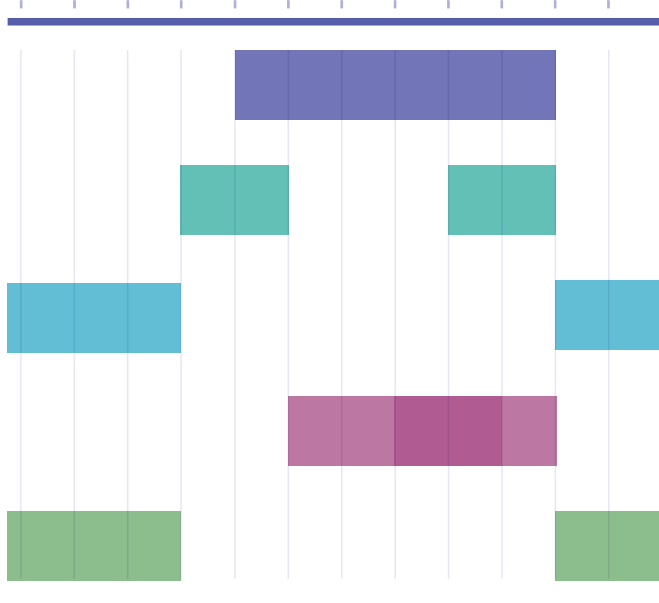
- tropical depression – sustained wind speed of 63 km/h or less;
- tropical storm – maximum sustained wind speed ranging from 63 to 117 km/h;
- hurricane, typhoon, severe tropical cyclone, severe cyclonic storm or tropical cyclone (nomenclature depending on the ocean basin) – an intense tropical weather system with sustained winds of at least 119 km/h.



Hurricanes can be categorized according to their sustained wind speed using the Saffir-Simpson Hurricane Wind Scale, which runs from 1 to 5. A category 1 hurricane has wind speeds of 119–153 km/h and will cause some damage. A category 5 hurricane has wind speeds greater than 252 km/h and will cause catastrophic damage (4).

The typical seasons for this weather phenomenon are as follows (2).

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



Typhoons in the western North Pacific region:  
**May to November**

Tropical cyclones in the Bay of Bengal and Arabian Sea:  
**April to June and September to November**

Tropical cyclones on the east coast of Africa:  
**November to April**

Hurricanes in the Americas and the Caribbean:  
**June to November, peaking in August and September**

Cyclones in the South Pacific and Australia:  
**November to April**

Cyclones can be hundreds of kilometres wide and can bring destructive high winds, storm surges, inland flooding, lightning and, occasionally, tornadoes (2). A storm surge is the abnormal rise of water generated by strong winds. Storm surges and battering waves can cause extensive damage along the affected coastline. In addition, a storm surge can travel several kilometres inland along rivers and estuaries (5).

# RISK FACTORS FOR CHEMICAL RELEASE

Analysis of past events suggests that petroleum refineries and other hazardous installations are susceptible to high winds, tornadoes, flooding and lightning leading to hazardous chemical release (6, 7). Cyclones can also cause major infrastructure damage that will hamper response.

## FACTORS THAT INCREASE THE RISK OF A CHEMICAL RELEASE AND HARM TO HEALTH DURING OR AFTER A CYCLONE INCLUDE THE FOLLOWING (8, 9):



### Location

- Location of industrial and chemical-storage facilities in coastal zones.
- High population density around industrial sites.



### Structures

- Structures that are vulnerable to storm damage and lightning strikes.
- Inadequate planning and building regulations.



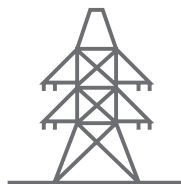
### Preparedness and warning systems

- Inadequate safety measures or emergency planning.
- Inadequate warning systems.
- Lack of public awareness about cyclone and flood risks.

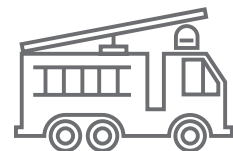
## A CYCLONE MAY INCREASE RISKS BY REDUCING RESPONSE CAPACITY IN THE FOLLOWING WAYS (7, 10):



**The release of hazardous materials** may hamper search and rescue operations.



**Damage to on-site emergency equipment** will hamper response, as will **damage to essential infrastructure** such as the power supply, water supply and telecommunications.



**Response activities are impossible until the storms have died down sufficiently** to allow safe movement. **The off-site emergency-response personnel and other resources may not be available**, as they may be occupied in dealing with the consequences of the cyclone.

