

Series: Hospitals Safe from Disasters, No 4

## Hospital Safety Index

# MEDIUM AND SMALL HOSPITALS SAFETY INDEX



**Pan American  
Health  
Organization**



**World Health  
Organization**  
REGIONAL OFFICE FOR THE **Americas**

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Emergency Preparedness and Disaster Relief Coordination

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7. PLANNING IN DISASTER -Planning and administration
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# Preface

The impact of torrential rain, earthquakes, hurricanes, landslides, and other hazards reveals the complexity of natural hazard vulnerability in Latin American and Caribbean countries. Many of the effects of natural hazards are seen in severe damage to health infrastructure. When hospitals that are built to provide health services are damaged or are unable to function, the ill and injured have no place to go for assistance. This has an enormous impact on populations that depend on these services on a regular basis.

Given this reality, the countries of the Americas agreed to adopt “Hospitals Safe from Disasters” as a national policy for risk reduction,<sup>1</sup> in order to ensure that all new hospitals are built with a level of safety that will ensure that they will continue to function during, and immediately after, severe natural-hazard events. This initiative also calls for the use of risk mitigation measures to retrofit existing hospitals, particularly those providing primary health care.

A “safe hospital” can be defined as a health care hospital whose services remain accessible and function at maximum capacity and in the same infrastructure, during and immediately following the impact of a major event. This implies structural stability, ongoing availability of basic services, and organization within the hospital.

The Pan American Health Organization, with the support of a group of experts from different countries, developed the Hospital Safety Index,<sup>2</sup> a tool for making a quick and reliable assessment of hospitals. It provides a snapshot of the safety level of a hospital, which is an essential hospital for a community, and as such must continue to function following an adverse event.

Because hospitals that belong to a health network have different functions, levels of safety to be achieved can be addressed differently and progressively. This manual complements the Hospital Safety Index and aims to improve the safety and response capacity of smaller hospitals in adverse events.

In this guide, medium and small hospitals are defined as those of low complexity, which along with the major hospitals, make up the health networks. Among them are primary

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1. The resolution “Safe Hospitals: A Regional Initiative on Disaster-Resilient Hospitals” (Resolution CD45.R8) was adopted by the Directing Council of the Pan American Health Organization in 2004 (available from: [www.paho.org/english/gov/cd/CD45.r8-e.pdf](http://www.paho.org/english/gov/cd/CD45.r8-e.pdf)).
  2. See Pan American Health Organization, Hospital Safety Index--Guide for Evaluators, Washington, D.C.: PAHO; 2008. <http://www.paho.org/english/dd/ped/SafeHosEvaluatorGuideEng.pdf>.

hospitals, which provide certain basic specialties (obstetrics and gynecology, pediatrics, internal medicine, and general surgery), hospitals that operate 24 hours per day and have inpatient services (in the case of medium-sized hospitals with 50 beds or less and in small hospitals with 20 beds or less).

This excludes medical offices, health centers, polyclinics that only provide outpatient services, and other hospitals that don't provide hospital services, such as clinical laboratories, diagnostic centers, etc.

It is important to understand that in a disaster situation, health networks are activated to care for those affected. In this context, hospitals, large, medium and small, are key to an effective response.

In most countries of Latin America and the Caribbean the condition of health infrastructure is precarious, particularly in less complex hospitals. This can be attributed to a variety of reasons, including:

- Some hospitals have outlived their usefulness but cannot be replaced and must continue functioning to meet the needs of the population.
- Others were not designed to provide this service, which has led to improvising in some hospitals.
- In many cases, these hospitals are located in vulnerable areas with poor soil quality, accessibility issues, or are exposed to hazards in the area.
- In other cases, the original design has been altered, thus affecting structural stability.
- Many have grown as the demand has increased, without taking account of structural integrity, architectural features, or basic services required.
- The budgets allocated to preventative maintenance are minimal and corrective actions are almost impossible to implement, thus accelerating the deterioration of these buildings.
- Often the quality of work falls below the normal standards due to budget cuts. This results in recruiting non-specialized and unskilled labor, use of inferior materials, minimal supervision, etc.

All of these factors contribute to increase the vulnerability of a hospital's structural, non-structural, and/or functional elements, which, if threatened by natural hazards can interrupt the provision of services. Many past disasters have confirmed this. Lessons learned indicate

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3. Pan American Health Organization, *Guidelines for vulnerability reduction in the design of new hospitals*, Washington DC: PAHO/WHO and the World Bank, 2004.

that most of the health infrastructure losses were due to location in vulnerable areas, inadequate design, substandard construction, or lack of hospitals maintenance.<sup>3</sup>

Ensuring that health care hospitals are safe during emergencies is a collective responsibility and involves the active participation of local authorities, other related sectors and institutions, and the general community. Health personnel have a key role in this endeavor: their work can contribute to increasing or decreasing the risks in their workplace.

It is well-known that the first response to a disaster occurs with locally available resources. Hospitals, therefore, must be prepared to provide services without interruption following an adverse event.

This guide outlines the risks that most often occur in hospitals of medium and low complexity, and is designed to build the capacity of these hospitals so that they can continue to provide services after an adverse event occurs. It provides information on identifying key areas of vulnerability in the structural, nonstructural, and certain functional aspects of a building in order to guide interventions that may be necessary to increase a hospital's safety from natural and other hazards. It has been prepared taking into account the realities of Latin America and the Caribbean, and we encourage users to adapt the contents that best apply to their country's situation.

To use this tool, the practices detailed in Annex 4 should be followed. This includes the formation of evaluation teams, among other actions.

The information in this manual will help health authorities to develop an intervention strategy and to prioritize actions according to their importance and the time and resources available. The process takes into account the importance of directing resources gradually to solve the problems already mentioned and to carry out activities in the short-term. Rather than a large budget, the process requires resourcefulness and the will to carry out the activities.

**This guide is organized in four chapters:**

- Chapter 1: Issues related to geographical location. It provides for rapid identification of the hazards posed by the site and terrain of a hospital.
- Chapter 2: Structural aspects. It describes aspects of diagnosing the safety of the hospital in terms of the type of structure, materials, and its history of exposure to natural or other hazards. It is important to note that structural components require specialized intervention, so the chapter describes warning signs that demand more detailed study according to the type of building structure.

- Chapter 3: Nonstructural aspects. It facilitates assessment of the safety of non-structural elements of the hospital, including lifelines, equipment, architectural elements, access routes, and the hospital's internal and external circulation.
- Chapter 4: Functional aspects. This chapter discusses evaluation of the level of institutional organization, the implementation of plans and preparedness programs to respond to adverse situations, the availability of resources, and the level of staff training.

**The following annexes are included:**

**Annex 1:** General information about the hospital.

**Annex 2.** An evaluation form, or checklist. This checklist summarizes information used in this manual that will be applied to the hospital.

**Annex 3.** An intervention plan for increasing the hospital's safety level. A matrix summarizes results from the evaluation and helps in planning how to introduce solutions.

**Annex 4.** Overview of the evaluation process.

Finally, it is important to emphasize that this tool does not attempt to solve all issues that would increase the vulnerability of a hospital. It prioritizes those items that could prevent a hospital from functioning as well as elements that should be addressed immediately. Likewise, results of this process should not be considered a definitive statement about whether a hospital can continue to function after an adverse event. For that, in depth vulnerability studies will have to be carried out.

# Aspects of the geographic location of the hospital

# 1

The effects of different hazards on health infrastructure have shown the vulnerability of hospitals, health centers, and health posts throughout the region. Studies have shown that many of the losses are due to the location of these hospitals in hazard-prone areas.

In fact, it is not uncommon to see hospitals that are covered by water or mud, that have lost their roofs in the hurricane season, been destroyed by a landslide, have major cracks in the walls, show evidence of settlement, etc. This occurs because at the time of planning, designing, and constructing a building, aspects of the site and the soils were not taken into account, factors that have a major impact on the safety of a hospital.

Generally, communities do not have micro-zone studies, hazard maps, or land-use plans that establish criteria for the location of buildings. The land obtained for the construction of a hospital might not be the safest. The building might be constructed on a backfilled area, located on a slope or near river banks, be on a geologic fault, or be in a site that would leave it cut off from transport routes. A site evaluation and vulnerability study must be undertaken and consulted before locating and constructing new hospitals.

An analysis of geographic factors can help estimate the hazards to which a hospital is exposed, taking into account prior emergencies and severe natural-hazard events that have occurred in the area, as well as the topography and type of soils where the hospital is located. As outlined in the Hospital Safety Index,<sup>4</sup> these factors can be divided into two groups: hazards, topography and geotechnical properties of soil, taking into account both natural hazards and those caused by human activity.

To this end, it is essential to review maps that specify hazards present in the area<sup>5</sup> and access different sources of information to understand prior adverse events. If hazard or risk maps do not exist, local entities should be consulted, such as civil defense and emergency commissions, as well as the local population.

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4. Pan American Health Organization, *Hospital Safety Index: Guide for Evaluators of Safe Hospitals*, Washington D.C.: PAHO/WHO, 2008. Available at: <http://www.paho.org/english/dd/ped/SafeHosEvaluatorGuideEng.pdf>.

5. A helpful source if risk maps are not available for the area is Pan American Health Organization, *Guía para la elaboración de mapas de riesgo comunitarios*, Quito: PAHO/WHO, 2006.

A preliminary inspection of the area immediately surrounding the hospital can provide a rapid assessment of the impact that hazards could cause. The team should identify the major and alternative access routes to the hospital, and inspect the land around the hospital to identify irregularities in the terrain, presence of nearby slopes, and proximity to bodies of water (sea, rivers, lakes, etc.) that can raise the water table, among other factors.

An analysis of hazards in the area surrounding the hospital must be taken into account when determining factors affecting a hospital's safety, considering the frequency, magnitude and intensity of destructive phenomena (hazards), topography and the geotechnical properties of soil. While geotechnical properties are not suited to measurement by the evaluation team, and these properties do not figure into the calculations of safety levels, it is important to consider the environment and context of the site of the hospital.

## 1.1 Hazards

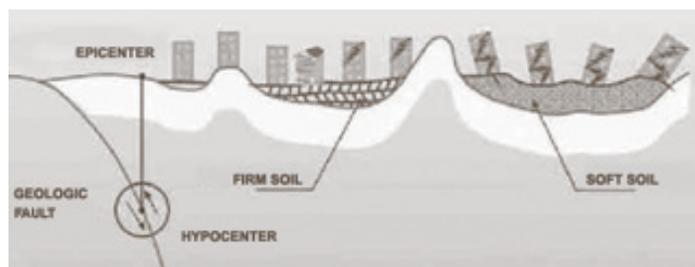
This section analyzes different types of hazards<sup>6</sup> (geological, hydrometeorological, social, environmental health, chemical, and technological) related to the hospital's location. The hazard level which the hospital may be subject to can be classified as high (high probability of a hazard or large-scale hazard), medium (high probability of a moderate hazard), or low (low probability of hazard or hazard of small magnitude).

### A. What geological events can affect the hospital?

#### A.1 Earthquakes

Earthquakes occur when a sudden release of energy in the Earth's crust, caused primarily by the rupture of geologic faults, creates seismic waves that move through the earth's crust. They manifest themselves as sudden ground vibrations and shaking of great intensity.

According to the analysis of soil and geologic history of earthquakes in the area, identify the level of hazard to the hospital.



The destructive capacity of an earthquake depends on a combination of factors: magnitude, distance from the hypocenter, soil characteristics (particularly its ability to amplify seismic waves), the strength of physical elements, and the level of preparedness of the population.

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6. For more information, see: Julio Kuroiwa, *Disaster reduction: living in harmony with nature*, Lima, Editorial NSG, 2004.

### Effects on health services

Depending on the time the event takes place, the type of construction, and population density, an earthquake can cause:

- high number of deaths;
- mass casualties, whether serious injury or minor bruises;
- serious damage to hospitals, including damage to columns, beams, walls, ceilings, and floors; broken windows; blocked doorways; damage to equipment and furniture; ruined supplies; detached walls and light fixtures, etc.;
- blocked access routes and disruption of basic services (power, water, communications, etc.).

## A.2 Volcanic Eruptions

The volcanic eruption is the output of molten rock (magma), gases, pyroclastic debris, and ash from inside the earth.

Identify the level of hazard to which the building is exposed based on the history of similar events, risk maps of the region, and the proximity and activity of volcanoes.



The impact that results from an eruption depends on the size and nature of the eruption, the topography of the area, and the vulnerability of the community near the volcano (e.g., proximity of the population or lack of monitoring).

### Effects on health services

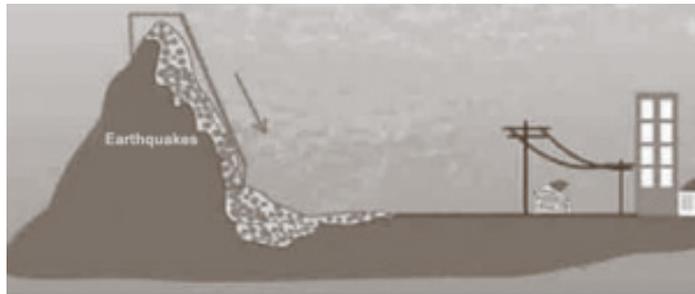
The health effects associated with volcanic eruptions depend on the type of event. They can cause:

- increased mortality;
- possible increase in demand for health care, whether for serious injuries that require complex treatments (such as trauma and burns), respiratory and eye problems, and illness caused by drinking contaminated water;
- serious damage to hospitals, including collapsed roofs due to the weight of the ash; destruction of building if in the way of lava flows; water pollution; deterioration of equipment due to the presence of ash, among others;
- blocked access routes and disruption of basic services (power, water, communications, etc.).

### A.3 Landslides

Landslides are the gradual or rapid downslope movement of surface matter (soil, rocks, and debris), due to gravity, changes in consistency of surface materials, and other factors that make a slope unstable.

To assess the level of hazard from landslides due to unstable soils, inspect the surroundings, review the history of similar events, and review the risk map.



Geological factors (such as seismic events), frequent and intense rains, topography, and human activities are factors that can result in unstable slopes that lead to landslides.

#### Effects on health services

Depending on the magnitude of the event, landslides can have the following impacts on health services:

- increased mortality;
- increased demand for services because of severe injuries requiring complex treatment;
- severe but localized damage to hospitals: destabilized structure, deterioration of the foundation, destruction of parts of the building, massive volumes of mud or debris inside the building with damage to nonstructural elements, among others;
- disruption of access roads and the provision of basic services.

### A.4 Tsunamis

Tsunamis are giant waves caused by undersea earthquakes, submarine landslides or volcanic eruptions on the ocean floor. They can travel thousands of miles, and cause widespread destruction along coastlines, bays, and harbors.



The energy of a tsunami depends directly on the magnitude of the triggering event, the wave height and speed. The damage it causes depends on the topography of the area, including the configuration of the coastline or bays, and the degree of preparedness of the population.

To identify the level of tsunami hazards, review hazard maps and gather information on similar events in the area.

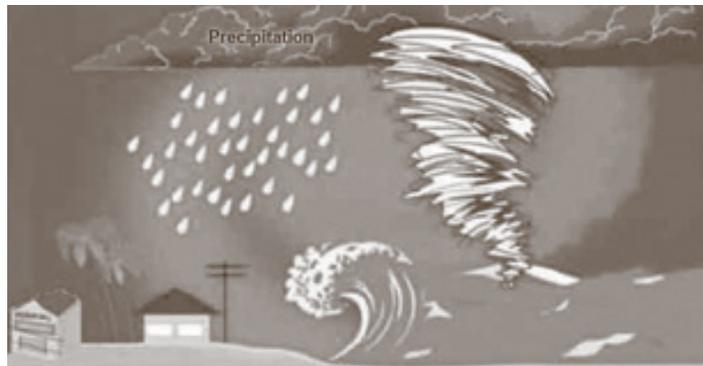
**Effects on health services**

Depending on the time the event occurs, the type of buildings, and population density, a tsunami can cause:

- high mortality;
- mass casualties, whether serious injury or minor bruises;
- serious damage to hospitals, from total loss destruction to compromised stability because of deterioration of the foundations, flooding inside the building with damage to nonstructural elements, loss of supplies, etc.;
- disruption of access roads and the provision of basic services.

**B. What weather-related phenomena can affect the health facility?****B.1 Hurricane**

Hurricanes (or tropical cyclones) are violent storms that arise over the warm waters of tropical oceans around a low-pressure center. Winds blow counter-clockwise in the northern hemisphere, forming spiral rain bands, which bring intense rainfall.



Factors affecting the impact of hurricanes are wind speed, rainfall, and the vulnerability of communities.

Based on the wind map and the history of these events, check the level of hazard to the hospital with regard to hurricanes.

**Effects on health services**

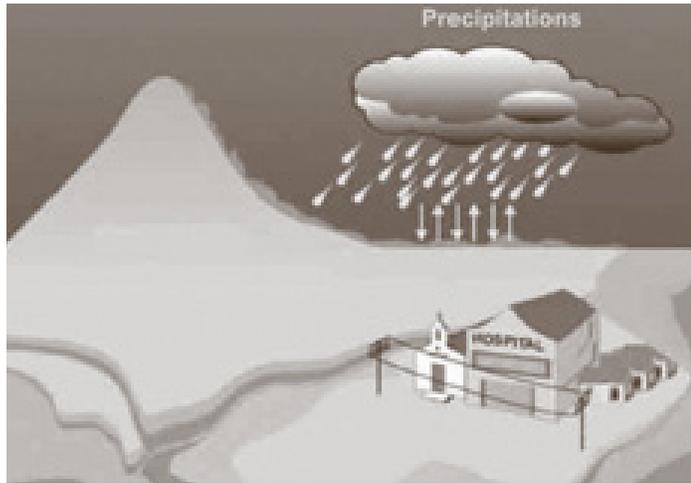
Hurricanes can have the following effects:

- Increased mortality;
- Increased demand for services for serious injury and trauma that require complex treatments;
- Serious damage to hospitals including: destruction of roofing, deterioration of the foundation of buildings, damage to exposed equipment, falling utility poles and lines, water damage inside building, loss of supplies, among others;
- Disruption of access roads and the provision of basic services.

## B.2 Torrential rains

Intense rainstorms may be accompanied by thunder and lightning. Flat or basin-shaped areas, such as valleys or low areas, are rapidly flooded and the water may remain trapped. In mountainous or steeply sloped areas, high-volume flash floods and landslides may occur.

Review the history of prior events and available hazard maps to evaluate the exposure of the hospital to flooding due to intense rainfall.



The impact of torrential rains is directly dependent on soil type, topography, rainfall, and watershed characteristics.

### Effects on health services

Flooding caused by intense rainfall can have the following effects:

- Increased mortality;
- Possible increase in number of persons with serious injuries and traumas requiring complex treatment;
- Severe but localized damage in hospitals, including: possible total destruction of the building if located on a slope; water damage to nonstructural elements; possible damage to foundations, among others;
- Disruption of access roads and the provision of basic services.

## B.3 River flooding or storm surge

The encroachment of the ocean, rivers, or lakes on land is generally caused by heavy sea swells or river and lake flooding. Flooding is part of a normal pattern for rivers, and increased rainfall results in waters flooding land along the river channel.

To evaluate the hospital's vulnerability to sea encroachment or river flooding, the history



The encroachment of the ocean or rivers has different effects relating primarily to the type of soils, topography of the area, and location of communities.

of similar events that did or did not cause flooding in the area surrounding the hospital should be reviewed.

#### Effects on health services

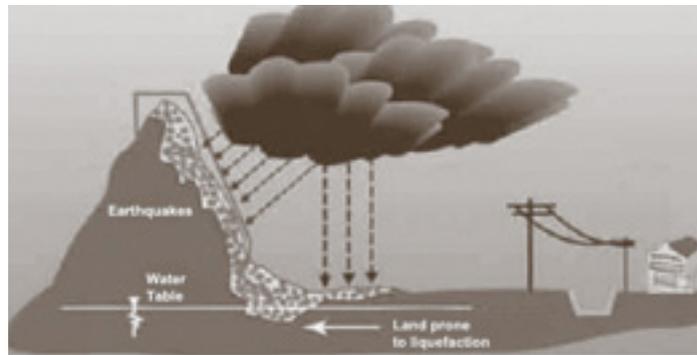
Flooding can have following impacts:

- Increased mortality;
- Possible increase in injuries and trauma patients requiring complex treatment;
- Serious damage to hospitals is possible depending on their proximity to rivers or the coast-line and location on floodplains. Equipment and lifelines can be affected, and building foundations weakened where soil settlement occurs;
- Disruption of access roads and the provision of basic services.

### B.4 Landslides and soil saturation

Certain landslides are manifested as the fast or slow movement of surface material of a slope, due to the presence of high moisture.

Using geologic maps and inspection of the surroundings, identify the hazard level to which the hospital is exposed in relation to landslides caused by soil saturation.



There are many factors that affect the impact of landslides caused by soil saturation, among them are rainfall, topography, erosion, soil type (drainage and filtration), and human factors.

#### Effects on health services

Depending on the magnitude of the event, this type of phenomenon can cause:

- limited number of deaths;
- increased demand for services for severe injuries requiring complex treatment;
- serious damage to hospitals is possible due to: deterioration because of massive volumes of mud or debris, possible damage to foundations, interruption of lifelines, among others;
- disruption of access roads and the provision of basic services.

## C. What social phenomena can affect health facilities?

### C.1 Population concentrations

Dense concentrations of people and overcrowding—whether in organized or spontaneous settlements—can lead to lack of security, violence, and social disorder, thereby affecting the routine activities of a community and its services, including the delivery of health services. When a hospital is located in or near an area that is overcrowded, its ability to provide services will be affected.

When evaluating the hospital's exposure to this hazard consider the type of population it serves, its proximity to areas that have large concentrations of people, and how prior events have affected the hospital.

#### Effects on health services

High population concentrations will affect the demand for services and disaster response, in particular:

- Congested transit services make access to a hospital difficult;
- People may damage or cause disorder to hospitals or services;
- Where the network of health services is inadequate, there is increased demand in densely populated and overcrowded areas;
- A hospital's functional capacity may collapse in an event with mass casualties.

### C.2 Displaced persons

Displaced persons have been forced to leave their homes or permanent residence to escape war, civil conflict, persecution, or because of adverse events caused either by natural forces or by human activity. Internally displaced persons have not crossed international borders but have moved to neighboring communities or isolated areas.

After reviewing relevant information, record the hospital's hazard level related to people displaced by war, social and political movements, immigration and emigration, and the impact of natural or human-caused disasters.

#### Effects on health services

- Possible increase in illnesses related to overcrowding and undernutrition;
- Increased demand for health services, which has a greater impact on the functional aspects of the hospitals.

### **C.3 Other social phenomena (specify)**

If other social phenomena (such as workers' strikes, protests, proximity to a high security prison, etc.) affect the level of safety of the hospital, specify the hazard and indicate the potential impact.

## **D. What environmental health phenomena can affect the health facility?**

### **D.1 Epidemics**

Epidemics involve the outbreak and widespread incidence of disease. They occur when the number of cases of a disease in a given population over a given period of time significantly exceeds the expected number.

Based on information about prior epidemics and specific pathogens that the hospital has dealt with, evaluate the degree to which epidemics would pose a hazard to the hospital.

#### **Effects on health services**

- The epidemic leads to increased rates of morbidity and mortality, with a possible collapse of the health system because of the increased demand for patient care.

### **D.2 Pollution**

Pollution refers to the presence of any agent (physical, chemical, or biological) in places, forms and concentrations that can be harmful to health, safety or welfare of the population.

#### **Effects on health services**

Depending on the type of pollution, effects that can result are:

- increased morbidity and possible mortality;
- water pollution, which without proper management, can lead to chronic illness in the population;
- the presence in the air of sulfur dioxide and nitrogen dioxide which can lead to a variety of health problems, ranging from irritated eyes, nose and throat to respiratory infections like bronchitis and pneumonia. Long-term effects include chronic respiratory infections, lung cancer, heart problems, and even damage to the brain and nervous system; it may also affect the operation of hospitals by contaminating their systems.

In assessing pollution hazards, one should consider external factors (for example, air pollution or contaminated water sources) that can compromise lifelines and other systems that are essential to the functioning of the hospital.

Based on past incidents involving pollution, rate the level of hazard to which the hospital is exposed.

### **D.3 Pests**

Review the location and background of the hospital to determine the level of hazard presented by infestations of animals and insects, including flies, fleas, rodents, mosquitoes, cockroaches, etc.

### **D.4 Other (specify)**

Review the history of other environmental health issues in the area where the hospital is located, and indicate the level of environmental health hazards not already mentioned.

## **E. What chemical and technological phenomena can affect the hospital?**

### **E.1 Explosions**

Explosions are the violent release of energy, most commonly resulting from a chemical reaction that causes the sudden escape of gas under high pressure into the environment. Energy generated by the chemical discharge may be extremely fast, generating a shock wave.

To evaluate the level of threat to which the hospital is exposed, inspect the area surrounding the hospital, inspect potential explosion hazards inside the hospital, and seek out information on any prior events.

#### **Effects on health services**

Depending on the type of event and the exposure of individuals or health services, explosions cause:

- a limited number of deaths;
- increased demand for health services because of severe injury or trauma requiring complex treatments, as well as harm to the eyes, skin, and respiratory function;
- severe damage to hospitals, including damage to the structure and to nonstructural elements (broken windows, damaged doors, etc.) and to the hospital's ability to function.

## E.2 Fires

Fire hazards are uncontrolled fires that cause damage to property and endanger lives.

To evaluate the level of fire hazard to which the hospital is exposed, inspect the area surrounding the hospital, inspect potential fire hazards inside the hospital, and seek out information on any prior events.

### Effects on health services

Depending on the type of event and exposure of individuals or health services, fire can cause:

- a limited number of deaths;
- burns and injuries that require complex treatments;
- effects to the eyes, skin and respiratory tract;
- severe effect on health services if there is a major influx of victims.

## E.3 Hazardous materials

Hazardous materials are items or agents (biological, chemical, or physical) which have the potential to cause harm to humans and the environment. These materials can be corrosive, reactive, explosive, toxic, inflammable, or biologically infectious either by themselves or through interaction with other factors. Improper handling of these materials can result in accidents, including contamination, fires, explosions, leaks, and spills.

### Effects on health services

Depending on the type and level of contamination, leaks and spills of hazardous products can cause:

- the number of possible victims to vary according to the density of the population exposed to the toxic cloud that may result from the leak or spill of hazardous materials. This number is also contingent on the effectiveness of emergency measures taken, including evacuation of persons at risk;
- increased demand for treatment will result from injuries to eyes and skin (ranging from minor irritation to severe tissue damage), the respiratory tract (ranging from acute or chronic damage), and the digestive tract (resulting from ingestion of contaminated foods);
- possible carcinogenic effects for the liver, kidneys, lungs, bloodstream, etc.;
- severe impact on structural, nonstructural, and functional components of the hospital, whether because the structure is compromised or because of a massive influx of victims needing specialized detoxification treatment.

To evaluate the hazard level of the hospital to accidents involving hazardous materials, it is necessary to inspect the area surrounding the hospital, determine whether prior accidents involving hazardous materials have occurred, and consult different sources of information. Take into account sites where chemicals and other potentially hazardous materials are stored (both on the grounds of the hospital and in the surrounding area), and take note of roads or other hazardous material transport routes in the vicinity of the hospital.

#### **E.4 Other (specify)**

Specify the level of other chemical or technological hazards in the area where the hospital is located.

### **1.2 Geotechnical properties of soil**

This section addresses general aspects of soil mechanics and geotechnical properties of soil as they relate to structural problems in hospitals.

## **F. What geotechnical problems can pose a hazard for the hospital?**

### **F.1 Liquefaction**

With liquefaction, the soil loses its capacity to bear loads and behaves like a liquid. This happens when unconsolidated soils (non-cohesive or readily disaggregated) are saturated with water and separate, usually because of an earthquake. The sediment moves downward and saturating water moves toward the surface, like a spring. The result is that the soils have greater fluidity and buildings will suffer from cracks and settling.

With information on the geotechnical analysis of the soil where the hospital is located, determine the hazard level of the hospital to loose subsoils.

#### **Effects on health services**

- A hospital built on unconsolidated soils can suffer serious structural damage. The damage is evident from settling, leaning, or through large cracks that can cause building failure. In extreme cases, buildings can tip over.

## F.2 Clay soils

In clay soils that are deposited through wind and water action (also known as sedimentary soils), the space between mineral particles is large. A slight increase in moisture can destroy the bond or cohesion between particles, resulting in ground subsidence or settling. Expansive soils that are clayey, dry, or compact, swell when they become wet. This causes a significant increase in soil volume, which can force slabs or walls that are not bearing heavy loads upwards.



Based on soil analysis and evidence from the buildings, indicate the hazard level of the hospital exposed to clay soil.

Buildings can be damaged by cracks in floors and walls when clay soil is saturated and expands.

### Effects on health services

- A hospital built on sensitive or soft soil can develop severe cracks in walls and floors, which endanger the structure.

## F.3 Unstable slopes

The stability of a slope depends on geological and material characteristics of the terrain, the angle of the slope, hydrological and climatic conditions, and the intensity of seismic conditions in the area. Slopes can be made unstable by filling or excavation, including from civil works and mining. Unstable slopes are considered a potential hazard since they are related to the movement of soil or rock mass.



Using information from geological maps and prior events in the area, specify the level of hazard that unstable slopes pose for the hospital.

A hospital built on or near an unstable slope is in danger of being damaged or destroyed.

### Effects on health services

Depending on the magnitude of an event, the failure of a slope can have the following impact on hospitals:

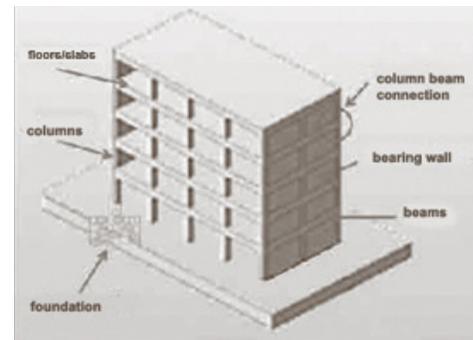
- Severe but localized damage to structures, including structure instability due to damage or deterioration of foundations; destruction of part of the structure; mud or debris inside the building which would damage nonstructural items, among others;
- Likely interruption of access roads and the provision of basic services.

# Structural Aspects | 2

The structural components of a building are those parts that keep the building standing. They include foundations, columns, load-bearing walls, beams, slabs (floors and roofs) and roof frames. Loads are transferred to the ground through the beams, columns, and foundations. The failure of one of these elements can cause serious problems, including total destruction of the building.

The behavior of buildings when exposed to different hazards varies depending on their structural design as well as the type and strength of the construction materials. While it is true that many hospitals are built with reinforced concrete,<sup>7</sup> this document also describes different construction techniques<sup>8</sup> most commonly used in Latin America and the Caribbean, such as masonry, steel, wood, earth,<sup>9</sup> or a combination of materials.

Floor structures or slabs differ according to the type of material and type of structure: they can be concrete (such as solid or lightweight slabs), steel, or wood. A variety of construction systems can be good. It all depends on whether they were designed for different demands, competently constructed, and adequately maintained. If this is not the case, they can be damaged by an adverse event.



Many structural deficiencies cannot be seen with the naked eye. It is therefore important for a specialist to participate directly in the evaluation in order to identify the type and level of vulnerability or damage possible and the respective measures of protection. The structural vulnerability assessment of a hospital and background on the design, construction, and current condition of the structure are essential for rapidly and assertively identifying damage that could occur as a result of an adverse event and to intervene before such damage occurs.

It is preferable that structural elements are assessed by structural engineers, but because it may be difficult to find individuals with these qualifications in all areas of the region, the information in this chapter is simplified so that health personnel can identify warning signs indicating that a detailed structural study should be made.

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7. The term “reinforced concrete” refers to concrete that uses steel rods to resist tensile stresses.

8. For clarification of technical terms used, see the glossary.

9. Earthen constructions can be made of adobe, rammed earth, taquezal, daub, or thatch.

The material in this chapter follows what is presented in the Hospital Safety Index, but it includes information on assessing reinforced concrete buildings as well as buildings constructed of materials that are most frequently used in medium and small hospitals.

Here, two structural sub-modules are addressed: the structural safety level taking into account the hospital's history, and the degree of safety taking into account the structural design and type of materials used in the building. The level of safety is ranked as: Low, Average, or High. For each item considered, members of the evaluation team should mark the safety level in the corresponding cell in the forms included in Annex 2 of this manual.

## 2.1. Degree of safety in relation to the history of the hospital

### 1. Prior major structural damage or failure of the hospital building(s)

**Recommended evaluation methods: interview, review of documentation and inspection.**

Evaluators should determine whether structural reports indicate that the level of safety has been compromised in the past by natural, technical or societal hazards or by other factors. The evaluation should be based on events equivalent in severity to those that current standards of structural safety are intended to protect against. These events may have caused settling, cracks in supporting walls, separation between structural elements, cracks in columns, beams and slabs, etc. This damage might not be visible because of repairs or remodeling that has taken place subsequent to any damage.



Structural damage sustained in a disaster can be hidden by subsequent repairs.

To obtain accounts of historical damage to a facility, it is important to interview personnel who have worked in the hospital for the longest time, irrespective of their position within the organization (i.e. include cleaning personnel, kitchen staff, and administration and support staff), as these can relate their experience of incidents or disasters in the past. Evaluators should ask specifically about structural damage that personnel may have observed. Evaluators should also request to see publication/accounts (e.g. formal/ press/Internet reports or photographs). Certain reports might be accessible on the Internet or through public records (e.g. library). Evaluators should determine whether the structural safety has been compromised using the evidence collected from staff, reports, photographs or visual inspection. This criterion is checked against the design level event. It is important to note

whether the facility has sustained damage due to events below the design level. If it has, then the safety level should be rated as Low.

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IF SUCH AN EVENT HAS NOT OCCURRED IN THE VICINITY OF THE HOSPITAL, LEAVE BOXES BLANK AND PROVIDE COMMENT.

IF DAMAGE HAS OCCURRED DUE TO A LESSER EVENT THAN THE DESIGN LEVEL THEN RATE AS LOW SAFETY.

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**Safety ratings for item No. 1:** *Low = Major damage and no repairs; Average = Moderate damage and building only partially repaired; High = Minor or no damage, or building fully repaired.*

## 2. Hospital built and/or repaired using the current safety standards

**Recommended evaluation methods: interview, review of documentation and inspection.**

Evaluators should make an assessment of prior construction work in the facility and the standards that were applied. The assessment should use the current safety standard (which may differ from the old standard). Evaluators should search for evidence from contracts, or information gathered from interviewing, among others, procurement and maintenance staff and, if possible, construction personnel (e.g. design engineer, architect and/or contractor).

Evaluators should verify whether the building has been repaired, the date of repairs, and whether repairs were carried out using the appropriate standards for safe buildings at the time of the repairs. Evaluators should check whether the standard used for the repairs differs from the current safety standard which is the reference for assessing this item.

Often, new construction or repairs are made without taking into account the effects to confront a particular threat or danger in the future, putting the hospital and its occupants unsafe due to the new vulnerabilities generated.

For example, this situation occurs:

- When repairs are made without following regulations that ensure the proper structural performance of the element or structural elements that have been repaired.
- When a new building is constructed next to an existing one, without respecting a safe distance. An earthquake can cause a collision zone between the buildings.

**Safety ratings for item No. 2:** *Low = Current safety standards not applied; Average = Current safety standards partially applied; High = Current safety standards fully applied.*

### 3. Effect of remodelling or modification on the structural behaviour of the hospital

**Recommended evaluation methods: interview, observation and inspection.**

Evaluators should verify whether modifications were carried out using current standards for safe buildings. Remodelling and modifications can be made using structural control – i.e. structural evaluation and proper rehabilitation or modification design that ensure good performance of the structure. It is unfair to rate as low a modified structure that meets the requirement of using an adequate structural design. Frequently, hospitals undergo modifications needed by different departments and services but without overall consideration of what effects they may have on the structure's resistance to hazards or future events, thus increasing the vulnerability of the facility and its occupants.



The emergency stairwell of a hospital (A), was “anchored” to the main building structure (B). In an earthquake this created a torsional response.

Some examples of this are:

- Eliminating a load-bearing wall in order to expand a space, or hanging a door or window in a load-bearing wall can compromise structural stability.
- windows are placed at a high level between two columns, or an open space between two columns is filled in with a masonry wall (for example to provide windows in rooms) failure of columns can result (the “short column” effect).

**Safety ratings for item No. 3:** *Low = Major remodelling or modifications have been carried out with major compromising effect on the performance of the structure (e.g., removing a load-bearing wall, opening for a new window, etc.); Average = Moderate remodelling and/or modifications with minor effect on the performance of the structure (e.g., openings for doors and small windows); High = Minor remodelling and/or modifications; no modifications were carried out; or major remodelling and/or modification enhancing the structural behaviour or having no negative effect.*

## 2.2. Building integrity

Submodule 2.2 consists of 9 items ( 4 – 12).

Since the structural system is usually hidden by dividing walls, cladding, or other nonstructural elements, when possible it is important to inspect the stairs, kitchen, laundry, and other areas where structural elements are more exposed.

## 4. Condition of the building

### Recommended evaluation methods: observation and inspection.

Evaluators should inspect the building, both internally and externally, for signs of deterioration such as broken plaster, cracks or sinking structural elements, and should determine the causes. Evaluators should assess the location of the cracks and their angle to determine the condition of the building. When assessing any damaged structural elements, evaluators should determine their function in maintaining overall structural stability and strength. For example, the risk posed by a damaged column on the ground floor is not the same as the risk posed by a similarly damaged column on the top floor. (The condition of the building is closely related to type of construction materials used for structural elements.) A crack may occur for a variety of reasons; some indicate a serious problem (design, overload) and others do not (change in volume, temperature, or weathering). If the building has been painted recently, check that cracks are not hidden. It is important to talk to the hospital's maintenance staff when conducting this investigation.

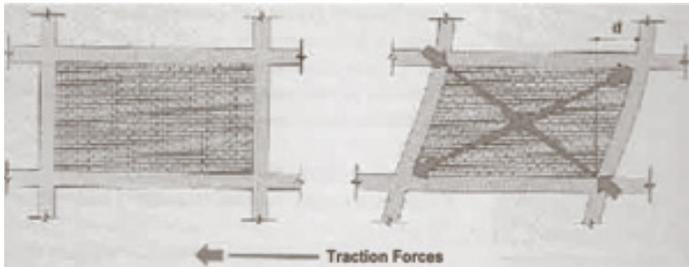
Look out for signs of the following damage:

In reinforced concrete buildings the presence of cracks in columns, beams and beam-column connections need special attention. It is important to assess where cracks are located, their width and angle, any loss of covering concrete, and exposure of steel to determine the level of maintenance or safety of the building.

In masonry construction, depending on the reinforcement system, a building's exposure to the weather or the quality of the construction may cause cracks in the walls. Cracks can move diagonally, following the mortar bed joints; others are nearly straight, breaking pieces of masonry. There are also horizontal



Cracks in concrete columns.



Typical failures in masonry walls. From Julio Kuroiwa, *Disaster reduction, living in harmony with nature*, Lima: Editorial NSG, 2004.

and vertical cracks that appear at the junctions of the wall with beams and columns respectively. Special attention should be given to the load-bearing walls (which transmit the gravity loads to the foundation), as well as to confined beams and columns (where they exist) and the floor and roof structures or slabs.

In buildings with steel structures special attention should be given to the connections of structural elements, whether they are welded, riveted or bolted. Any failures in these connections should be noted, as well as cracks in the columns and beams around corresponding connections.



Metal structure that failed as the result of an earthquake.

When inspecting wooden structures, special attention must be given to the presence of cracks in the columns and beams, as well as displacement in the connections of the structural elements.

Among all the building systems, earthen constructions are the most vulnerable to seismic forces. One should check for the presence of cracking in the walls, either horizontal (at the base of the wall or in the middle), vertical (in the center of the wall), or diagonal (which may extend to the corners of the wall). Deformation or noticeable leaning must also be noted. Cracks indicate the need for structural reinforcement throughout the building.



Typical failures in adobe construction.

**Safety ratings for item No. 4:** *Low* = Cracks on the ground and first floors; Major deterioration caused by weathering or normal ageing; *Average* = Some deterioration caused only by weathering or normal ageing; *High* = No deterioration or cracks observed.

## 5. Condition of construction materials

### Recommended evaluation methods: observation and inspection.

This item is closely related to item 4. When a structure is built primarily with reinforced concrete, the presence of cracks and rust can indicate that incorrect amounts of concrete components (cement, rock, sand and water) were used. This could also be evidence of water seepage into the concrete slab. As a result, permeability may be high and the resistance of materials low, which increases the vulnerability of these elements and puts the structure at risk. With regard to rusting iron and cracks in concrete, one or both of these conditions may be present. For example, concrete forms may show signs of rust, but cracks may or may not have evidence of oxidation.



Steel exposed by loss of covering.

In concrete masonry structures, it is necessary to consider the quality, type, and nature of the blocks, as well as the thickness, continuity, and uniformity of the joints. Another important aspect is the presence of pipes and other materials that pass through load-bearing walls.



Crack in a load-bearing wall breaks the masonry brick.

Special care is required for those walls which are subject to moisture and humidity. If the material used in these circumstances is of low quality, it is possible that there may be weaknesses in these walls. The stability of the building is at risk if this problem is evident in the load-bearing walls.

Steel structures can behave positively in earthquakes, but they can be vulnerable to hurricane strength winds and prolonged exposure to fire. Oxidation weakens steel, and failure of these structures is seen when foundation and connections of supporting elements rust.<sup>10</sup> However, it must be noted that any material (with appropriate design, analysis, detailing, construction and maintenance) can be used to make safe buildings.

Earth constructions are highly vulnerable to earthquakes, floods, and landslides. They do not have seismic resistant properties, and the construction materials deteriorate over time. Prolonged exposure to water can cause an earthen structure to collapse.

10. Pan American Health Organization, *Is your hospital safe? Questions and answers for health personnel*, Quito: PAHO, 2007.

Buildings with wooden structures are generally resistant to seismic forces, but they are very vulnerable to fires, floods, landslides, and high winds. Contact with moisture directly affects wood, can cause deterioration, and create an environment for bacteria. It is important to emphasize the need to treat wood adequately to prevent deterioration and prolong its useful life.

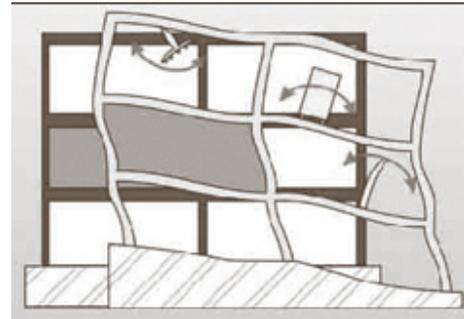
Evaluators should indicate whether the elements in poor condition are of structural value to the hospital building. Buildings may have indicators in place to measure movement which the evaluators can use. Evaluators may need to have a ruler to measure the size of any cracks.