# MECHANISMS OF CHEMICAL RELEASE



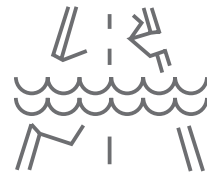
## Damage to buildings and structures and release of waste

Cyclones can result in a chemical release in a variety of ways (11, 12). **High winds and tornadoes can directly damage buildings and structures at chemical installations by tipping over storage tanks and dislocating piping and connections** between storage and processing units. Such high-force winds may also launch objects such as tree branches and rooftops into the air and into storage vessels and pipework (6). Gaseous toxic chemicals released from punctured or ruptured storage tanks can be blown over populated areas or can dissolve in rainwater to produce toxic or corrosive rain (6). Flooding of internal plant drainage systems may release waste oil or other chemical waste if not segregated from surface water drainage systems.



## Toxic reactions and fire

**The released chemicals can mix and react with the water, potentially generating toxic reaction products or a fire or explosion hazard (13).** When flammable hydrocarbons are released into the floodwaters, ignition can result in pool fires. These are buoyant flames above a horizontal pool of vaporizing hydrocarbon fuel and can carry a fire to new sources of flammable materials or into residential areas (14). They are a particular risk at storage depots or refineries for petroleum products.



## Toxic runoff

**Runoff from inundated areas can carry with it chemicals** such as eroded soil containing fertilizers, herbicides and pesticides (in a rural catchment area), or heavy metals, petroleum hydrocarbons and polycyclic aromatic hydrocarbons (runoff from roads, motorways and bridges) (15, 16).

**HIGH WINDS,  
HEAVY RAIN  
AND POWERFUL  
WAVES**



## Damage to freight ships and oil tankers

**High winds and powerful waves can damage freight ships and oil tankers either directly or indirectly through collision with rocks** releasing chemicals into the sea, which may then be washed onto shore. In the case of hydrocarbons that float on water, these may be blown onto shore in the form of fine spray.



## Damage to power supply

**General damage to the power supply can cause process upsets** and affect safety measures such as temperature and pressure monitors and control valves, potentially resulting in runaway chemical reactions and blow-down.



## Lightning damage

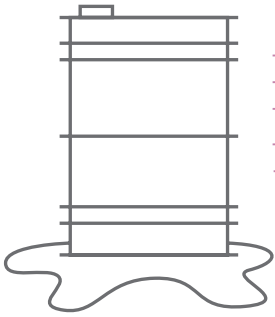
**Lightning can directly strike structures and storage tanks that contain flammable materials,** causing fires or explosions (6, 17). Oil and gas facilities are particularly vulnerable. Lightning strikes can also disrupt electrical circuitry and safety control systems, leading to chemical release (17).

# POTENTIAL IMPACTS ON HUMAN HEALTH

Cyclones, when they come onto land, can lead to heavy rain, strong winds and large waves.

The general public, rescuers and those involved in clean-up operations may be exposed to a range of hazards, which can be divided into those related to chemicals and those unrelated (9,18). Examples are given below.

## Chemical-related



- **Burns** from fires and exposure to corrosive chemicals (formation of toxic and/or flammable vapours upon reaction of the released chemicals with the floodwaters).
- **Respiratory tract injury** from inhalation of irritant gases, including combustion products, and fibres (e.g. from damaged asbestos and fibreglass insulation).
- **Poisoning** from exposure to spilled toxic chemicals and the consumption of contaminated food or water.
- **Carbon monoxide poisoning** resulting from the incorrect use of fuel-burning generators for electricity, barbeques, braziers or buckets of coal or charcoal for heating and cooking, or petrol-driven pumps and dehumidifiers to dry out flooded rooms (15, 19, 20).
- **Injuries and poisoning** in workers involved in rescue and clean-up, including excessive exposure to pesticides used for vector and rodent control.