**Safety ratings for item No.5:** *Low = Rust with flaking; cracks larger than 3 mm (concrete), excessive deformations (steel and wood); Average = Cracks between 1 and 3 mm present (concrete), moderate and visible deformations (steel and wood) or rust with no flaking; High = Cracks less than 1 mm (concrete), no visible deformations; no rust. This section depends on the experienced judgment of a structural engineer.*

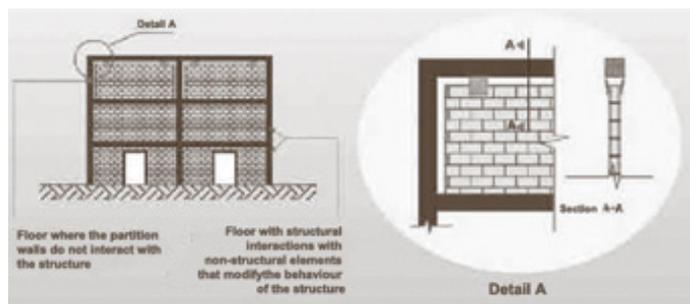
## 6. Interaction of nonstructural elements with the structure

**Recommended evaluation method: observation.**

In extreme conditions, nonstructural elements – because of their weight and rigidity – can affect the behaviour of structural elements, putting the stability of a structure at risk. Evaluators must determine whether nonstructural elements are completely tied to the structure – i.e. if “short columns” are present, if joints are flexible and if expansion joints have been used. An example of non-structural/structural interaction would be, for instance, if a nonstructural dividing wall falls during an earthquake because of a bad anchor and the wall falls onto



Representation of the behavior of non-structural elements during an earthquake.



Partition walls can affect the behavior of the structure.

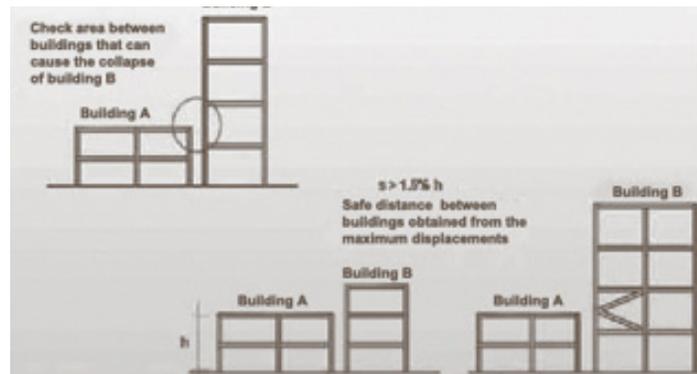
a staircase beam, obstructing the staircase and, in the worst case, destroying it. It is important to speak to hospital’s maintenance staff during this investigation and to look at records, plans and drawings.

**Safety ratings for item No. 6:** *Low = Partition walls rigidly attached to the structure, suspended ceilings or facades interacting with the structures, damage would have significant effect on the structure; Average = Some of the preceding nonstructural elements interacting with the structures, damage would not affect the structure; High = There are no nonstructural elements affecting the structure.*

## 7. Buildings proximity

**Recommended evaluation methods: observation and inspection.**

In the case of an earthquake, buildings that are too closely spaced, depending on their height and proximity, can pound against each other until damage is sustained. Evaluators should inspect the exterior of the hospital to determine whether such problems might arise. Most earthquake building codes consider a minimum separation of 10 cm when the shorter of two adjacent buildings is 10m high, which is 1.0% of the height of the building. Evaluators should check whether the floor plates are aligned. In buildings where floors are not aligned, pounding of floor slabs against adjacent columns or structural walls can cause serious damage that in severe cases can lead to collapse. Evaluators should also include the assessment of separation joints in buildings with multiple wings or distinct sections that are intended to perform as separate structures.



Types of impact between buildings and ways of preventing or avoiding it.

In buildings where floors are not aligned, pounding of floor slabs against adjacent columns or structural walls can cause serious damage that in severe cases can lead to collapse. Evaluators should also include the assessment of separation joints in buildings with multiple wings or distinct sections that are intended to perform as separate structures.

In the case of high wind events and fires, there can be wind tunnel effects between closely-spaced buildings. Pressure from the wind can build around certain sections of a structure, placing much greater force than the load for which a multistorey building was designed. The separation of buildings can also reduce the spread of fires from one building to another. It is important to talk to hospital staff as there may be a noticeable impact when high winds occur periodically.

Evaluators should inspect the exterior of the hospital to determine whether such problems might arise, and analyze the space between the health facility and neighboring buildings.

If there is only seismic hazard, consider the following options:

**Safety ratings for item No. 7:** *Low = There is almost no separation between buildings or separation is less than 25 mm (1 inch); Average = Separation is between 25 to 100 mm (1 to 4 inches); High = Separation is more than 100 mm (4 inches). Note: For adjacent buildings over 2-storeys, the safe separation should be determined by calculation by the Engineer.*

For fire threat, consider the following:

*Low = separation between buildings is smaller than 5 m.; Average= separation is between 5 to 15 m.; High= separation is bigger than 15 m.*

If both hazards, consider the worse case.

## 8. Structural redundancy

**Recommended evaluation methods: observation and inspection.**

Redundancy is a normal part of structural systems and is essential for the safety of buildings, especially in high winds and earthquakes. The evaluation aims to ensure that the hospital building can resist the lateral forces caused by hazards, such as high winds and earthquakes, in the two main orthogonal directions of the building.

Evaluators should review structural plans (i.e. engineering drawings) of the hospital building and should verify at the site whether the structure meets the design criteria in the two principal orthogonal directions. A building with fewer than three lines or axes of resistance in any of the major directions is vulnerable to major demands of resistance and rigidity. In other structural systems it will be necessary to evaluate structural safety of other designs such as flat slab with flat beams and to note the safety level. In earthquake prone areas, flat slab structural systems should not be permitted. Consequently such systems should attract a “low” rating in these circumstances.

Several problems relating to structural redundancy in the design of health facilities should be emphasized:

- The use of too few columns in large, open areas (few columns and large spans) becomes extremely critical. This is often found in reception areas, treatment and diagnosis areas, cafeterias, etc.
- Location of openings (doors, windows, etc.) in inside and outside shear walls causing large forces to concentrate in certain weak elements.

- A sudden interruption in the uniformity of the structural system along the length and breadth of large areas.

When examining lines of resistance, it is important to consider portal frames, load-bearing walls, and column-beam connections, among other elements.

**Safety ratings for item No. 8:** *Fewer than three lines of resistance in each direction; Average = Three lines of resistance in each direction or lines without orthogonal orientation; High = More than three lines of resistance in each orthogonal direction of the building.*

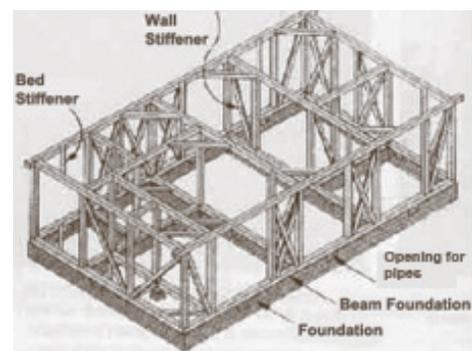
## 9. Structural detailing, including connections

**Recommended evaluation methods: observation and inspection.**

Joints for structural components are among the most critical design elements for lateral loads. These joints are used in the structure of all buildings, and are especially important for hospitals in earthquake-prone areas. Notwithstanding the construction year of the building, evaluators should determine the characteristics of joints both through on-site observation and by reviewing structural plans (i.e. engineering drawings), and should apply clear-cut criteria to them; if the building is located in a moderate or high seismic zone, more emphasis should be given to detailing evaluation work.

When dealing with prefabricated construction, evaluators must do a detailed examination of the joints; they will be numerous, not monolithic, and in most cases will be welded or wet joints. Joints should be assessed for cracks or fractures, which would put the joints, and ultimately the structure, at risk. Prefabricated buildings that are prone to damage in earthquake shaking should be given a “low” safety rating in earthquake prone areas.

In reinforced concrete buildings, structural elements are of structural concrete or concrete with steel reinforcement. In this type of structure it is important to look for cracks in beam-column connections, as well as broken or missing cover concrete in these areas.



Wooden structure of a building.



Severe damage in beam/column connection.

In masonry building, walls are built of concrete block or clay bricks joined by mortar. In confined masonry construction, unreinforced masonry walls are confined with reinforced concrete tie-columns and tie-beams. In this type of structure, vulnerability of the joints will depend on the connection between confining elements (i.e., beams and columns). Alternatively, there is reinforced concrete-block masonry construction. In this form steel reinforcement is placed horizontally and vertically throughout the masonry walls without the need for confining columns and beams.

In steel or wood frame structures, the evaluator must carefully examine the connections, since there will be more of them, they will include a variety of components, and generally will have welds, rivets, bolts, etc. They should all be inspected to verify that there are no cracks, fissures, or missing connections. In hurricane-prone regions, roofs on steel and wood frame structures are particularly vulnerable to high winds, so techniques used to attach the roof to the structure of the building must be assessed.

In adobe and earthen constructions the intersection of walls are generally weak, the connections between the floor and load-bearing walls are often inadequate, elements are very heavy, and walls lack reinforcement. These problems can be aggravated by poor quality material, large and poorly distributed openings for doors and windows, and unsatisfactory foundations. Health facilities built of adobe or other earth materials should, where possible, be replaced entirely or reinforced to protect the lives of users.

**Safety ratings for item No. 9:** *Low = No evidence of engineered building records, or built according to an old design standard; Average = Built according to previous design standards and no retrofitting work to a current standard; High = Built according to a current standard.*

## 10. Safety of foundations

**Recommended evaluation methods: observation and inspection.**

Foundations are the most difficult structural elements to evaluate because they are neither accessible nor visible. To add to this difficulty, corresponding plans for foundations are often not available. If the facility is old the plans may not be archived in the administration, maintenance department or public record. In some cases the plans may be with a construction company that has done studies for the purpose of expansion, remodelling or repairs.

It is important to make every effort to access the plans to determine the type of foundations (e.g. shallow, deep, isolated and, if a combination, whether they are united or isolated).

Buildings are more vulnerable to seismic forces when they do not have braced beams connected to the foundation.

When evaluating this item it is important to take into account the information about soils at the site from the submodule on “Geological hazards” in Module 1 in order to determine soil–structure interactions.

Some important aspects that the evaluator can consider, are as follows:

- The level of groundwater and type of soil at the building site play a critical role in determining the facility’s vulnerability to floods and differential settlement of the foundations, and the associated effects on vertical structural elements.
- In earthquake-prone areas, liquefaction can occur if the building is on saturated, unconsolidated soils, as in the case of sand beds, saturated silt or un-compacted fill. Liquefaction has caused severe damage to infrastructure, and evaluators should carefully substantiate whether such conditions are present at the hospital site.
- Evidence of subsidence in relation to the soil surface. Presence of cracks in the floors.
- Differential settlement of material and gradual downward movement of foundations due to consolidation of soil. This leads to damage if settlement is uneven and is evident where there is vertical deformation (leaning of the building) or cracks where floor levels change.
- Loss of foundation support.
- In earthen constructions it is common to see shallow, inadequate foundations on uncompacted soils. To protect walls from soil moisture and rains, it is preferable to build them on raised foundations and waterproof them. This observation also applies to wood and steel frame buildings; their foundations should be raised and waterproofed to avoid rust or deterioration of the wood by moisture.

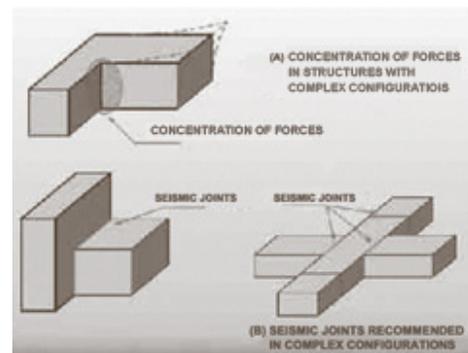
**Safety ratings for item No. 10:** *Low = No evidence that foundations were designed according to standards (foundation size, soil survey) and/or there is evidence of damage; no plans are available; Average = Little evidence (drawings, soil survey) that foundations were designed according to standards; and/or there is evidence for moderate damage; High = Strong evidence that foundations were designed according to standards with strong evidence of no damage.*

## 11. Irregularities in building structure plan (rigidity, mass, resistance)

### Recommended evaluation methods: observation and inspection.

Irregular structures can be expressed in terms of shape, configuration and torsional eccentricity (i.e. the distance between the centre of mass and the centre of rigidity). While evaluators inspect the exterior and interior of the hospital, they should look for inconsistencies in the hospital plan from the perspective of rigidity (shape and type of materials used for resistant vertical elements) as well as the distribution of mass (concentrated and distributed). Evaluators should try to identify at the site and by using diagrams whether seismic joints divide the structure into regular parts or whether irregular configurations are present, such as L-shaped, T-shaped, U-shaped or cruciform plans, or more complicated configurations.

Another aspect that evaluators should check is the relative position of the frames (framework of beams and columns) and the shear walls since this will determine the response of horizontal diaphragms (slabs) in terms of displacement and rotation. The presence of large openings in horizontal diaphragms due to interior patios or for access to stairs and elevators make the structure more vulnerable to lateral loads caused by earthquakes and intense hurricanes. During extreme phenomena such as earthquakes or high winds, poorly distributed mass can cause excessive loads in some areas of a structure, resulting in its collapse. Evaluators should determine if these conditions exist and whether there are structural elements designed to mitigate them.



Using seismic joints for buildings with complex configurations.

**Safety ratings for item No.11:** *Low = Shapes are irregular and structure is not uniform; Average = Shapes on plan are irregular but structure is uniform; High = Shapes on plan are regular and structure has uniform plan, and there are no elements that would cause significant torsion.*

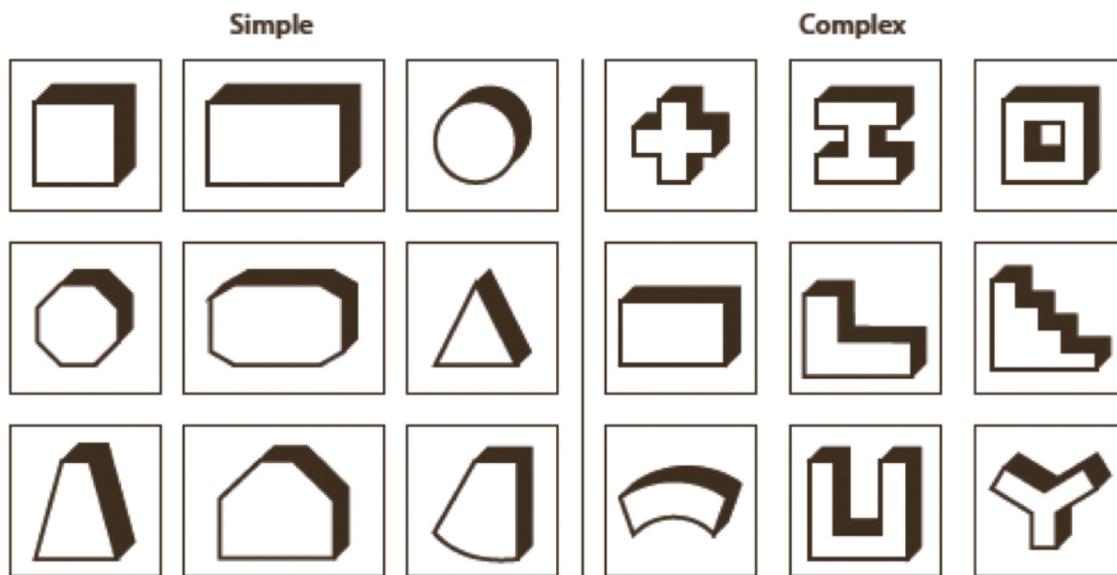


Figure 1 - Simple and complex shapes in plan.

## 12. Irregularities in elevation of buildings

**Recommended evaluation methods: observation and inspection of each building.**

As in items No.11, the irregularity of a building on elevation can be expressed in terms of its shape, configuration, and torsional eccentricity. Evaluators must take note of the following:

- Discontinuity in structural components and abrupt changes in shape.
- The narrowness of the building (height-to-width ratio) in the principal orthogonal directions can give an idea of the building's ability to withstand vibrations generated by lateral loads caused by earthquake and wind forces.
- The differences in height between the floors (often the case in the lobby and lower floors of hospitals) which can cause concentrations of tension in changes of level. A so-called "soft floor", an undesirable feature in earthquake-prone zones, can be present owing to significant changes in rigidity due to variations in height. Evaluators should be aware that an in-fill wall can convert a column designed for support along its entire height into a "short" column. Short columns have caused the collapse of buildings that were supposedly resistant to seismic forces.
- Besides irregularities in the elevation of buildings, variation of the type – as well as mass and rigidity – of materials can alter resistance to loads that affect the build-

ing. Evaluators should determine whether elements (such as columns and walls) are symmetrically distributed in height, to the edges, providing rotational rigidity.

- High concentrations of mass on upper floors of a hospital, owing to the placement of heavy items such as machinery, equipment and water tanks on upper floors. These can increase inertial forces and cause excessive displacement.

**Safety ratings for item No. 12:** *Low* = The presence of soft stories or two or more of the other condition conditions (discontinuity in elevation, concentration of masses, and short columns); *Average* = Presence of any one of these conditions, except soft storeys; *High* = None of these conditions are present.

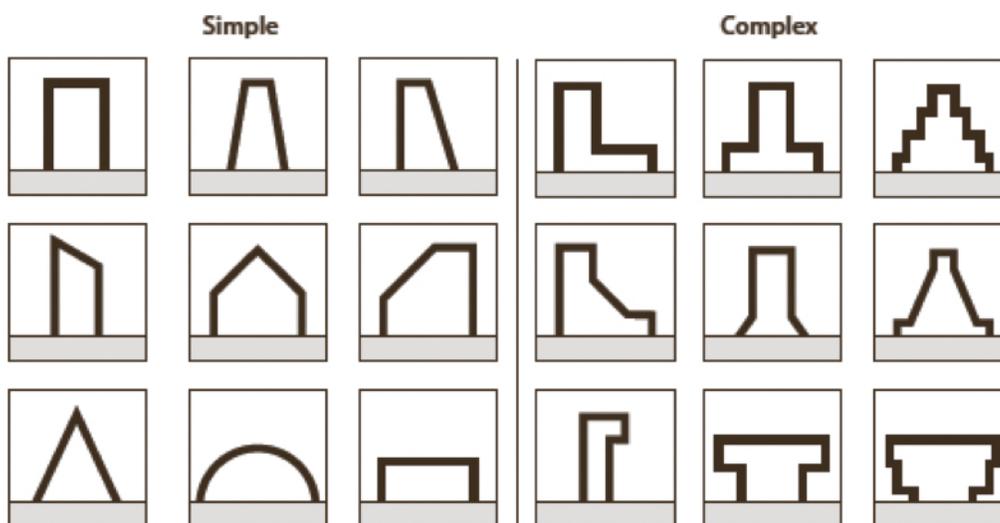


Figure 2 - Simple and complex shapes in elevation.

### 13. Structural integrity of roofs

**Recommended evaluation methods: observation and inspection.**

Evaluators should assess the slope of the roof, roof overhangs and roof deck connections to resist uplift loads. The objective of this item is to ensure that the roof is completely and securely fastened, welded, riveted or cemented. Evaluators should look for large roof overhangs of more than 50 cm in high wind areas. They should also check that reinforced cast is in place so that concrete roof decks have exceptionally good wind performance.

Satisfactory connections include a high frequency of fasteners. For steel roof decks, there should be screw attachment rather than puddle welds or powder-driven pins; for precast

concrete decks, there should be anchor plates and nuts; and for wood-sheathed roof decks, there should be screws and fixations in the corner regions of the roof.

**Safety ratings for item No.13:** *Low = Monopitch or flat light roofs, and/or large roof overhangs; Average = Pre-stressed concrete roof, gable roof with gentle slope, satisfactorily connected, no large roof overhangs; High = Reinforced cast in place on concrete roof deck or hipped light roof, satisfactory connections, no large roof overhangs.*

## 14. Structural resilience to hazards other than earthquakes and strong winds

### Recommended evaluation methods: inspection.

This item focuses on structural safety for multiple hazards other than earthquakes and strong winds. A hospital may have taken action to increase its safety with regard to certain hazards, but not to the full range of hazards that may affect the facility, thus leaving the hospital at high risk. With regard to hazards present in the area where the hospital is located, structural expertise is needed to assess whether the building as a whole has the level of structural safety necessary to enable it to continue providing health services in emergencies and disasters. Evaluators should refer to hazards which may affect the site of the hospital (see Module 1).

Evaluators should assess the global structural performance and the resilience of the building structure for single or multiple hazards other than high winds (sustained or periodic) and earthquakes (e.g. other meteorological hazards, flooding and other hydrological hazards, landslides and other geological hazards). Evaluators should use their knowledge and expertise to assess the danger that these hazards could pose to the structural elements of the hospital.

Evaluators should verify whether the hospital is adequately designed – from the structural stand-point – to withstand other phenomena (e.g. landslides, rockfalls, volcanic eruptions, floods, fires and explosions), and whether preventive or corrective measures necessary to improve the level of safety have been implemented. Evaluators should identify any measures that have been adopted to reduce the risk to structural safety (e.g. anti-flood gates). Evaluators should assess the possible behaviour of the complete building in light of all the other hazards in the area. For example, a hospital may be located on



Structure built with loss mitigation measures against flooding.

an “unstable” incline and have a risk of sliding or, alternatively, a resilience measure such as a wall of containment may have been built to stabilize the incline and protect the building. It should be noted that a building can be adequately designed to resist earthquakes and hurricanes but can still be very vulnerable to floods or volcanic eruptions.

**Safety ratings for item No.14:** *Low = Low structural resilience to hazards present at the site of the hospital; Average = Satisfactory structural resilience (taking account of structural risk reduction measures in place); High = Good structural resilience (taking account of risk reduction measures in place).*

# Nonstructural Aspects | 3

**N**onstructural elements are those that do not form part of the load-bearing system of the health facility. These components may or may not be attached to the load-bearing structure, and include architectural elements (for example, partition walls, facades, windows, doors, ceilings, etc.); systems that are critical to the function of a hospital (such as the electrical system, water and sewerage systems, communications, and heat, ventilation, and air conditioning systems); and the contents of the building (including medical and laboratory equipment and supplies, office equipment, and furniture). In the case of health care facilities, the cost of these nonstructural elements is higher than the cost of the structure. Studies indicate that nonstructural components generally account for more than 60% of the total cost of a hospital.<sup>11</sup>

With certain exceptions, the failure of nonstructural elements does not pose a risk to the stability of a structure. However, failure of these elements can put the lives and well-being of the hospital's occupants at risk. When assessing the safety of nonstructural elements, evaluators look at whether items are properly anchored so that they will not become dislodged or detached. If certain items fall or tip over they can damage strategic structural elements. The ability of critical (lifeline) systems to function in the event of a disaster and the presence of alternative or back-up systems must be assessed.

This chapter examines the following groups of nonstructural elements:

1. **Critical (lifeline) systems**, which include electrical systems, telecommunications, water supply, fuel storage, medical gases, wastewater and storm drains, all of which are essential for a hospital to function. Interruption of these services in the event of an emergency could shut down the facility.
2. **Systems for heating, air conditioning, ventilation, and/or hot water**, including equipment, ductwork, and pipes.
3. **Furniture, storage units, and office equipment**, including support and anchoring methods, and protection of the contents.

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11. Pan American Health Organization, *Is your hospital safe? Questions and answers for health personnel*, Quito: PAHO, 2007.

4. **Medical and laboratory equipment and supplies used for diagnosis and treatment**, taking into account their current condition and degree of safety.
5. **Architectural elements**
  - Components of the building envelope (such as windows, doors, awnings, balconies, among others), which must be protected from the impact of strong winds, water, flying objects, seismic forces, etc.
  - The condition and safety of access routes, and safety of movement both inside and outside of the facility must be considered. Lighting, fire protection, and suspended ceilings, among other elements, are included in this grouping.

It is important to emphasize that failure to carry out preventative and corrective maintenance directly impacts on the vulnerability of the building, which can become critical in an emergency situation, and can even contribute to a disaster.

For example, it is common to find that failures in wastewater and storm water drainage systems affect other elements such as walls and partitions, electrical connections, ceilings, equipment, etc. Faulty electrical wiring is a fire hazard that will put the entire facility at risk, including the lives of occupants. Poorly maintained ventilation systems can give rise to hospital-acquired infections.

It is advisable to evaluate in detail the condition of lifeline systems and equipment, and to ensure that there is a plan for routine maintenance, with a budget exclusively assigned to maintenance.

### **3.1. Lifelines**

#### **3.1.1 Electrical System**

#### **15. Capacity of alternate sources of electricity (e.g. generators)**

It is vital that a hospital have an alternative power source that can handle requirements when service from the local power supply network is interrupted from the regular power supply (local power source, generator, batteries, etc.); this might be a common occurrence even without disaster conditions.

The evaluator should verify that the alternate source is operational (electrical generator, solar, uninterrupted power supply (UPS), batteries, etc.) and check the condition and ensure that there is adequate fuel reserves for the generator for at least 72 hours.

Evaluators should confirm that the hospital's power plant operators have training in emergency preparedness and response. The evaluator should also verify that there are emergency lights, with charged batteries, that are ready to use should the need arise.

Evaluators should check if the generator and auxiliary units are at risk of water damage in flood-prone areas.

Batteries should be stored safely to avoid posing a hazard, as follows:

- Storage areas should be ventilated separately.
- Batteries should be sealed.

**Safety ratings for item No. 15:** *Low = There is no alternative power source that can meet the needs of the hospital or the existing one is not working; Average = There is an alternative power source but does not supply all the critical areas or has fuel reserve to run less than 72 hours; High = There is an alternative power source that meets the needs of the entire facility and it is operational for more than 72 hours.*

## 16. Condition and safety of alternate source(s) of electricity

**Recommended evaluation methods: observation, review of documentation (plans and records), and inspection.**

Evaluators should determine whether or not the generator(s) can be used indoors or outdoors, and based on this, the most appropriate location for them. For outdoor generators, evaluators should inspect the casing and any form of protective covering. Depending on the location, the potential for flood damage, vandalism or theft of generators should be evaluated. The vulnerability of generators to strong winds, seismic forces or proximity to adjacent structures that might fall and cause damage should also be evaluated. Drainage at the generator's location should be evaluated (i.e. how run-off is managed if the equipment is outside and, if placed indoors, whether there are floor drains or openings. Visual inspection can be supplemented by information from maintenance and inspection records.

For hospitals in high-wind or earthquake-prone areas, evaluators should ascertain whether the generator is well-anchored and braced, without the possibility of falling or shifting. This involves inspection of supports for the generator in the ground or flooring and the condition and type of connections (i.e. checking for corrosion or other deterioration). If springs are used to avoid vibration and noise, they must be well-anchored since these devices amplify seismic waves. The connections for fuel lines and electricity cables must be flexible to avoid breakage should the generator shift or fall. The lower that these heavy pieces of equipment are placed in the structure, the less the chance that they will fall over, but they may still slide.

There should be easy and safe access to the equipment. The possibility that doors or other exits could be blocked by cables or fuel lines if the equipment shifts or falls should be considered. Evaluators should check the availability and storage of fuel, confirming that supplementary tanks are always full and are located so that fuel can reach the generator by gravity rather than relying on pumping at the time of an emergency. The evaluator should verify that the tanks containing flammable liquids are located far enough so as not to affect the safety of the hospital and, also, that they are not close to danger points such as power plants, boilers, and stoves, etc. These places should be marked, fenced and protected from winds, floods, landslides and liquefaction. Fire protection systems should be also checked.

Evaluators should inspect the physical condition of the fuel tanks and electrical and hose connections. The type of fuel lines and electrical cables used; these should be flexible so they do not break if the generator shifts or tips over.

Batteries can be highly dangerous, particularly when charging, and are prone to serious risk in an earthquake, wind, flood or fire event. The condition of the batteries and replacement batteries for the starter should also be inspected to ensure that they cannot be damaged. Evaluators should check for protection against electrical discharge caused by atmospheric changes – i.e. grounding arrangements for lightning.

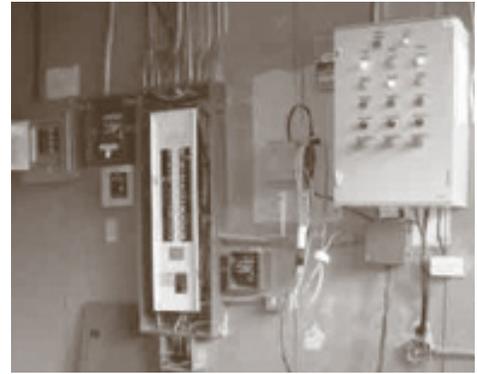
**Safety ratings for item No. 16:** *Low = No alternate sources; generators and fuel reserve are in poor condition, there are no protective measures; Average = Generators are in fair condition, some measures provide partial protection and security to generator and fuel reserve; High = Generators are in good condition, well-secured and in good working order for emergencies, fuel reserves are protected in a safe zone.*

## 17. Condition and safety of electrical equipment, cables and cable ducts

### Recommended evaluation methods: observation and inspection.

Evaluators should check the condition of the electrical networks throughout the hospital. These should be protected from flooding and fire, and in earthquake-prone zones and areas of high winds they should be anchored. They should be channelled through cable racks or conduits that protect them from twisting, breaking or from general deterioration. When cables travel along roofs that empty through drainpipes or gargoyles, the cables should be positioned above the overflow level. When the building has a basement or other areas that are likely to flood, evaluators should inspect the location of sockets, large switchgear or isolators and whether they need to be raised. In earthquake-prone areas, when electricity lines pass from building to building or over expansion joints in the same building, these joints should have sufficient flexibility to accommodate the relative movements during earthquakes.

Evaluators also should inspect the main breaker and those of different circuits to ensure that it is adequate for the installed load and irregular voltage (commonly seen in certain cities and towns) which can cause overheating of the electrical system and can damage equipment. Also, check the conditions of electrical outlets. Evidence of irregular voltage includes varying levels of brightness of lighting fixtures, equipment damage, and continual activity of voltage regulator, or by measuring voltage, among others.



Non secure electrical boxes.

An important element is the separation of electrical networks from other systems that they may affect – such as water supply or sewage systems. If they are in close proximity to protective systems for electrical atmospheric discharge, consideration should be given to metal shielding and additional electrical grounding and bonding.

Evaluators should inspect the position of outside power lines in relation to features on the hospital grounds. All power lines on hospital grounds should be placed underground to protect them from damage and flying debris during high winds. If electricity poles are located on hospital grounds, evaluators should ensure that transformers are well anchored. The possibility that poles could fall because of soil liquefaction, wind or other hazards should be considered. Tree branches can break or interfere with above-ground power lines; likewise, tree roots can interfere with buried power lines.

**Safety ratings for item No. 17:** *Low = Electrical equipment, power lines, outlets, cables and ducts are in poor condition, there are no protective measures; Average = Electrical equipment, power lines, outlets, cables and ducts are in fair condition; some measures provide partial protection and security; High = Electrical equipment, power lines, outlets cables and ducts are in good condition, well-secured and in good working order.*

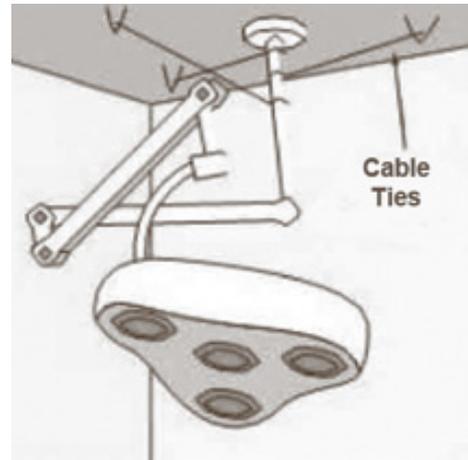
## 18. Lighting system

**Recommended evaluation methods:** observation, review of documentation (plans and records), and inspection.

Evaluators should review lighting in critical areas of the hospital, including the emergency department, intensive care unit, operating theatre, laboratories etc. They should test levels of lighting in rooms, the function of lighting fixtures, and the safety of their bracing or sup-

ports. Some lights are suspended from ceilings, others are attached to the structure.

In the case of lighting used in surgery or obstetrics, manufacturers' installation instructions generally suggest that they be bolted to beams. Evaluators should ensure that lighting fixtures are not supported by false ceilings, especially where there are earthquake hazards. Where water filtration occurs on upper floors, leaks could cause short circuits in light fixtures. These areas should also have rechargeable lamps. Evaluators should confirm that lighting is connected to the emergency power system or UPS. Visual inspection can be supplemented by information from maintenance and inspection records.



Securing hospital lighting.

Evaluators should ensure that both internal and external lighting are operational and correctly sectioned so that any area that needs lighting has it. Evaluators should work with maintenance staff to determine whether there is sufficient stock of lighting supplies (e.g. flashlights, head-torches, batteries and light bulbs in case of light failure in a disaster). They should ensure that emergency lighting systems are adequate for the level and type of use of an area, especially on stairs and walkways, in corridors and in the critical medical and non-medical areas of the hospital. Lighting should be clear of plants or other vegetation which could pose a physical risk or affect performance. Visual inspection can be supplemented by information from maintenance and inspection record.

**Safety ratings for item No. 18:** *Low = Poor level of lighting; there are no protective measures; Average = Lighting is satisfactory in the critical areas; some measures provide partial protection; High = Good levels of lighting and protection measures in place.*

## 19. Emergency maintenance and restoration of electric power supply and alternate sources

**Recommended evaluation methods:** interview, review of documentation (plans and records), and inspection.

The maintenance division should provide the operations manual for electrical power systems, as well as preventive maintenance records. Evaluators should verify that there are emergency procedures for maintaining systems in emergency/disaster situations. Evaluators should check that personnel have been trained to an appropriate standard to maintain the

correct level of safety of the electrical power supply and alternate source (e.g. generators, batteries, power inverters, etc.) of the hospital in both routine and emergency/disaster situations. For example, every 10 days the generator should start without a load transfer and every 30 days with a load transfer; the automatic start time should take a maximum of 10 seconds.

**Safety ratings for item No. 19:** *Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.*

### 3.1.2 Telecommunications system

#### 20. Effectiveness of the communications systems

**Recommended evaluation methods:** observation, review of documentation (plans and records), and inspection.

Depending on the size of the hospital, the internal communications systems (loudspeakers, public address systems, speaker systems, intercoms, bells, sirens, etc.) and external systems (internet, two-way radio, telephone, etc.) are the instruments used for contacting different hospitals in a health service network, institutions that have a role in disasters and other contacts.

Where a facility has telephone service, telephone exchange or computer network, the condition of cables connecting devices should be inspected to ensure that they will function in case of an emergency. Telephone wires must be isolated from electrical wiring to prevent overloading the telephone system; the same applies to wiring for internal communication systems.

Evaluators should ensure that both internal and external communications systems are connected to the backup power source in the hospital, and verify that the communications system is operational.

**Safety ratings for item No. 20:** *Low = The communications system is in poor condition; or there is no system; Average = A basic communication exists and is in fair condition; High = A high communication system exists in a good condition.*

## 21. Alternate communications systems

**Recommended evaluation methods: observation and inspection.**

Evaluators should verify the condition of the hospital's alternate independent communications systems (including radio-communications, satellite telephone, Internet, mobile telephones, pagers) to maintain internal as well as external contact in the event of an emergency or disaster.



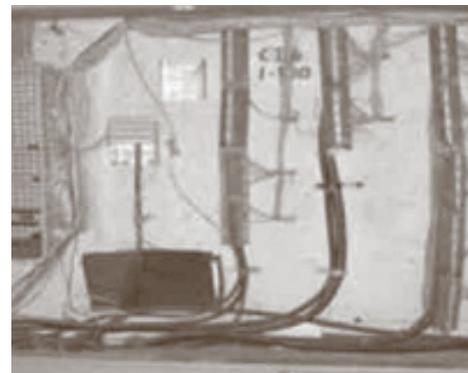
Components of internal networks should be reviewed to ensure that vulnerabilities at different points of the system have been eliminated.

**Safety ratings for item No. 21:** *Low = Alternate communications systems do not exist, are in poor condition, or do not function; Average = Hospital-wide alternate communications system in fair condition, but is not tested on an annual basis; High = Alternate communication system in good condition and tested at least annually.*

## 22. Protection of communications equipment and cables

**Recommended evaluation methods: observation and inspection.**

When evaluating communications equipment, including cables, it is important to determine their level of vulnerability to a variety of hazards including earthquakes, hurricanes, and flooding. In seismic zones or areas of high winds, the evaluators should verify that telecommunications equipment (radios, satellite telephone, video conferencing system, patch panel, server rack etc.) are well-protected and anchored for increased security.



Improper and unsafe cabling.

Evaluators should check the condition and safety of the sites for the telephone exchange and computer network server. Doors and windows in the facility should be checked for their resistance to flooding and strong winds, and should have moderate fire proofing.

Outside cables on the hospital grounds should be in underground conduits to protect them from damage during high winds and other hazards. Telephone exchange consoles, computers and servers should have anchors to prevent tipping or sliding. In areas which require anchoring and/or bracing, the quality of anchors and braces should be assessed. There should be adequate conduit tubing for cables to prevent them from deteriorating. Mobile telephone towers in the vicinity of the hospital should have back-up generators. Visual inspection can be supplemented by information from maintenance and inspection records.

Evaluators should also check the condition of antennas, their bracings and supports. Antennas and lightning rods are exposed and attached to the highest part of the structure, and are vulnerable to strong winds. There should be at least three tie-downs, spaced 120 degrees apart; four tie-downs should be spaced 90 degrees apart. Grounding devices for lightning rods should be correctly installed and not be used to anchor other systems.

**Safety ratings for item No. 22:** *Low = Equipment and cables in poor condition and/or are not protected, at high risk of failure due to hazards; Average = In fair condition, some measures provide partial protection; High = Good condition, communication equipment well-secured.*

### **23. Emergency maintenance and restoration of standard and alternate communications systems**

**Recommended evaluation methods: interview, review of documentation (plans and records), and inspection.**

The maintenance division should provide the operations manual and preventive maintenance records for electrical power systems. Evaluators should verify that there are emergency procedures for maintaining standard and alternate communications systems in emergency/disaster situations. Evaluators should check that personnel have been trained to an appropriate standard to maintain the correct level of safety of the communications system and the alternate source of communications in the hospital in both routine and emergency/disaster situations.

**Safety ratings for item No. 23:** *Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.*

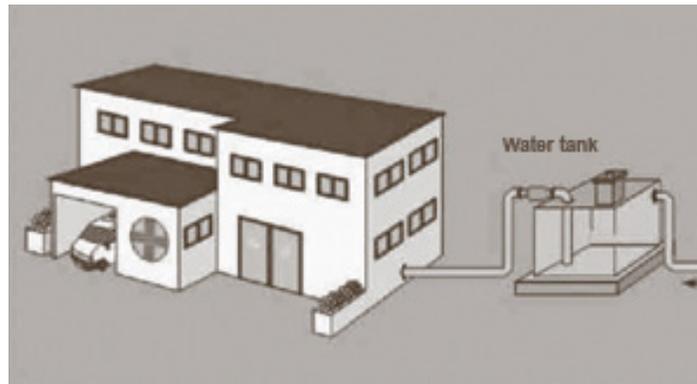
### 3.1.3 Water supply system

Section 3.1.3 consists of 6 items (24 – 29).

#### 24. Water reserves for hospital services and functions

**Recommended evaluation methods: observation, review of documentation (plans and records), and inspection.**

Evaluators should verify that water tanks have a permanent reserve that is sufficient to provide water for at least 72 hours in accordance with official national guidance, in addition to a water reserve for fires (it is advised to provide at least 300 litres daily per bed). Evaluators should also verify that water storage is sufficient to satisfy essential services. This could be ascertained from service and maintenance records.



Typically, water storage for hospitals is in cisterns or reserve tanks on the ground floor and elevated tanks. It is important to check locations in the hospital that are not served by the main water system and to confirm that their reserves are sufficient for 72 hours. If wells, boreholes or aquifers exist on hospital grounds, evaluators should determine the percentage of water supply they provide and whether they are used regularly or as reserves.

If a prolonged suspension of water service is expected, there should be plans for saving water and distributing it to the most critical services (for example, surgery, emergency, and sterilization services). This requires knowledge of the distribution network, and mechanisms to shut off water supply intermittently to certain areas. Other options for emergency situations include temporary storage in areas such as swimming pools or plastic bladders. Plans for incorporating stored supply to that of the main facility should be in place.

**Safety ratings for item No. 24:** *Low = Sufficient for 24 hours or less, or water tank does not exist; Average = Sufficient for more than 24 hours but less than 72 hours; High = Guaranteed to cover at least 72 hours.*

## 25. Location of water storage tanks

**Recommended evaluation methods: observation, review of documentation (plans and records), and inspection.**

Evaluators should visit all water tanks, whether elevated on separate towers, on the building or inside the building, or pressurized or hydropneumatic systems, to determine the safety of the installations and of the site. Cisterns should not be located in areas susceptible to flooding, because of the risk of contamination, and they should not be placed in areas with landslide hazards. The pump should also be located above the reference flood level, and joints sealed with neoprene.

In earthquake-prone areas, connections to water tanks must have adequate flexibility to withstand shaking. Any breakages in lines can result in the entire back-up water storage draining away and also undesirable water ingress/flooding of some parts of the hospital.

Water storage tanks should have appropriate covers to prevent access by non-authorized personnel and to stop items from falling inside. The tanks should not show cracking, damage, corrosion or vegetation/allergen growth. It is important to determine whether the failure of a water tank would flood critical areas of the hospital, and there should be provision to direct overflow safely away in such an event. Visual inspection can be supplemented by information from maintenance and inspection records.

Elevated tanks should meet these same criteria in addition to being supported by above structural roof elements. Special attention should be given to the means by which plastic tanks are supported and anchored. In high winds they can tip over if they are empty, which will affect the attached pipes. Air valves extend above the level of the tank cover and should be braced to avoid movement or breakage in high winds. Any hydraulic network components on the roof should be anchored.

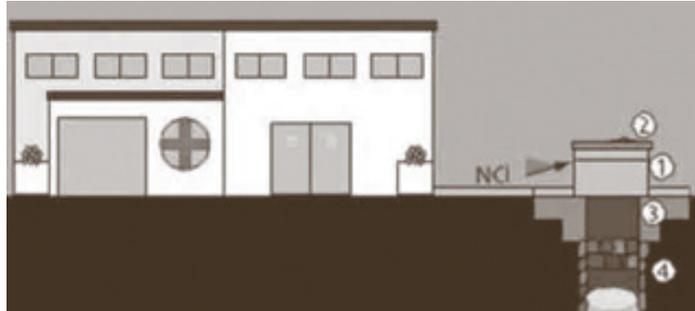
**Safety ratings for item No. 25:** *Low = The site is vulnerable with high risk of failure (e.g. structural, architectural and/or system vulnerabilities); Average = The site is exposed to moderate risk of failure (e.g. structural, architectural and/or system vulnerabilities); High = The site is not exposed to visually identifiable risks (e.g. structural, architectural and/or system vulnerabilities)*

## 26. Alternate water supply to the regular water supply

**Recommended evaluation methods: interview and inspection.**

Evaluators should identify the agency or mechanism to supply or restore water service to the hospital if the existing regular water supplies (e.g. public mains systems) fail.

There should be redundancy in all critical or lifeline systems, and it is advisable for the facility's main cistern/tank to be supplemented by at least two sources that can maintain the necessary reserve capacity. Another option is to use private wells or boreholes to supply the facility; their availability should therefore be confirmed.



(1) Wellhead raised above maximum flood level; (2) cover to prevent entry of polluted water into the well; (3) reinforced concrete rings to enhance the well's mouth; (4) protection of the pit walls (reinforced concrete rings).