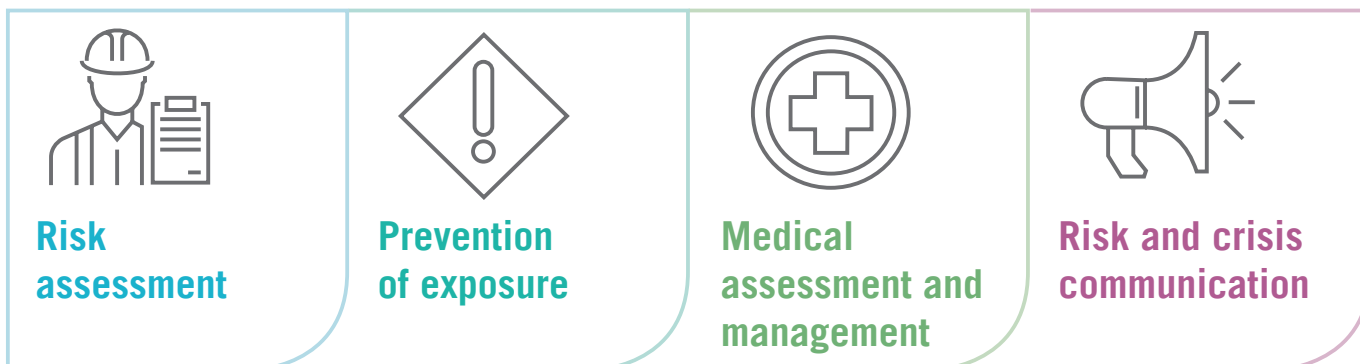
## Non chemical-related



- **Drowning.**
- **Electrocution**, lightning strikes.
- **Hypothermia** from immersion in water at less than 24 °C.
- **Venomous bites and stings** from displaced animals (20).
- **Injuries and deaths** as a result of flying, falling and floating debris. Injuries may also occur during the rescue and clean-up phases, e.g. when cutting and moving fallen debris.
- **Consequences of evacuation**, e.g. increased risk of infectious diseases at the evacuation sites, exacerbation of pre-existing health problems during patient transfer, saturation of health-care facilities with consequent inability to provide adequate treatment, potential problems with water supply and sanitation, etc. (21).
- **Diseases**, diarrhoeal, vector- and rodent-borne.
- **Psychosocial effects**, including post-traumatic stress disorder (15, 18).

# RESPONSE AND RECOVERY CONSIDERATIONS

Key activities in response and recovery are:



## A

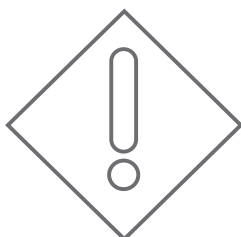
### Risk assessment



1. Obtain information on potentially affected hazardous sites, including waste dumps, in order to assess the risks to health and determine the appropriate risk-management measures.
2. Identify the chemicals involved in the accident: check if an inventory is available, e.g. in the site emergency plan; if not, use the *Flash environmental assessment tool* (22). Look for labels with hazard information.
3. Collect and consider any clinical information available from exposed individuals as this may help to identify some chemicals or chemical groups.
4. If feasible, organize the collection and analysis of environmental samples (air, soil, water, crops) in order to identify and quantify contamination by chemicals.
5. Assess the possibility of contamination of drinking-water sources and foods.

## B

### Prevention of exposure



1. Based on the risk assessments, provide advice as required to the civil defence, fire or other designated service on the need for:
  - containment measures
  - restrictions on access to contaminated sites
  - the need for personal protective equipment (PPE)
  - shelter-in-place or evacuation advisories for affected communities.
2. Ensure that people involved in clean-up and rescue operations are adequately equipped with PPE and are aware of the possibility of chemical spills.
3. Organize facilities for decontaminating chemically-exposed individuals.
4. Provide comprehensive information to the general public regarding precautionary measures (see 'Risk and crisis communication' overleaf).

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# C

## Medical assessment and management

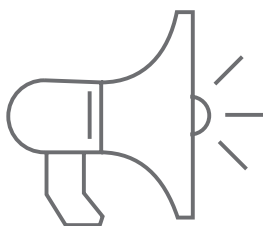


1. Ensure that chemically-exposed individuals are decontaminated before they enter the health-care facility.
2. Ensure that health personnel follow procedures for wearing PPE when managing chemically-contaminated victims.
3. Conduct triage and patient assessment. Note that chemical injuries or poisoning may be combined with traumatic injuries.
4. Obtain advice on the management of chemical exposure from a poisons centre, if available.
5. Provide specific medical treatment (e.g. antidotal treatment) as required.
6. Consider the need to collect biological samples from chemically-exposed individuals (including first-responders) in order to identify and, if possible, quantify exposure.
7. Register all exposed individuals and ensure adequate documentation and record-keeping in case there is a need for long-term follow-up.
8. Ensure that, after the first response, measures are taken in the recovery stage to prevent indirect chemical effects and long-term exposures. Provide mental health and psychosocial support for affected communities.

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# D

## Risk and crisis communication



1. Provide information, updated as necessary, to the public, first-responders and decision-makers about chemical and other hazards arising from the event. Ensure that the public is informed about:
  - the Natech event(s)
  - who is in charge
  - what is being done
  - the nature and hazards of the chemicals involved
  - what individuals should do to protect themselves and their families
  - when to seek medical attention
  - how to get further information.
2. Some specific health-protection topics include:
  - food and water advisories, in case of contamination
  - prevention of carbon monoxide poisoning
  - precautions during clean-up, e.g. use of personal protective equipment, safe use of cutting equipment, handling of asbestos cement, etc.
  - potential hazards in flood-damaged homes.

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