To avoid contamination of underground wells, reinforced concrete walls should be built around the well opening. The well opening should be above the reference flood height and covered. The pump, if not submersible, should be protected and neoprene seals used.

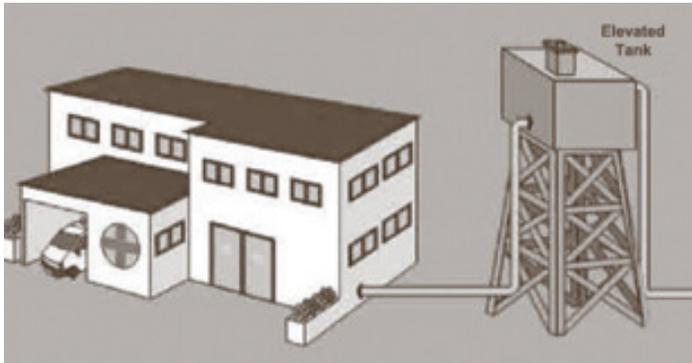
The evaluator should identify the entity responsible for restoring local water supply if it fails, and should check the facility's access by tanker trucks supplying water storage tanks.

**Safety ratings for item No. 26:** *Low = Provides less than 30% of daily demand in an emergency or disaster scenario; Average = Provides 30–80% of daily demand in an emergency or disaster scenario; High = Provides more than 80% of daily demand in an emergency or disaster scenario.*

## 27. Safety of the water distribution system

**Recommended evaluation methods: observation, review of documentation (plans and records), and inspection.**

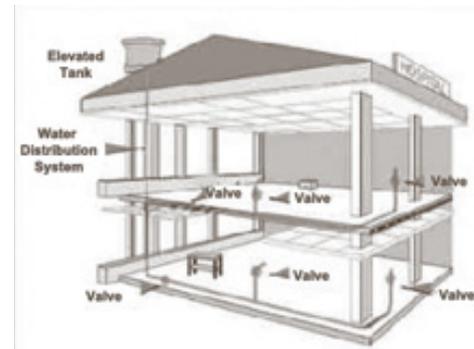
Evaluators should verify the condition and proper function of all elements of the water distribution system, including storage tanks, valves, pipes and connections. The components connecting the local water service to the cisterns are a critical part of the network. The



cistern float valve controls the amount of water that enters the tank and shuts off flow when the cistern is full. If the valve is not in proper working condition, water will be wasted without filling the cistern, and the run-off can erode structural supports.

Evaluators should check the general condition of the hospital water distribution network, including pumps, to ensure that water reaches the necessary service points.

Leaking pipes can cause damage in any of the areas where they are located: along suspended ceilings, behind walls and underground. Pipe connections are vulnerable and should be checked for signs of deterioration. It is important to check that flexible connections are used, for example, between exterior tanks and points where pipes enter the building and between pumps and impulsion pipes. Flexible connections should be used where components are in contact with structural elements, and should be firmly anchored so that the structure and water pipes move together if there is seismic shaking.



In areas with extremely cold weather, evaluators should also consider the measures to protect from freezing temperatures which could affect the functioning of the water distribution system. Evaluators should also check that the pipe lagging is in place and is protecting appropriate pipes from cold and hot temperatures in order to maintain the system's appropriate temperature range.

The water system should comply with the current legal standards for water for human consumption. There should be a water safety plan which is aimed at assessing and managing the potable water system, including regular water quality testing and maintenance. The materials to be used for supplying water should adhere to the following requirements:

- They should be able to function effectively to provide the required services, including in hazard situations.
- All equipment to be installed should be of low water consumption.

In areas at risk of volcanic eruptions, covers should be designed to be watertight and should be able to protect against contamination of the water, as well as sustaining the weight of deposits; it would be advisable to design covers with a slope.

In areas where there are patients with mental health conditions or there are prisoners, plumbing fittings should be protected against the possibility of vandalism, noise and suicide.

Visual inspection can be supplemented by information from maintenance and inspection records.

**Safety ratings for item No. 27:** *Low = Less than 60% are in good operational condition; Average = Between 60% and 80% are in good condition; High = Above 80% are in good condition.*

## 28. Water quality control

**Recommended evaluation methods:** interview and documentation (including records).

Supplying safe water is essential in a hospital. There must be a water quality control program in place that would be accelerated in the case of a disaster, when water sources might be contaminated and other factors might affect the safety of the water. This program should ensure the safety of water at supply points, storage, and distribution. Regular water sampling should be carried out, and any necessary corrective measures identified. Attention should be given to maintenance issues such as regular cleaning and disinfection of water storage tanks, among other tasks. If an after-treatment is necessary, chlorine can be used as disinfectant, because of its high efficiency and easy acquisition.



Ensure that the facility has a water quality control program in place that includes necessary corrective measures.

**Safety ratings for item No. 28:** *Low = Water quality control program does not exist; Average = Water samples are taken sporadically but follow-up with corrective measures is lacking; High = Water samples are taken regularly and corrective measures are applied.*

## 29. Emergency maintenance and restoration of water supply systems

**Recommended evaluation methods: interview and documentation (including records).**

The evaluator should verify whether maintenance personnel have been trained to an appropriate standard to maintain the correct level of safety of the water quality controls and supplies and alternative water sources of the facility. The maintenance division should provide the operations manual and preventive maintenance records for the water supply systems. Evaluators should verify that there are emergency procedures for maintaining the water supply systems in emergency/disaster situations. Evaluators should check that personnel have been trained to an appropriate standard to maintain the correct level of safety of water quality controls, supplies and alternative sources to the hospital in both routine and emergency/disaster situations.

**Safety ratings for item No. 29:** *Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.*

### 3.1.4 Fuel storage (gasoline, LPG and others)

Section 3.1.3 consists of 1 item (30).

## 30. Fuel reserves

**Recommended evaluation methods: observation, review of documentation (plans and records) and inspection.**

Evaluators should verify that the hospital has fuel supplies or storage tanks of adequate size and safety. Evaluators should verify the level of demand for fuel at the maximum capacity of the hospital, taking into account the additional capacity required to respond to emergencies and disasters. The evaluators should check the size of reserve tanks to ensure that the reserve is sufficient to meet the demand for each type of fuel at the maximum capacity of the hospital for at least 72 hours (bearing in mind there may be a high increase in service demand) to enable the hospital to respond in emergencies and disasters. Evaluators should observe how much fuel is available at the time of the assessment. They should also determine how often fuels are delivered and whether supplies can be delivered effectively during emergencies or following disasters, especially if access and road networks have been compromised. Hospi-

tals that do not have fuel reserves or fuel tanks and provided with fuel from petrol stations on a contractual basis, for instance, should be given a low rating. In earthquake-prone areas, the fuel connections between the generator and the tank should be flexible.

The fuels used for kitchens, hospital boilers and other services may differ, so it is important that all fuel tanks are very clearly labelled and, where possible, stored in different areas. In earthquake-prone zones and high-wind areas, it is important that fuel tanks are well-anchored to prevent them from tipping. Evaluators should visit the fuel tanks and cylinders to determine the safety and security of the installations and the tanks/cylinders, and should verify that the tanks/cylinders are safe and secure from hazards (e.g. anchors, banded enclosures, safe from fire). Fuel tanks should be located at least 2 m away from power lines and from combustible elements such as weeds or dry grass, in a radius of at least 3 metres. It is important that evaluators verify that the tanks containing flammable liquids are at a safe distance from the hospital and its electrical plant, boilers, kitchens, and other areas that could pose a fire risk. If tanks are located in publicly accessible places, they must be protected by a security gate with a lock or padlock.

Where tanks/cylinders are supported by concrete or brick walls, the walls should be checked for cracks and the braces or anchors checked for signs of sinking or general deterioration. Large horizontal tanks can slide and break connection hoses, so in seismic areas they should be supported with clamps or flexible connections. Evaluators should check that there are appropriate isolation valves to ensure that fuel tanks can be isolated in the event of damaged pipework.

It is important to keep in mind that the heavier the tank/cylinder and the higher its centre of gravity, the greater is the likelihood that it will tip over. Cylinders positioned vertically should be anchored/supported in at least three directions.

Visual inspection can be supplemented by information from maintenance and inspection records.

**Safety ratings for item No. 30:** *Low = Sufficient for 24 hours or less, or fuel tank does not exist, or fuel tank is unsecured; Average = Sufficient for more than 24 hours but less than 72 hours, or storage area is in fair condition but inadequate for major hazards; High = Guaranteed to cover at least 72 hours and tank storage area is in good condition and has adequate security and safety for major hazards.*

### 3.1.5 Medical gases (oxygen)

Section 3.1.5 consists of 3 items (31 - 33).

#### 31. Medical gas reserves for adverse events

**Recommended evaluation methods:** observation, review of documentation (plans and records) and interview.

Evaluators should check the reserve capacity for medical gases used in the facility. It is also important to confirm how frequently gases are delivered.

Taking into account routine use and the potential number of victims that would use the hospital in the event of a disaster, verify the medical gas reserve capacity and the distance from the gas supplier.

**Safety ratings for medical gas reserves are:** *Low = There is less than one day of reserve; Average = There are one to three days of reserve; High = There are at least three days of reserve.*

#### 32. Safety of storage areas for medical gas tanks and/or cylinders

**Recommended evaluation methods:** observation, review of documentation (plans and records), and inspection.

Evaluators should visit areas where medical gas bottles, tanks and cylinders are stored to verify that they are safe and secure and that they are prevented from falling over and protected from hazards (e.g. obstacles, fire, anchors, braces). The size of the storage areas must also be adequate for the correct handling of bottles, tanks and cylinders from deliveries. Oxygen cylinders should be capped and attached to permanent walls or structures, using adjustable tie-downs, chain, or other fasteners, taking into account that the cylinders must be easy to move when needed, but prevented from falling. Each cylinder containing gas must have permanent marks that show whether it has pure gas or a mix of gases inside. Storage areas should also show the types of risks and safety measures to be taken, so that the necessary control actions are applied when manipulating the cylinders. The cylinders should not be painted.



Some gas cylinders are not strapped.

In earthquake-prone zones and high-wind areas, medical gas tanks in storage areas should be well-braced or anchored. Vertical oxygen tanks should be well anchored in three or four directions, with welded connections or bolts. Evaluators should ensure that anchoring is adequate and the materials are in good condition. Narrow vertical oxygen tanks should be secured with three, evenly spaced tie-downs, separated by 120 degrees, in case of high winds or seismic activity. Horizontal tanks should be anchored to walls so they cannot slide during seismic events. Evaluate whether medical gas tanks have fixed or removable fasteners.

If these tanks or cylinders are stored in undesignated parts of the hospital, such as corridors, the rating should be “low”. Evaluators should ascertain that the personnel responsible for managing medical gases know all safety procedures and isolation requirements for each type of gas being used. Fire extinguishing equipment must be available, and personnel must be trained in its use.

Visual inspection can be supplemented by information from maintenance and inspection record.

**Safety ratings for item No. 32:** *Low = Medical gas tanks and cylinders in storage areas are poor condition; no protection measures, not secured; personnel are not trained to operate medical gas and fire extinguishing equipment; Average = Medical gas tanks and cylinders in storage areas are in fair condition, some measures provide partial protection; the quality of anchors and braces is inadequate; personnel are trained to operate equipment; High = Good condition, well-secured and protected, anchors are of good quality for major hazards; medical gas and fire extinguishing equipment operated by qualified personnel.*

### 33. Location of storage areas for medical gases

**Recommended evaluation methods: observation and inspection.**

Oxygen supply banks, as well as storage tanks of medical gases, should be located outside the hospital building because of the risk of tank discharge and explosion. Evaluators should verify that there is a site designated solely for storage of tanks and/or cylinders and related equipment for medical gases, and that only this equipment occupies the designated area. These areas should be well-ventilated, well-illuminated and clearly marked and labelled. There should be secure enclosure around the site, with signage indicating that the gases and equipment are dangerous.



Fire protection equipment should be readily available, and personnel should be trained in handling the equipment.

The location should be in an area unlikely to flood, at a distance from any heat sources, and protected from flying or falling debris. The site should be easily accessible for facilities, maintenance and fire response personnel.

**Safety ratings for item No. 33:** *Low = No sites reserved for medical gases, or sites for medical gases are at high risk of failure due to hazards; there are no protective measures, and storage is not accessible; Average = Reserved areas in fair condition and fair location; some measures provide partial protection; High = In good condition, well-secured and other protective measures are in place; storage is accessible.*

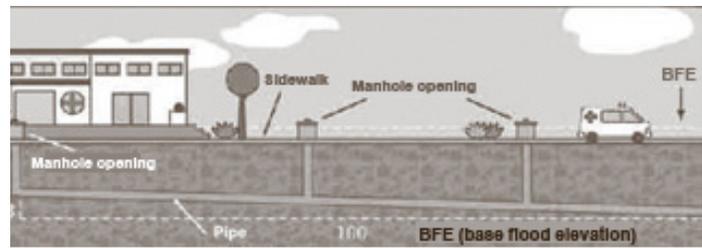
### 3.1.6. Sanitation system

Section 3.1.6 consists of 3 items (34 - 36).

## 34. Safety of nonhazardous wastewater systems

**Recommended evaluation methods:** observation, review of documentation (plans and records), and inspection.

Nonhazardous wastewater or sewerage systems consist of a network of pipes that carry the wastewater from the hospital to the sewer unit or to a separate system. They also include special systems such as septic tanks, infiltration wells and oxidation ponds, as well as filters, hydraulic traps or siphons. These systems treat and dispose of residuals, prevent the entrance of odour or insects from the treatment or excreta systems, and unclog and clean the pipes.



Sewerage system manhole openings above the BFE, base flood elevation.

Ventilation systems maintain atmospheric pressure within wastewater systems. Grease, plaster, mud and sand must be filtered out to allow for the effective performance of treatment and excreta systems.

Evaluators should, therefore, verify the physical and functional condition of equipment, clamps and anchors, the means of discharge or evacuation, leakages due to defective or miss-

ing hardware, and the state of the waste vents in covers. Evaluators should look for leaks in the system and should assess the state of the registry (presence of faecal matter). They should check overflows of deposits, the location of treatment tanks, pits and septic tanks, percolation of wells, grease, plaster or mud traps and so on, and the proximity of wastewater systems to potable water systems, verifying that the sanitation system lies downstream from the potable water system.

Evaluators should ensure that facilities for hospital wastewater disposal do not have the possibility to contaminate local serviceable drinking water. Evaluators should verify types of independent or combined systems for water intake through the base of the system (drains, showers, others) as a result of rain or flooding. They should check the operation of the valves that prevent sewage water from regurgitating back into the cistern, as well as the location of the treatment systems in respect to the potable water management system. Visual inspection can be supplemented by information from drawings, plans and site records.

Evaluators should check if there are sufficient toilets (at least 1 per 15 patients and staff) that are functioning and accessible and that safely separate the user from excreta.

**Safety ratings for item No. 34:** *Low = System for nonhazardous wastewater disposal does not exist or is in poor condition; Average = System is in fair condition, but little or no evidence of compliance and maintenance; High = Wastewater disposal system is in good condition with good capacity and evidence of compliance and maintenance.*

### 35. Safety of hazardous and non-hazardous solid waste system

**Recommended evaluation methods:** interview, observation, review of documentation (plans and records), and inspection.

The responsible division of the hospital (e.g. engineering or maintenance) should ensure that solid waste does not pollute the environment and does not cause any risk to health.

Like liquid waste, solid waste is classified as hazardous or nonhazardous with each type treated differently. Waste is considered hazardous when it is included within the following classification: sharps, bio-infectious, pathological, pharmaceutical, genotoxic, chemicals, substances with high content of heavy metals and radioactive pressurized containers.



There are three important steps to the management of waste that should be checked by evaluators, namely:

- *Segregation or classification of waste.* This is key as wrong classification can cause problems later and lead to loss of time. The level of preparedness of personnel and the establishment of biosecurity protocols must be checked, including the use of appropriate containers for different types of waste – such as high-resistance red polypropylene bags for hazardous substances, sharps containers, containers for special elements, and black bags for nonhazardous waste.
- *Handling and storage.* Personnel in charge of handling should know the different types of waste and correct management. They should wear personal protective clothing and equipment and should adhere to the routes and schedules established. Nonhazardous materials can be placed in areas served by the municipal services, separate from hazardous materials.

Hazardous materials should be safely stored in sealed bags in containers with secured lids, safe from tipping. It is preferable for medical waste containers to be permanent structures. The area must be located away from inpatient services (in service areas) and closed in a way that prevents break-ins or animal access. The location should be covered but accessible for cleaning, protected to avoid rain, flooding or leakage outside the area, clearly marked with the universal symbol, accessible to transportation teams, and with enough storage space to hold the amount of waste that accumulates between collections.

- *Collection and transportation.* Transportation to the place of final treatment or disposal will be in special, closed vehicles with specific timelines, leaving the collection area perfectly clean. Solid waste should be disposed of in a safe and proper manner in accordance with appropriate legislation and guidance.

**Safety ratings for item No. 35:** *Low = System for hazardous and/or nonhazardous solid waste disposal does not exist or is in poor condition; Average = System is in fair condition but little or no evidence of compliance and maintenance; High = Disposal system has good capacity and evidence of compliance and maintenance.*

### 36. Emergency maintenance and restoration of all types of hospital waste management systems

**Recommended evaluation methods:** interview, review of documentation (plans and records).

The maintenance division should provide the operations manual and preventive maintenance re-cords for hazardous solid waste management systems. Evaluators should verify that there are emergency procedures for maintaining hazardous solid waste systems in emergency/disaster situations. Evaluators should check that personnel have been trained to an appropriate standard to maintain the correct level of safety of waste management systems of the hospital in both routine and emergency/disaster situations.

The maintenance department should demonstrate that the hospital's wastewater drains into the public sewerage system and that measures are in place to prevent contamination of other water systems.

**Safety ratings for item No. 36:** *Low = The plan does not exist, or the plan is only on paper; Average = The plan exists but personnel are not assigned to and/or not trained in maintenance, and/or appropriate tools are lacking, and/or funds have not been budgeted for maintenance; High = The plan exists, personnel are assigned to and trained in maintenance, appropriate tools are available, and funds have been budgeted for maintenance activities.*

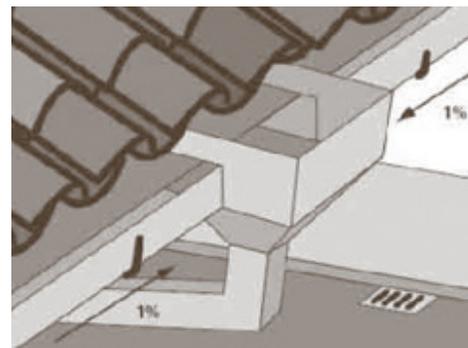
#### 3.1.7 Storm drainage system

Section 3.1.7 consists of 1 item (37).

### 37. Safety of the storm drainage system

**Recommended evaluation methods:** interview, observation and inspection.

In periods of intense rainfall or in events related to the El Niño phenomenon, storm water drainage is critical to avoid flooding in the facility. Evaluators should inspect roofs and gutters to ensure that there is enough of a slope for water to drain away from the building. Generally any drainage element should be sloped by at least 1% (for concrete surfaces) and 2% (for other surfaces) to allow water drainage. Where necessary, gutters or channels should be increased in size to accommodate storm water.



Roof rainwater guttering system.

Where flat roofs are surrounded by walls, evaluators should ensure that there is a system for rapid water drainage. This would include ensuring that the roof has a slope, that the number and diameter of drains are sufficient for the area draining into them, and that drains are completely unobstructed and protected by screens or grills. Additional holes can be made in drains, or the number of drain openings can be increased.

In areas subject to volcanic ash fall, the slope of the roof and/or drainage gutters should be checked. In addition, the strength of the structure supporting the gutters and roof should be checked to ensure that it can support the weight and removal of ash without causing damage.

Failures in the storm drainage system can have consequences for other elements of the hospital, as for the function of the building. Connections of the system should be checked regularly and to avoid deformation, chains, hooks, or other supporting elements should be used. Components that might fail because of corrosion should be replaced, and they should be maintained with anti-corrosive materials. Roofs, gutters, drains, and downspouts must be regularly cleaned to avoid blockages. These activities should be completed without fail before the rainy season.

Ensure that there is an adequate system for storm water drainage. If the drainage system has inadequate capacity, rate as low safety. This includes inspection of the slope of the roof and gutters, and confirmation that maintenance of drainage components is adequate.

**Safety ratings for item No. 37:** *Low = Storm drainage does not exist, or it is in poor condition; Average = The storm drainage system is in average condition; High = Storm drainage system is in good condition and is regularly maintenance.*

## **3.2 Heating, ventilation, air conditioning (HVAC) and hot water, mainly in critical areas**

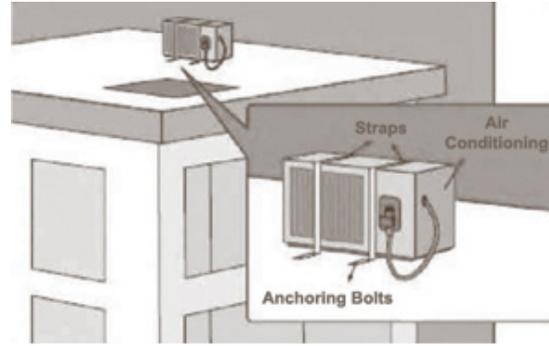
Section 3.2 consists of 2 items (38 & 39).

### **38. Condition and safety of HVAC components**

**Recommended evaluation methods: observation, review of documentation (plans and records), and inspection.**

All the components of HVAC and hot water systems must be protected from adverse events. Evaluators should inspect the following:

- Enclosures for boilers should be located away from the hospital building. Preferably, they should be housed in installations with some roof cover, isolated from fuel storage, in areas that are easy to access and difficult to obstruct or flood. When central air-conditioning units are on the roof of buildings they should be protected from the weather. Any HVAC equipment should be easy to access (obstacles to access should be cleared) and positioned in locations that are protected from flooding. Control panels should be protected from boiler temperatures, and have necessary fire protection equipment.
- Boilers and other HVAC equipment can pose major risks in disasters. They can tip over due to seismic shaking, breaking the water pipes and causing flooding. The water supply for the fire-extinguishing system can be put at risk when water connections are broken. In earthquake-prone areas, all pipes should have flexible connections. Fire danger increases if cables or gas hoses are cut or liquid fuel spills. Evaluators should confirm that the boiler is anchored to the foundation. Individual hot-water heaters should be connected at the top and bottom to a solid wall. Solar heaters are usually located on roofs and are vulnerable to strong winds as well as seismic forces. Evaluators should confirm that these elements are well-fastened to the roofing structure.
- Air-conditioning units are very heavy and are generally located in areas with ventilation, such as on roofs, upper floors of the hospital, or floors dedicated to building machinery and equipment. Because of their weight, air-conditioning units can significantly change the behaviour of the structure. Unless they are well-secured or anchored, the units can move or overturn and, as a result, can cause partial or total collapse of the building.
- Smaller split systems have the evaporator inside and the compressor and condenser outside, on the roof, patio or elsewhere. The outside equipment is vulnerable to strong winds and floods and must be well-anchored using all screws and located out of reach of water that would damage the electrical system. Indoor units should be firmly anchored to structural elements; if they should fall they could injure people or damage other equipment. The condition and safety of window units or small portable units should also be checked.
- All heating, ventilation and air-conditioning (HVAC) ductwork pipes should be in good condition and must be securely and correctly anchored and supported by



Properly secured air condition unit.

the building structure. In earthquake-prone areas, there should be no possibility of horizontal movement. Connections should be flexible, while the bracing should be rigid but should allow ductwork to move in three directions. Evaluators should check that valves operate and should review the condition of pipes in kitchens, boilers or other areas where there is steam to ensure that coatings or piping are protected. Evaluators should check that condensation will not affect the insulation of piping and that leaks from upper floors will not affect elements and services below. Humidity can ruin false ceilings and other hospital elements or equipment that come into contact with the piping.

- HVAC equipment should be functioning properly.

**Safety ratings for item No. 38:** *Low = HVAC equipment in poor condition, less than 60% pipes are in good condition; limited protective measures against hazards; not secured; Average = HVAC equipment in fair condition, but no regular maintenance; between 60-80% pipes are in good condition; some measures provide partial protection against hazards; High = Good condition, well-secured and protected from hazards; above 80% piping are in good condition and are well-secured.*

### 39. Emergency maintenance and restoration of HVAC systems

**Recommended evaluation methods:** interview and review of documentation (plans and records).

Given the importance of heating, ventilation, air conditioning, and/or hot water equipment for the hospital's operation, special attention must be given to maintenance and keeping them in good working order.

The hospital's maintenance division should provide the operations manual and preventive maintenance records for the HVAC systems. Evaluators should verify that there are emergency procedures for maintaining the HVAC systems in emergency/disaster situations. Evaluators should check that personnel have been trained to an appropriate standard to maintain the correct level of safety of the hospital's HVAC systems in both routine and emergency/disaster situations.

**Safety ratings for item No.39:** *Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.*

### 3.3 Furniture and fittings, office, and storage equipment

Section 3.3 consists of 4 items (40 - 43).

#### 40. Safety of shelving and shelf contents

**Recommended evaluation methods: observation and inspection.**

Evaluators should verify that shelving (whether as shelving units or wall attachments) and its contents should be safely secured from falling. Shelves should not pose an occupational hazard or be at risk of falling in a hazard event. The evaluator should check that they are located where they will not obstruct emergency access, evacuation routes or emergency exits. Shelves of medical contents should all have lips or railings to prevent bottles or other material from falling. It is advisable to place heavy items on lower shelves to give more stability.

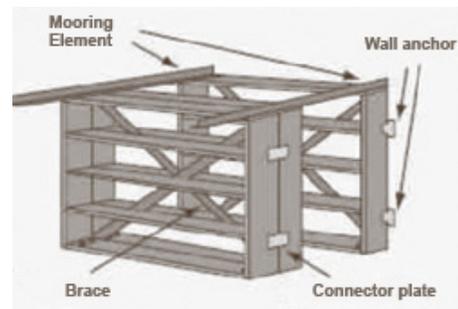


Illustration of properly braced shelving.

In hospitals prone to earthquakes, high winds and floods through doors or windows, evaluators should verify that shelves are anchored to the walls and floors, and/or are braced, and that the contents are secured. Clinical areas, offices, libraries and clinical records archives commonly have shelving units with glass doors. These units should be connected to each other and unbreakable material should replace the glass. Where there are rows of high, free-standing shelves, these must be anchored to the floor, connected to each other at the top by ties that cross the room and attached to the wall at each end of the row of shelves. Connecting the shelves increases lateral stability, lessening the chance that they will fall. For tall shelving made of combustible material, the condition of lighting fixtures and wiring near the shelves should be inspected. (References: 2, 7, 15, 19).

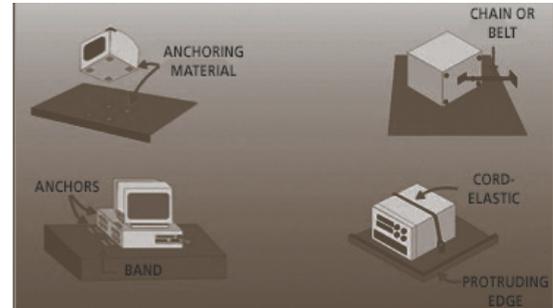
**Safety ratings for item No. 40:** *Shelving is not safely located (or in seismic and wind-prone areas not attached to walls in more than 20% of cases); Average = Shelving is safely located (and attached to walls in seismic and wind-prone areas) and contents are secured in 20–80% of cases; High = More than 80% of shelving and the contents of shelves are safely located, attached to walls, and contents are secured.*

## 41. Safety of office equipment (computers, printers, etc.)

**Recommended evaluation methods: observation and inspection.**

Much of a hospital's information is found on its computers. To ensure that a facility continues to function, computers and their contents must be secured against damage caused by natural hazards.

Evaluators should verify that computer tables are secure and will not move. Also that computers, servers, and printers are fastened to tables or that the tables have railings or lips that can prevent equipment from sliding off. If tables are on wheels, the wheels should be in the locked position. Where there is raised access flooring that allows computer wiring to run under the floor, the evaluators should check anchors to the structural slab and vertical and horizontal bracing.



In hospitals which are at risk of flooding or heavy rain, computer centres and computers, particularly servers, should be located where they will not be at risk of water damage. Basements and ground-floor areas are particularly susceptible to flooding. Sprinkler systems for firefighting systems may also damage computers and other electronic equipment. (References: 15, 19).

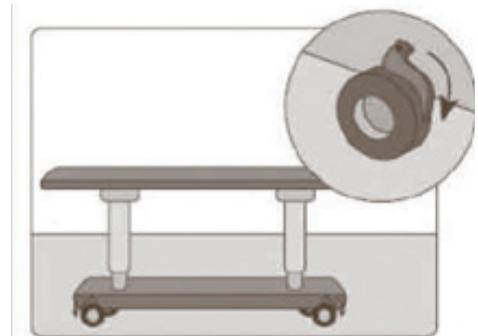
**Safety ratings for item No. 41:** *Low = No measures to protect office equipment from hazards are in place; Average = Office equipment are in safe locations, some measures offer partial protection from hazards; High = Office equipment are in safe locations, well-secured and good protective measures in place.*

## 42. Protection of furniture and fittings

**Recommended evaluation methods: observation and inspection.**

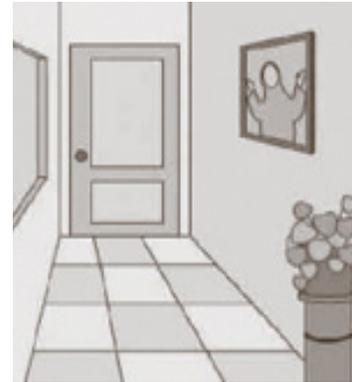
Evaluators should ensure that furniture and fittings are fixed, and check that access, doors, and hallways are always free of potential obstacles.

Chairs and tables with wheels should have brakes locked and personnel should be aware of how the locking mechanisms work. Filing cabinets on wheels should



have chocks or be attached to walls to keep them from shifting, and filing drawers should have latches to keep them from sliding open, particularly in seismic areas.

It is common for articles to be hung on walls and above desks or placed on the top of shelving (clocks, pictures, televisions, etc.). Such objects must be completely anchored; nothing should hang directly above a work station or door.



Items on walls and shelves should be properly secured.

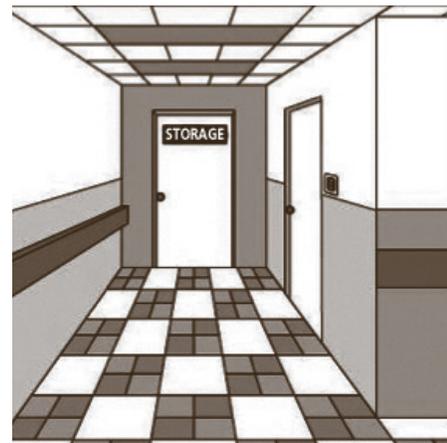
Evaluators should ensure that measures are in place to keep furnishings from moving (for example, brakes are engaged, cables, straps, or other anchoring devices are in place).

**Safety ratings for item No. 42:** *Low = Furniture and fittings are not anchored and wheels on furniture are not locked; Average = Some furniture and fittings are anchored and wheels on furniture are locked in some cases; Good = Furniture and fittings are anchored and wheels on furniture are locked.*

### 43. Protection of warehouses and storage from adverse events

**Recommended evaluation methods: observation and inspection.**

Warehouses where supplies and materials used for emergencies are stored must be protected from adverse events. Often warehouses and storage are located in rooms or structures on lower floors or even outside the hospital building, and this is not taken into account for mitigation measures. The loss of these supplies and materials will result in a limited response to the emergency.



The lower level of the hospital is a good place for emergency supplies.

The evaluator should check that these areas are not vulnerable to earthquakes, floods, volcanic eruptions, high winds, fires, explosions, and others, and that supplies are protected.

**Safety ratings for item No. 43:** *These areas are not protected; Average = Only half of the areas are protected; High = All of these areas are protected.*

### 3.4 Medical and laboratory equipment and supplies used for diagnosis and treatment

Section 3.4 consists of 2 items (44 - 45).

Application of recommendations in this section depends on the level of complexity of the health facility being evaluated, the services provided, and the equipment available.

#### 44. Protection of medical and laboratory equipment

**Recommended evaluation methods: interview, observation and inspection.**

Depending on the size and purpose of the equipment, there should be anchors and fastenings to prevent their movement because of seismic shaking, strong winds, or flooding. In addition, protection against voltage surges and overload of electric lines should be in place.

Fixed equipment must be completely anchored. Brakes on mobile equipment must be applied; when mobile equipment is not in use it should be placed against a wall, with brakes applied, and in some cases strapped to the wall. Personnel should be aware of how braking mechanisms work as well as anchoring used to support oxygen tanks.



Poor example of medical equipment above a patient bed.

Evaluators should check that tables and equipment are fastened – in order to avoid tipping or displacement– and that they are protected from flooding. Mobile equipment should have functional brakes as well as mechanisms to fasten them to walls.

Evaluators should ensure that basic equipment and supplies in emergency departments are protected. Equipment on shelves must be anchored, and the contents of shelves protected. In the case of laboratories, protecting potentially dangerous samples from falling or leaking in the case of adverse events should be emphasized, since these materials can pose a contamination hazard to personnel and patients.

Ceiling light fixtures in operating and delivery rooms must be well anchored to prevent them from swinging and falling. The operating or delivery table must be completely immobilized and equipment should be attached to rolling carts and brakes applied when in use. Straps, latches, and brakes on all equipment should be inspected.

Life support equipment should be completely anchored to eliminate the possibility of being disconnected from the patient. Because this equipment must continue to function even when there are power outages, they should be connected to alternative power sources during emergencies. Evaluators should ensure that grounds connections are in place to protect equipment from electrical discharge.



Evaluators must ensure that equipment is protected, that bracing and anchoring devices are in use (for both stationary and mobile equipment). Equipment stored on shelves should be braced and portable equipment must have brakes applied on wheels. Confirm that equipment is located above flood level and could not be exposed to strong winds.

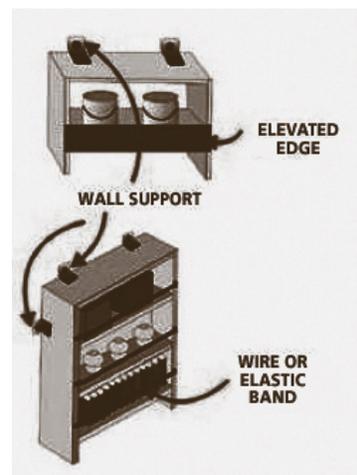
**Safety ratings for item No. 44:** *Low = 20% or less of equipment is protected; Average = Between 20% and 80% of equipment is protected; High = More than 80% of equipment is protected.*

#### 45. Condition of medical and laboratory equipment

**Recommended evaluation methods: interview, observation and inspection.**

All medical equipment in the hospital should be checked to ensure that they are in good condition and that they receive periodic maintenance.

Therefore, tables and X-Ray equipment should be in good condition. Basic and auxiliary equipment in the emergency unit should be checked to ensure it is in good condition. In surgery rooms, lamps should be inspected for adequate illumination. Anesthesia, monitoring, and life support equipment, among others, must be inspected. In the pharmacy, refrigeration for medications must be inspected. Evaluators should check for leaks from any source that might damage equipment, including from water systems, or condensation relating to air conditioning units.



Securing contents on shelves.

When inspecting the laboratory, evaluators should pay special attention to handling and securing biological samples. Biosafety measures should be in place. If biological and chemical

containers break or leak at any time, technicians, patients or the laboratory itself could be contaminated.

In settings where maximum sanitation is maintained, inspection must be rigorous. Sanitation and hygiene levels must be inspected throughout the facility to prevent contamination.



Secured contents on shelves, non-secured items on counter top.

Evaluate the condition of the medical and laboratory equipment and review scheduled maintenance. Also, given the medical services being provided at the facility, there should be sufficient medical and laboratory equipment to ensure the full range of medical services can be undertaken.

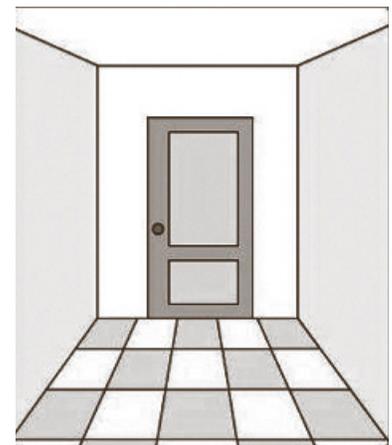
**Safety ratings for item No. 45:** *Equipment is lacking or 20% or less of equipment is in good condition; Average = Between 20% and 80% of equipment is in good condition but not regularly maintained; High = More than 80% of equipment is in good condition and is regularly maintained.*

### 3.5. Architectural components

#### 46. Condition and safety of doors, exits and entrances

**Recommended evaluation methods: observation and inspection.**

Evaluators should check the condition of the hospital's doors, exits and entrances and their ability to resist wind, fire, and seismic and other forces. Doors should be completely attached to the frames with no obvious gaps (between the door and frame, or between the frame and wall). Doors and doorframes are a good indication whether the adjacent structures have moved, especially if there are gaps, if the door is difficult to open, or if there is excessive wear. In the case of automated doors, evaluators should check if there is a provision to open the door safely and if there are alternative manual operations. Doors, exits and entrances should be free of obstacles and wide enough to allow rapid movement of patients and hospital staff in emergency situations. Evaluators should pay special attention to doors, exits and entrances to critical



areas for emergency situations, such as emergency department, intensive care unit, operating theatres, etc.

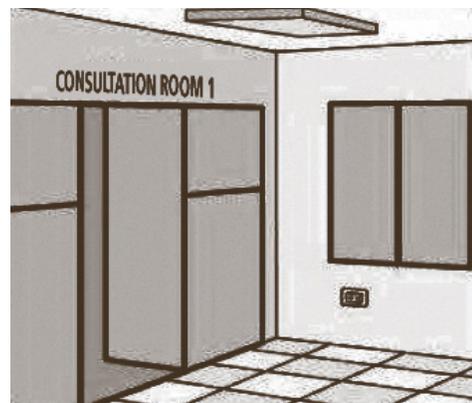
On lower levels that are susceptible to flooding, it is recommended that doors and screening made of wood and other materials that can be damaged by water be replaced by materials that do not deteriorate in wet conditions, such as plastic, aluminum and/or steel (which should be protected from rust). If replacement is not feasible, these elements should be protected with waterproofing. In areas exposed to strong winds, metal storm doors can prevent damage to the facility from wind pressure. Where external doors are not provided with storm shutters, they should have 3 hinges along one side and a latch and 2 bolts (top and bottom) along the opposite side.

**Safety ratings for item No. 46:** *Doors, exits and entrances in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; entrance width is less than 115 cm; Average = In fair condition, subject to damage but damage would not impede the function of this and other elements, systems or operations; or entrance width is less than 115 cm; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations; and entrance width is equal to or larger than 115 cm.*

#### 47. Condition and safety of windows and shutters

**Recommended evaluation methods: observation and inspection.**

Windows, shutters and frames should be able to withstand appropriate forces such as wind or impact damage, especially in critical areas of the hospital (e.g. emergency department, operating theatres, intensive care unit, sterilization unit, pharmacy, etc.). Evaluators should check the thickness and type of glass in the windows and the integrity of the frame with the wall. It is advisable to use windows with laminated glass or polycarbonate glazing in critical areas, especially for hospitals at high risk of earthquakes and hurricanes which often cause breakage of glass due to the significant deflections of the building.



Where wooden frames and shutters are used, they should be checked for rot, moisture and termite damage. If frames are not secure, wind and rain can ingress into the building,

damaging medical equipment, which may impact on patient care and the safety of staff and patients. It is very difficult to function in a flooded hospital.

**Safety ratings for item No. 47:** *Low = Windows and shutters in poor condition, subject to damage and leakage which would impede the function of this and other elements, systems or operations (e.g. weak protective glazing); Average = In fair condition, subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations; protective glass (e.g. polycarbonate glazing, blast film) has been added in critical wards.*

#### 48. Condition and safety of the elements of the building envelope (e.g. outside walls, facings)

**Recommended evaluation methods: observation and inspection.**

Evaluators should review the technical and construction status of the elements of the building envelope, including outside walls and facings, which can be made of different materials such as masonry, glass, wood and aluminium as well as composite materials. The elements should be reviewed to ensure that they are not cracked, misshapen or loose. It is recommended that, in earthquake-prone zones, facings should not be veneered but should be integrated into the wall. In earthquake-prone zones or high-wind areas, these walls should be appropriately braced to the structural elements so that they resist seismic and wind forces. If a building envelope has fixed sections of glass or wood, the evaluator should apply the same criteria as for windows and shutters made of these materials. Analysis should be more rigorous at hospital entrances and in the critical areas responsible for providing health and associated services in emergencies and disasters.

Poor conditions of the hospital's grounds also have an impact on its safety. During disasters the condition of the hospital's boundaries and fencing can impact on perfor-



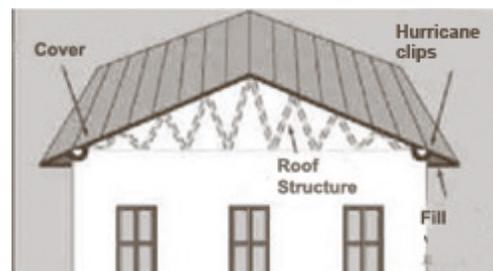
mance. For example, if many people trespass on the grounds, this can affect access and other performance issues. This should be carefully reviewed when evaluators inspect the exterior of the facility. Viewing the grounds and neighboring areas from upper floors of the building will help in assessing the condition of the perimeter of the facility.

**Safety ratings for item No. 48:** *Low = Building envelope in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.*

## 49. Condition and safety of roofing

**Recommended evaluation methods: observation and inspection.**

The evaluators should go up on the roof of the hospital to make a thorough assessment. Leakage from water storage systems on the roof, or problems with waterproofing can put sections of a facility out of service, which would have grave consequences for critical areas. Equipment located on the roof and storm water drainage should be assessed at this time.



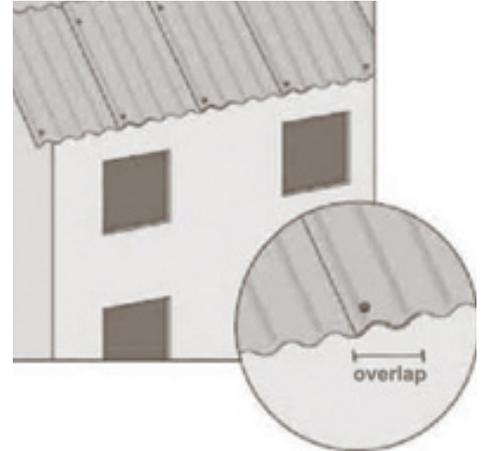
Strong winds can lift and destroy the roofing, so it is advisable to close any openings under the roof deck with masonry or other materials. Even membrane waterproofing attached to timber and concrete roof decks can be lifted off from the decks by the wind. This should be complemented with the use of hurricane straps or clips that fasten roof structures to structural elements such as supporting walls, beams, and columns.

In areas with high rainfall, extending the eaves on roofs to cover exterior walkways protects the structure and personnel. It is important to ensure that eaves are braced for strong winds and that there is adequate storm water drainage.



If the hospital is in an area exposed to volcanic eruptions, the condition of the roof and its ability to withstand the extra weight of ash fall must be considered. When volcanic ash gets wet it prevents water from draining through gutters, which adds to the weight.

If there is evidence of leaks in tile or concrete roofing and roofs, the evaluators should look for cracks and areas where joints with masonry are faulty (epoxy resins and waterproofing materials are recommended). For leaks in lightweight, metal roofing, evaluators should ensure that roofing panels overlap. The presence of holes or cracks in roofing material should also be checked. Depending on the material, angles of 20% to 25% are recommended to assist in water runoff and to lessen wind pressure.



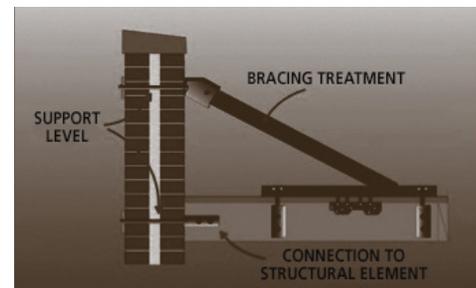
Evaluators should check that anchors for roof sheets are sealed with silicone or other waterproofing material. All roofing materials should be reviewed for their ability to withstand strong winds, ash fall, or intense rainfall.

**Safety ratings for item No. 49:** *Low = Roofing is in poor condition or damage would affect the performance of the hospital; Average = Roofing is in average condition or damage would not affect the performance of the hospital; High = Roofing is in good condition or there is no or minor potential for damage that could affect performance of the hospital.*

## 50. Condition and safety of parapets and other outside elements (railings, cornices, ornaments, etc.)

**Recommended evaluation methods: observation and inspection.**

Evaluators should assess the safety and levels of protection provided by railings and parapets to stairways, corridors and walkways inside and outside the hospital, as well as roof access and roof perimeters, considering whether their failure could endanger occupants and hospital operations. Evaluators should keep in mind the importance of these elements in preventing injuries from falls by patients, staff and visitors. Unattached parapets have been known to fall down during earthquake shaking, killing people below and also impeding access.



Securely restrained parapet walls.

**Safety ratings for item No. 50:** *Low = Parapets and other outside architectural element(s) in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition; subject to damage but damage to element(s)*

*would not impede the function of this and other elements, systems or operations; High = In good condition; no or minor potential for damage that would impede the function of this and other elements, systems or operations.*

## 51. Safe conditions for movement outside the hospital buildings

**Recommended evaluation methods: observation and inspection.**

Movement in the hospital grounds outside the buildings must be ensured so that pedestrians, ambulances and supply transport can access the facility with the speed required during emergencies and disasters. This item also complements item 59 on access routes, which focuses on roads outside the hospital grounds, and item 60 which focuses on emergency exit and evacuation routes. External obstacles to access can severely disrupt the function of the facility. Evaluators should observe whether there are trees, lampposts and monuments and architectural designs that could fall because of natural forces and obstruct pedestrian and vehicle access to the facility. The impact on access for people with mobility impairments and wheelchairs should be considered and tested. The pavement within the hospital grounds should be checked for potholes, raised areas or other obstacles that could impair pedestrian and vehicle traffic.



It is important to determine whether fire-fighting trucks can have access on all sides of the facility. In this respect the headroom required for these trucks with their equipment must be taken into account.

**Safety ratings for item No. 51:** *Low = Obstacles or damage to structure or road and walkways will impede vehicle and pedestrian access to buildings or endanger pedestrians; Average = Obstacles or damage to structure or road and walkways will not impede pedestrian access, but will impede vehicle access; High = No obstacles, or potential for only minor or no damage that will not impede pedestrian or vehicle access.*

## 52. Safe conditions for movement inside the building (e.g. corridors, stairs)

### Recommended evaluation methods: observation and inspection.

Evaluators should verify that conditions are safe for movement throughout the facility. Interior corridors should be spacious and free of obstacles to ensure ease of movement for personnel, stretchers and medical equipment. Special attention should be given to stairways and exits because of their importance if evacuation occurs during earthquakes or other emergencies. Access for people with mobility or sensory impairments, as well as wheelchair access, should be considered. Adequate signage must be present to facilitate the movement of staff, patients and visitors. Areas with restricted access should be under the surveillance of hospital security personnel.



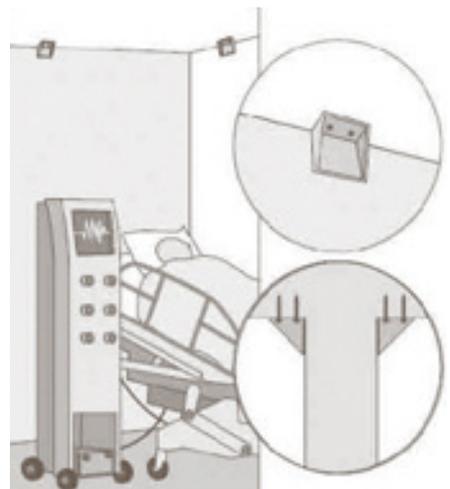
Corridors should not be blocked with stored items.

**Safety ratings for item No. 52:** *Low = Obstacles and damage to element(s) will impede movement inside the building and endanger occupants; Average = Obstacles or damage to elements will not impede movement of people but will impede movement of stretchers, wheeled equipment; High = No obstacles, potential for no or minor damage which will not impede movement of people or wheeled equipment.*

## 53. Condition and safety of internal walls or partitions

### Recommended evaluation methods: observation and inspection.

Internal walls and partitions can be made of masonry, glass, wood, aluminum etc., and may be a combination of these materials. Evaluators should review the technical and construction aspects of these elements to ensure they are not cracked, deformed or loose. Evaluators should rate the hospital on the basis of the condition of the materials and the level of bracing against the hazards identified as potentially affecting the hospital. In earthquake-prone and high-wind areas, interior walls should be adequately braced by structural elements so that they can resist seismic shaking and wind forces. The evaluation of internal walls should be more rigorous in critical areas such



Clips securing ceiling to walls.

as intensive care units, emergency department, operating theatres, laboratories etc. Special attention should be given to glass wall divisions close to or near beds or cots.

In areas that are prone to flooding, lightweight materials that would be damaged by water should not be used for partitions. Cracks or other damage to these partitions would affect electrical and other systems that are behind the walls. Masonry partition walls are preferable on lower floors that are prone to water damage. However, the way masonry partition walls will affect the behavior of the structure if there is an earthquake must be taken into account.



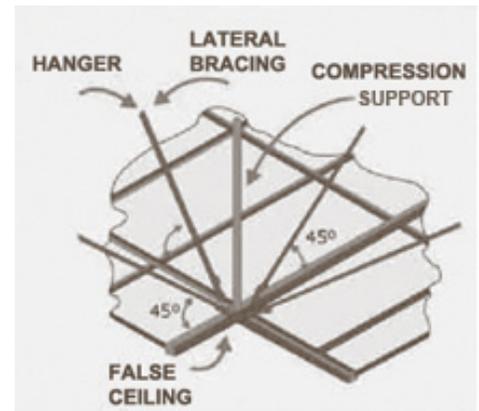
Base of walls and doors deteriorated.

**Safety ratings for item No. 53:** *Low = Internal walls and partitions in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, element(s) are subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.*

#### 54. Condition and safety of false or suspended ceilings

**Recommended evaluation methods: observation and inspection.**

There is a wide variety of false or suspended ceilings used in buildings. Those made of metal are the heaviest and cause the greatest damage if they fall. The level of bracing is a major determinant of the safety ratings for the hospital. Because the bracing is usually not visible, evaluators should request relevant personnel (e.g. maintenance staff) to take some ceiling sections apart so the condition of the ceilings and anchors, and the weight and stability of ceiling tiles, can be checked. In earthquake-prone zones both angled and vertical bracing should be used to brace ceilings from horizontal seismic forces. In areas where these elements can be subjected to strong winds, they can fall, become projectiles, collide with other objects and, in the worst case, injure people. If they do fall, they can obstruct critical areas and passageways in the hospital, thus affecting its functional capacity.



Evidence of moisture damage and detached suspended ceilings can be caused by problems with roofing or in water, HVAC, or electrical systems that pass through the space above the ceiling.

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IF THE HOSPITAL DOES NOT HAVE FALSE OR SUSPENDED CEILINGS, LEAVE BOXES BLANK AND PROVIDE COMMENT.

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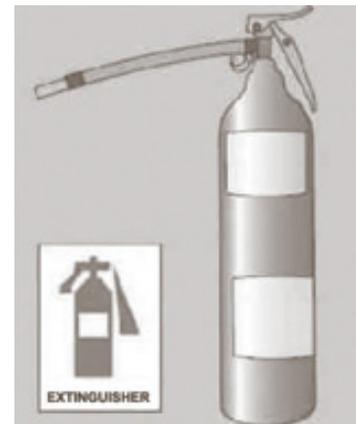
**Safety ratings for item No. 54:** *Low = False or suspended ceilings in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, element(s) subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.*

## 55. Condition and safety of the fire protection system

**Recommended evaluation methods: observation, review of documentation (plans and records), and inspection.**

The hospital must be protected against fire, since this type of hazard can stop services in a hospital when they are most needed. Hospitals are considered to be buildings which are extremely difficult to evacuate; therefore, the most important aspect of fire safety is to have the best means of prevention and protection in place.

Protection of patients and staff when there is a building fire is of utmost concern. Passive fire protection measures will be based on the combustible level of each area, the level of compartmentalization, the use of incombustible material, fireproof doors, firewalls, and the location of doors and windows in respect to other buildings and other areas.



The main objective should be to prevent fires from starting and, if a fire starts, to prevent its spread in order to avoid evacuation of the building.

Evaluators should determine whether the hospital design incorporates firewalls, doors and designated escape routes, which provide a high level of safety. They should also review the fire protection measures in areas at highest risk of fire, including boiler rooms, fuel tank storage, medical gases, electrical panels, electrical switch rooms, pharmacy etc. Evaluators can find this information in maintenance records, the facility's fire plans, and policies and procedures.

The early detection of fire and/or smoke is a critical line of defence against fire in hospitals. Evaluators should review the installation, maintenance and testing of the fire and smoke detection systems throughout the hospital. There should be detectors and fire alarms that are both visual and audible. The system must allow for the transmission of local alarms, general alarms and verbal instructions.

Portable fire extinguishing devices should be accessible, clearly marked and labelled, in usable condition, and well anchored so they do not fall. Expiry and maintenance dates on extinguishers should be checked. Hospitals should have sprinkler systems and these should be examined and checked against maintenance service records for good operation.

There must be a sufficient number of functional water hydrants or dry risers available or connected to a permanent supply of water. Evaluators should confirm that all aspects of the extinguisher systems are tested on a regular basis and that personnel responsible for using the equipment have had practical training and have been tested on how to use it in a time of need. Note the expiry and/or refill dates of fire extinguishers and of flow tests for fire hydrants. Examine logbooks and service and maintenance records of the equipment tests and dates of inspections by emergency/fire-fighting personnel.

Evaluators must confirm that the fire protection measures are located in areas at highest risk of fire, including boiler rooms, fuel tank storage, medical gases, electrical panels, electrical switch rooms, pharmacy, laboratories, storage for unsealed batteries, etc.

**Safety ratings for item No. 55:** *Low = No system has been installed, or it is expired, or inaccessible; element(s) are subject to damage, and damage would impede the function of this and other elements, systems or operations; Average = Partially installed, or partially inaccessible; element(s) are subject to damage but damage would not impede function; High = System fully installed and regularly maintained; no or minor potential for damage that would impede the function of this and other elements, systems or operations.*

## 56. Emergency maintenance and restoration of the fire protection system

**Recommended evaluation methods:** interview, observation, review of documentation (plans and records), and inspection.

The maintenance division should provide the operations manual for the fire protection systems, as well as records showing preventive maintenance of fire extinguishers and fire hydrants. Evaluators should verify that:

- A manual plus training on the management of fire protection systems are available.
- There are records of preventive maintenance of equipment (extinguishers, hydrants, etc.)
- The equipment is to be found in the appropriate places and is freely accessible.
- The network of pipes, pumps and accessories is exclusively for the hydrants.

- Hoses are appropriately joined to the valves on the cabinets for the hydrants.
- The network of hydrants has its own water cistern.
- The fire safety officer (warden) team in the hospital has been established.
- Personnel are trained and drills have been carried out.
- A plan of action and procedures for fire response are available.
- Inflammable materials and liquids are stored in safe places that are reserved exclusively for these substances.

**Safety ratings for item No. 56:** *Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.*

## 57. Condition and safety of stairways and ramps

**Recommended evaluation methods: observation and inspection.**

Special attention should be given to the safety of stairways and ramps because of their importance in the case of evacuation. Evaluators should ensure that they are free of obstacles or of items that could fall and obstruct them. They should have railings so that they can be used safely at their maximum capacity, the stairs themselves are free from damage and have clearly marked or defined edges keeping in mind that hospital patients will be more vulnerable than typical users. Stairs should be of an anti-slip material or have strips of anti-slip material to prevent falls or accidents.



Evaluators should consider whether damage or failure of stairways and ramps could endanger occupants of the hospital. Additional attention should be focused on areas where there is the highest concentration of people and use.

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IF THERE ARE NO STAIRS AND RAMPS, LEAVE BOXES BLANK AND PROVIDE COMMENT.

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**Safety ratings for item No.57:** *Low = In poor condition, subject to damage or there are obstacles, which would impede the function of this and other elements, systems or operations; Average*

= *In fair condition, subject to damage but damage and obstacles would not impede the function of this and other elements, systems or operations; High = In good condition, no obstacles, potential for no or minor damage that would impede the function of this and other elements, systems or operations.*

## 58. Condition and safety of floor coverings

**Recommended evaluation methods: observation and inspection.**

Floors can be made of a variety of materials, including terrazzo, ceramic or clay tile, linoleum, wood, etc. They may be attached with adhesives, be laid over a membrane (such as a floating floor), or suspended. Evaluators should verify that the flooring is watertight, anti-skid, and free of cracks or loose sections, especially in critical and high-traffic areas. There should be no uneven sections or depressions that could cause people to fall or cause carts and equipment to tip over. In areas where there are large numbers of conduits, cables and suspended floors, evaluators should ensure that the flooring is braced to resist lateral seismic loads.



To reduce the incidence of hospital-acquired infections, seamless floor coverings are preferred in healthcare facilities.

**Safety ratings for item No. 58:** *Low = Floor coverings in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, subject to damage but damage would not impede function; High = Seamless flooring in good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.*

## 59. Hospital access routes

**Recommended evaluation methods: interview, observation, review of documentation (including maps) and inspection.**

Access is essential if the hospital is to function properly. The emphasis in this item is on access routes outside the hospital grounds. Evaluators should review the main access routes to the hospital. Maps showing micro- and macro-locations of the hospital are helpful. Evaluators should determine the effectiveness of the hospital's security and protection system

in terms of vehicle and pedestrian access. Access for people with mobility impairments should also be reviewed. Interviews with hospital employees, patients and, where possible, people living near the facility, can provide information about the types of routes and at what time of day routes are congested.



Collapsed trees blocking access to hospital.

Evaluators should note the presence and condition of waterways (e.g. creeks, rivers) and storm drains that service the area, and should determine whether flooding or storm run-off would flood certain access routes, making them impassable. Evaluators should note structures and trees along the access routes that would impede traffic if they fell during an emergency or a disaster such as an earthquake, or in a high-wind event such as a cyclone.

Alternate routes should be identified in case major access routes are obstructed. It is important to determine whether alternate routes are taken into account in the hospital's emergency and disaster risk management programmes, including response plans.

Ascertain that access routes are free of obstacles (e.g., kiosks, street vendors, barriers); that there are no elements that could obstruct the routes (trees, utility poles, possible flooding, etc.); and that traffic lights are present to control traffic. Ensure that there are alternative access routes to the hospital.

**Safety ratings for item No. 59:** *Low = Access routes subject to obstacles and damage that would impede access and the function of other elements, systems or operations; Average = Access routes subject to some obstacles and damage that would not impede access and function; High = No or minor potential for obstacles or damage that would impede access and the function of other elements, systems or operations.*

## 60. Emergency exits and evacuation routes

**Recommended evaluation methods: observation and inspection.**

Evaluators should verify that hospital exit and evacuation routes are clearly marked and free of obstacles to enable emergency evacuation. Evaluators should confirm that evacuation routes are indicated both inside and outside the hospital. They should also verify that security personnel understand these signs, since during



a crisis they are responsible for directing and protecting everyone on the grounds of the facility. They should check that emergency doors are not locked from the in-side so that they do not impede an emergency evacuation. If the hospital relies on automatic doors, check that these doors can be opened manually or there are alternative exit points.

**Safety ratings for item No. 60:** *Exit and evacuation routes are not clearly marked and many are blocked; Average = Some exit and evacuation routes are marked and most are clear of obstacles; High = All exit and evacuation routes are clearly marked and free of obstacles.*

## 61. Condition and safety of other architectural elements

**Recommended evaluation methods: observation and inspection.**

Evaluators should verify check other architectural elements of the hospital that have not been taken into account under previous items. Special attention should be given to the condition of anchors and supports of exterior architectural elements. For instance, chimneys should be structurally sound, be capable of resisting seismic or wind loads and have the stability required for their height, whether they are self-supporting or braced. Seismic shaking can cause chimneys to fall, resulting in considerable damage and even death. It is not advisable to use window boxes or other similar adornments on the exterior of buildings since, besides the risk posed if they fall, these elements can increase building and seismic loads. The evaluator should examine the safety of signage inside and outside the hospital since this could fall and harm occupants or damage the facility.



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IF THE HOSPITAL DOES NOT OTHER ARCHITECTURAL ELEMENTS, LEAVE BOXES BLANK AND PROVIDE COMMENT.

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**Safety ratings for item No. 61:** *Low = Other architectural element(s) in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, element(s) are subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.*

# Functional Aspects | 4

Hospitals are essential to providing health care in an effective, efficient, and timely manner. Providing treatment for the ill has technical, administrative, ethical, and legal implications which are present at all times and under all circumstances, even during emergencies and disaster situations.

For a hospital to remain safe and continue to function in an emergency situation, certain features that can make them especially vulnerable should be taken into account:

- They generally function 24 hours a day, without interruption; even when at risk from hazards or after an emergency or disaster.
- They accommodate a diverse public, including patients who need specialized care;
- Hazardous materials are found in the facilities;
- They depend on a network of basic services to function;
- Expensive equipment and other supplies are necessary to save patients' lives.

Hospitals require a wide range of human, material, economic, and technological resources to function. These elements come together as a whole, and the structure sustains the processes which, in turn, support the outcomes. In this ensemble of resources, everything is linked, and what effects one element has implications on the whole facility and on treatment and care outcomes.

There have been cases where hospitals have ceased to function even though the structure and other elements of the building were not affected. Functional collapse, which occurs not only as the result of adverse events, can be attributed to many things, from saturation of services to the lack of emergency preparedness.

Coordination between a hospital and other institutions in the health delivery network is essential if services are to be provided to populations in emergency situations. For these reasons, it is important to improve a hospital's preparedness, taking into account the functional aspects described here.

Functional capacity of the hospital during and after a severe natural (or other) hazard event also depends on the technical and administrative organization of its personnel and how this affects their ability to respond to such situations. This chapter addresses the general orga-

nization of the hospital's authorities, implementation of plans and programs, availability of resources, the level of development and preparedness of its personnel, and the level of safety of the priority services needed for the facility to function. It is essential for the managers of the hospital being assessed to provide the evaluators with their disaster plan and all relevant documentation.

This chapter addresses the most common aspects of functional vulnerability pertaining to the hospitals, emphasizing organizational details related with emergency and disaster preparedness. This refers primarily to the level of preparedness for major emergencies and disasters of the personnel in the hospital, and to what degree the disaster plan has been implemented.<sup>12</sup>

#### **4.1 Organization of the hospital's disaster committee**

Evaluation of a hospital's level of organization for responding to disasters begins with an assessment of the disaster committee.

The functional organization of the committee defines levels of authority, roles, and responsibilities within a hospital, so that activities are in line with the institution's goals and efforts are not duplicated. The committee must promote collaboration between individuals in the group and improve the efficiency and effectiveness of communication.

The disaster committee defines the processes and strategies that are put into practice in major emergencies and disasters and outlines the methods for carrying out actions efficiently (for example, by using action cards).

Finally, evaluators should assess the logistics that will allow the committee to perform satisfactorily, for example, if there is a physical area assigned to them with the necessary equipment.

#### **62. Hospital Emergency/Disaster Committee**

**Recommended evaluation methods: interview and review of documentation (including terms of reference).**

Evaluators should verify that a committee has been formally established (with policy directives) to coordinate hospital emergency response and recovery operations. Responsi-

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12. See Pan American Health Organization. *Hospital safety index: guide for evaluators*, PAHO: Washington, D.C., 2008.

bility would also include coordination of preparedness measures to develop the readiness of the hospital for response and recovery. Evaluators should verify that the hospital positions on the Hospital Emergency/Disaster Committee are occupied by senior personnel from different and key hospital departments/disciplines (e.g. hospital director, director of administration, chief of nursing, medical director, chief of surgery, chief of laboratory services, chief of maintenance, chief of emergency services, chief of transportation, chief of security and chief of support services). The leadership and commitment of senior executives provides critical support for emergency and disaster management, including for preparedness, response and recovery.



Evaluators should obtain a copy of the committee's terms of reference and verify that the list of members corresponds to current personnel. Evaluators should determine if the committee functions effectively by meeting on a regular basis and taking action to fulfill its responsibilities via effective leadership and coordination.

**Safety ratings for item No. 62:** *Low = Committee does not exist, or 1–3 departments or disciplines represented; Average = Committee exists with 4–5 departments or disciplines represented, but is not fulfilling functions effectively; High = Committee exists with 6 or more departments or disciplines represented and is fulfilling functions effectively.*

### 63. Committee member responsibilities and training

**Recommended evaluation methods:** interview and review of documentation.

Evaluators should determine whether committee members are fulfilling their collective and individual responsibilities regarding emergency and disaster management (i.e. in preparedness, response and recovery operations). Members should have participated in internal or external training courses that enable them to understand the role of the committee with respect to hospital emergency and disaster management and their individual roles. Evaluators should look for evidence of active participation by members in coordination meetings, joint assessments, planning and implementation of activities in preparedness, response and recovery.

**Safety ratings for item No. 63:** *Low = Committee does not exist or members are untrained and responsibilities not assigned; Average = Members have received training and have been officially assigned; High = All members are trained and are actively fulfilling their roles and responsibilities.*

## 64. Emergency Operations Centre (EOC)

**Recommended evaluation methods: interview, review of documentation (plans and records) and inspection.**

Evaluators should verify that an EOC has been designated in a safe and secure location. The EOC should already be equipped or there should be arrangements to rapidly equip a converted meeting room for immediate set-up and operation. Evaluators should determine that minimum equipment and supplies are readily available to set up the EOC for communications, information management (documentation, monitoring boards/screens), identification, security, and well being of EOC staff. The EOC should be backed up by an information management system that supports emergency operations and that can link to data from the hospital's information management system. There should be a procedure for setting up and managing the EOC, including designation of a responsible person to set up and ensure smooth operation of the logistical aspects of the centre. There should be an alternate EOC with the same characteristics.

The EOC must be located in an accessible, protected and secure area (reviewed by a civil/structural engineer), and all means of communication should be installed (telephone, fax, internet, etc.) as well as necessary furnishings.

**Safety ratings for item No. 64:** *Low = The EOC is not designated or is in an unsafe or insecure location; Average = The designated EOC is in a safe, secure and accessible location, but would have limited operational capacity immediately in an emergency; High = The EOC is in a safe, secure and accessible location with immediate operational capacity.*

## 65. External stakeholder directory and other contacts

**Recommended evaluation methods: interview, review of documentation, and inspection.**

Evaluators should verify that an up-to-date directory with contact information of external stakeholders and emergency support services is available to the Hospital Emergency/Disaster Committee, EOC staff and other key hospital administration and emergency staff, including switchboard operators. An assigned staff person should be identified as responsible for maintaining and regularly updating the directory. The directory should include all relevant contacts of emergency/



disaster agencies and the healthcare network together with key personnel for the hospital. Evaluators should check a random set of telephone numbers, focusing on external stakeholders.

**Safety ratings for item No. 65:** *Low = Directory of external stakeholders does not exist; Average = Directory exists but is not current (more than 3 months since it was updated); High = Directory is available, is up to date and is held by key emergency response staff.*

## 66. Action cards available for all personnel

**Recommended evaluation methods: interview and review of documentation.**

Action cards are documents that summarize the activities to be implemented by the hospital's personnel. Evaluators should check that action cards describe the assigned duties of each hospital staff member in the context of a disaster. It is advisable to randomly ask staff members about the contents of cards assigned to them.

**Safety ratings for item No. 66:** *Low = Action cards do not exist; Average = There are cards, but personnel are not familiar with them; High = All staff members have cards and know their contents.*

## 4.2 Hospital emergency or disaster response plan

Submodule 4.2 consists of 20 items (67 – 87).

This submodule evaluates the hospital's operational planning for internal and external emergency and disaster events. The purpose of the emergency and disaster planning is to identify measures that should be put into practice before, during and after an emergency or disaster so that the hospital is ready to respond and essential hospital services continue to function. The hospital's plans and procedures for emergency or disaster response should be documented and detailed in an existing hospital emergency or disaster response plan which:

- Integrates the hospital response plan with the community or local response plan, and with health response plans at other levels;
- Provides for cooperation with other services and institutions;
- Includes referral and counter-referral of patients (to and from other facilities);
- Takes into account technical and logistical support, as appropriate to the type of organization and complexity of the facility.

Evaluators should ensure that hospital response and recovery planning will enable the hospital to conduct the following actions:

- **Before:** Anticipate events which are expected to affect the hospital and its operations, and that may require an emergency or disaster response.
- **During:** Activate and implement the response plan and procedures, including the hospital incident management plan.
- **After:** Return to normal activities and hospital operations. Evaluate the effectiveness of the preparedness measures and the response, such as with an after-action review (AAR), leading to planning for corrective actions. Plans and procedures for resuming normal function and repairing any damage should be addressed in a recovery plan which may be separate or may be part of the response plan.

## 67. Hospital emergency or disaster response plan

**Recommended evaluation methods: interview and review of documentation (plans).**

Evaluators should verify that the hospital has a documented, routinely reviewed and updated all-hazards emergency or disaster response plan that defines actions to be taken in anticipation of, during and after any type of emergency or disaster to which the hospital is expected to respond. Evaluators should review the plan and confirm if the hospital has the necessary resources to implement it.



Evaluators should check the content of the response plan. At least the content of the all-hazards plan includes sections on the hospital incident management system, coordination, logistics, roles and responsibilities of key staff and departments, human and financial resources, patient reception and management, including triage and decontamination, communication, staff welfare and security as a minimum.

Response and recovery plans should also be reviewed after exercises and after a major incident. Evaluators should verify if an After Action Report (AAR) is conducted after a major incident affecting the hospital, including identification of lessons for planning corrective action. This should be a major part of the response plan and should be included as one of the major tasks for the Hospital Emergency/Disaster Committee and staff who coordinate emergency management activities in the hospital. It may take the form of a debriefing of the hospital personnel who were involved in the incident response. The results are collated

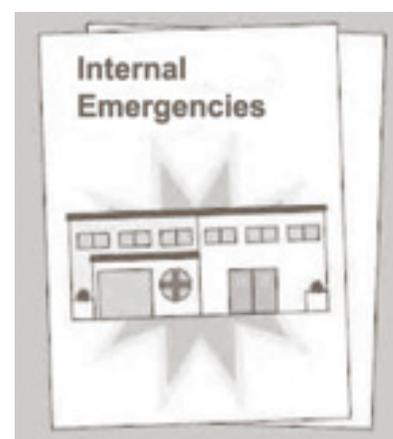
and presented to the committee for further actions, including improvement and updating of plans.

**Safety ratings for item No. 67:** *Low = Plan is not documented; Average = Documented plan is complete, but is not easily accessible, not up to date (more than 12 months since the last update); High = Plan is complete, easily accessible, reviewed/updated at least annually, and resources are available to implement the plan.*

## 68. Hospital hazard-specific sub plans

**Recommended evaluation methods:** interview and review of documentation (plans).

Evaluators should refer to Module 1 for an assessment of hazards which may affect the hospital. Evaluators should verify that hazard-specific response sub plans (sometimes called contingency plans) are established for the most likely external and internal emergency scenarios (e.g. associated with specific geological, hydrometeorological, biological, technological and societal hazards). Evaluators should review the hazard-specific sub plans (e.g. flood, building fire, epidemic, airplane crash, terrorist incident) and confirm if the hospital has the necessary resources to implement the plans. When the hospital emergency response plan (see item 66) has addressed all the requirements for responding to specific hazards, then the hospital should be rated “high” for item 67.



**Safety ratings for item No. 68:** *Low = Hazard-specific response sub plans are not documented; Average = Documented plans are complete but not easily accessible, not up to date (more than 12 months since last review/ update); High = Documented plans are complete, reviewed/updated at least annually, and resources are available to implement the plans.*

## 69. Strengthening of hospital’s essential services

**Recommended evaluation methods:** interview and review of documentation (plans).

Evaluators should verify that the plan specifies actions to be taken before, during, and after a disaster to strengthen the treatment capacity of the hospital’s critical services (emergency room, surgery department, among others). The disaster plan should specify the type of actions that will be taken and the resources needed (personnel, supplies, equipment, etc.).

**Safety ratings for item No. 69:** *Low = Actions are not included or are addressed only in document; Average = Actions are included but resources are not available; High = Actions are included, resources available and have been completely implemented.*

## 70. Procedures to activate and deactivate plans

**Recommended evaluation methods: interview and review of documentation (including procedures).**

Evaluators should verify that there are procedures for how, when and by whom the emergency response plan, sub plans and contingency plans are activated and deactivated, including triggers and early warning mechanisms. In particular, evaluators should determine:

- what type of signal is used and the criteria for activating plans for internal or external events;
- who has the responsibility for activating and deactivating the hospital's emergency or disaster response plans;
- whether hospital staff have been trained in the activation procedures;
- how often the activation procedures are tested.
- activation procedures out of office hours, at weekends and during holidays.

Activation may be triggered or requested by local authorities, the civil defence organization, emergency services, public safety agencies, a central agency responsible for health/medical emergencies, or other outside entities. These requesting entities may be able to provide information about what casualties the hospital could expect – such as the type of the event, the number of casualties, the nature of their injuries or other health effects, estimated time of arrival at the hospital etc.

**Safety ratings for item No. 70:** *Low = Procedures do not exist or exist only as a document; Average = Procedures exist, personnel have been trained, but procedures are not updated or tested annually; High = Up-to-date procedures exist, personnel have been trained, and procedures have been tested at least annually.*

## 71. Special administrative procedures for disasters

**Recommended evaluation methods: interview and review of documentation (including procedures).**

Evaluators should verify that the plan includes specific procedures for staffing personnel in

essential services for the first 72 hours after an event, how procurements will be handled, and necessary logistics for executing the plan.

The plan must address measures to ensure the well being of staff during the emergency. Evaluators should verify if space has been designated and measures are available so hospital personnel can rest, sleep, eat, drink, observe faith-based practices and meet personal needs during an emergency.

In large-scale emergencies in which family members of staff are affected, plans should also consider what support (e.g. child care or elder care) the hospital can provide for immediate family members to encourage staff to continue working. The disaster plan (when it refers to region-wide events such as hurricanes and earthquakes) should take into account the real possibility that several of the facility's personnel would be unable or unwilling to report for duty at the healthcare facility because their domestic situations would be in disarray.

**Safety ratings for item No. 71:** *Low = No procedures exist or are addressed only in document; Average = Procedures are included in plan, but the administrative process is slow; High = Procedures are included and personnel are familiar with how to implement them.*

## 72. Financial resources for emergencies and disasters

**Recommended evaluation methods: interview and review of documentation.**

Evaluators should verify that the hospital has a specific budget and access to funds for use in the response to emergency and disaster situations, as well as for recovery. This budget should be consistent with activities outlined by the hospital's disaster committee. While financing for public hospitals is limited and generally directed to immediate needs, it is critical that funds be permanently assigned for emergency and disaster preparedness.



Evaluators should confirm that:

- the budget is sufficient to implement measures outlined in the plan;
- cash is available for immediate purchases, and there is a list of suppliers that will extend credit to the hospital;
- the quantity and availability of medical equipment and supplies are known.

Hospitals should also have additional financial resources calculated annually for the overall emergency and disaster risk management programme, including preparedness measures.

**Safety ratings for item No. 72:** *Low = Emergency budget or mechanism to access emergency funds is not in place; Average = Funds are budgeted and mechanisms are available but cover less than 72 hours; High = Sufficient funds are guaranteed for 72 hours or more.*

### 73. Expansion of usable space for mass casualty incidents

**Recommended evaluation methods:** interview, review of documentation (including procedures) and inspection.

Evaluators should verify that procedures are in place to expand space and provide access to extra beds for mass casualty incidents – i.e. when the number of patients exceeds normal capacity. Expansion areas should be identified before the event and these areas should be clearly signed. Evaluators should verify that staff have been trained, the procedures for expanding space have been tested and that adequate resources are available for implementation. Procedures for expansion of capacity should be part of hospital exercises. Ensure the expansion space has accounted for the provision of lifelines (water, power, sanitation, etc.), logistics and necessary staffing.

**Safety ratings for item No. 73:** *Low = Space for expansion has not been identified; Average = Space has been identified; equipment, supplies and procedures are available to carry out the expansion and staff have been trained, but testing has not been conducted; High = Procedures exist and have been tested, personnel have been trained, and equipment, supplies and other resources are available to carry out the expansion of space.*

### 74. Procedures for admitting and treating patients during emergencies

**Recommended evaluation methods:** interview and review of documentation (including procedures and reports).

Evaluators should confirm that the hospital has measures in place to deal with an emergency or disaster involving a massive influx of victims to health centers. A variety of processes related to mass casualties are needed to avoid incorrect classifications or interpretations of triage, duplicated registrations, erroneous information, missing information about treatments already undertaken, etc. Protocols for treating



mass casualties simplify the organization of tasks and, therefore, improve quality of treatment and patient outcomes. Assigning responsibilities to the facility's health care staff will ease the process from the moment that casualties begin to arrive at the facility.

Evaluators should determine whether staff have been trained in these procedures and whether resources can be mobilized at all times. Hospitals should identify in advance non-essential hospital services that can be suspended in order to maximize resources (e.g. staff, clinical support, financial) for critical services during emergencies and disasters.

**Safety ratings for item No. 74:** *Low = Procedures do not exist or exist only as a document; Average = Procedures exist, personnel have been trained but would not be available at all times; High = Procedures exist, personnel have been trained, and resources are available to implement procedures at maximum hospital capacity for emergency and disaster situations at all times.*

#### 74. Triage for major emergencies and disasters

**Recommended evaluation methods:** interview, review of documentation (including procedures and reports) and inspection.

Evaluators should verify that space has been designated and personnel have been trained to carry out triage in a major emergency/disaster situation. The triage procedures for a major emergency or disaster should have been tested and there should be resources (e.g. staff, materials) available to conduct triage. In the event that chemical or radioactive materials may be present, triage should take place outside the hospital and before patients enter the emergency department.

A hospital emergency department requires a wide range of supplies to manage a mass casualty incident. These include triage tags, charts, vests and marking tape for triage areas. Evaluators should check that the availability of these supplies will cover the planned maximum capacity for at least 72 hours to ensure that the hospital can sustain the provision of services in an emergency or disaster situation.

**Safety ratings for item No. 75:** *Low = Designated triage location or procedures do not exist; Average = Triage location and procedures exist and personnel have been trained, but procedures have not been tested for emergency and disaster situations; supplies cover less than 72 hours maximum hospital capacity; High = Location and procedures exist and have been tested, personnel have been trained, and resources are guaranteed for at least 72 hours to implement at maximum hospital capacity in emergency and disaster situations.*

## 76. Transportation during an emergency

**Recommended evaluation methods: observation, review of documentation (including procedures) and inspection.**

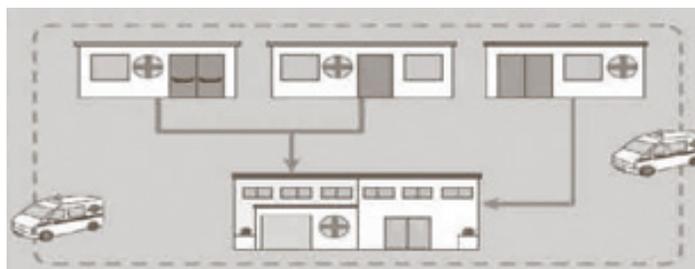
Evaluators should verify that procedures are in place to ensure availability and access to ambulances and other vehicles and necessary modes of transportation for the movement of patients, staff, equipment and supplies during an emergency or disaster. Procedures should address the communications between hospitals, vehicles and personnel at the scene of the emergency, as well as coordination of patient distribution and referral. Safety and security procedures should apply to the use, storage and maintenance of vehicles. Vehicles may be available to the hospital via agreements from other sources. Evaluators should note that transport may be provided via land, water and air.

**Safety ratings for item No. 76:** *Low: Transport logistics not considered in the plan; ambulances and other vehicles and modes of transportation are not available; Average = Transport is considered in the plan, some vehicles are available, but not in sufficient numbers for a major emergency or disaster; High = Transport logistics considered in the plan and there are enough resources (owned by the hospital and/or agreements).*

## 77. Coordination mechanisms and cooperative arrangements with local healthcare network and other agencies

**Recommended evaluation methods: interview and review of documentation (including arrangements and reports).**

Evaluators should verify that formal coordination mechanisms and cooperative arrangements exist between the hospital and public and private agencies that provide rescue and pre-hospital emergency care, under the coordination of the local health sector authority.



Hospitals must be able to function jointly as a health delivery network. In this context, medium and small hospitals should coordinate very closely with the closest hospital, and the service network should address how to assist remote communities.

No health facility, however large and complex, will be able to offer all services, and treatment capacity might be limited as a result of a major emergency or disaster. For this reason,

coordination within the health services network, together with a very strong classification and distribution of patients, will optimize the existing health network in a region, as well as making additional staff available, when necessary.

Evaluators should verify that formal coordination mechanisms and cooperative arrangements exist between the hospital and local health authorities, public, private and other nongovernmental hospitals (especially neighbouring hospitals), practitioners and volunteer groups to ensure provision of essential health services in the community during times of emergency or disaster. Arrangements should have been tested in regular exercises (at least annually).

**Safety ratings for item No. 77:** *Low = No arrangements exist; Average = Arrangements exist but are not fully operational; High = Arrangements exist and are fully operational.*

## 78. Linkage with local emergency response plan

**Recommended evaluation methods: interview and review of documentation (including arrangements and reports).**

To provide coordinated response in emergency situations, organization at the local level (i.e., municipality, region, or district) must be linked with that of hospitals of the relevant jurisdiction, taking into account both their resources and limitations. Evaluators should verify that formal coordination mechanisms and cooperative arrangements exist between the hospital and local emergency/disaster management agencies (e.g. local emergency management coordination committees, emergency services, civil protection, fire, police) in order to support hospital functions in time of emergency or disaster. The arrangements could include assistance with patient transfers and diversion of other incoming patients, traffic diversion, security, communications, logistics, decontamination, fire suppression etc. This coordination must be documented in a written agreement for parties involved. Arrangements should have been tested in regular exercises (at least annually).

**Safety ratings for item No. 78:** *Low = The plans are not linked or there is no documentation that demonstrates linkage; Average = Plans are linked but not operational; High = Plans are linked and operational.*

## 79. System for referral of patients

**Recommended evaluation methods: interview and review of documentation (including procedures and reports).**

Evaluators should verify that the hospital has documented criteria for receiving and referring patients during an emergency or disaster. The plan includes specific procedures for the transfer and reception of patients to and from other health facilities within and outside the geographical area where the hospital is located (including measures to ensure their safety during transfer).

**Safety ratings for item No. 79:** *Low = Procedures do not exist or exist only as a document; Average = Procedures exist and personnel have been trained, but procedures have not been tested for emergency or disaster situations; High = Procedures exist and have been tested, personnel have been trained, and resources are available to implement measures at maximum hospital capacity in emergency or disaster situations.*

## 80. Procedures for communicating with the public and media

**Recommended evaluation methods: interview and review of documentation (including procedures and reports).**

Evaluators should verify that procedures are in place for communicating with the public and media in case of an emergency or disaster, and that a spokesperson(s) has been nominated for this role. Evaluators should determine if spokespersons have received specific media training and if exercises have tested this skill.

**Safety ratings for item No. 80:** *Low = Procedures do not exist, no spokesperson nominated; Average = Procedures exist and nominated spokespersons have been trained; High = Procedures exist, nominated spokespersons have been trained, and procedures have been tested at least annually.*

## 81. Mobilization and recruitment of personnel during an emergency or disaster

**Recommended evaluation methods: interview and review of documentation (including procedures).**

Evaluators should verify that procedures are in place for the mobilization of existing on-duty and off-duty staff and recruitment and training of employable personnel and volunteers

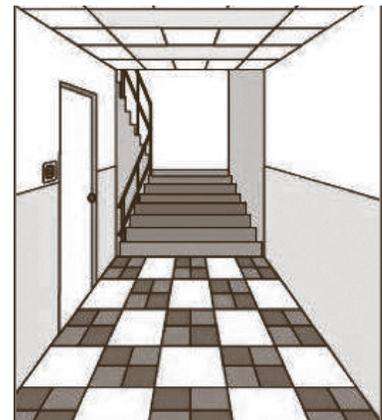
to meet surge capacity needs of high-demand clinical and support services (e.g. emergency department, surgery, intensive care units, security, managerial and administrative support). Evaluators should verify if staff emergency rosters exist and are maintained. These rosters should identify staff who are on call at all times for key roles for the immediate response to emergencies and disasters, and other staff who will be mobilized in accordance with the scale of the response. Strategies to address evening, weekend and holiday coverage, as well as necessary incentives (e.g. overtime pay), should be considered.

**Safety ratings for item No. 81:** *Low = Procedures do not exist or exist only in a document; Average = Procedures exist and personnel have been trained, but the human resources for an emergency situation are not available; High = Procedures exist, personnel have been trained, and the human resources are available to meet anticipated needs in an emergency.*

## 82. Evacuation plan

**Recommended evaluation methods:** interview, review of documentation (plan) and inspection.

While the aim of this material is to avoid situations that demand evacuation of a hospital, events might require moving patients and workers from one part of the facility to another, or outside of the facility. Evaluators should verify criteria and procedures for vertical, horizontal and partial evacuation of patients, visitors and staff to a safe location with the necessary medical, logistical and administrative support. The criteria should enable triage for evacuation of patients. Training of staff and the regularity of evacuation drills should be evaluated. Signs must indicate evacuation routes and hallways, and exits must be clear and capable of handling evacuations at all times. Once the danger has passed, the disaster plan should address the return of patients and staff to the hospital.



All areas of the hospital must be evaluated to ensure effective evacuations.

**Safety ratings for item No. 82:** *Low = Plan does not exist or exists only as a document; Average = Plan exists and personnel have been trained in procedures, but tests are not conducted regularly, and/or evacuation routes are not adequate; High = Plan exists, personnel have been trained, and evacuation drills are held at least annually.*

### 83. Staff availability and preparedness

**Recommended evaluation methods: interview, review of documentation and inspection.**

The actual staffing levels of hospitals during normal functioning may be lower than the planned staffing levels for a wide range of reasons – including funding shortages, security concerns, staff absenteeism etc. The availability of staff will have a significant bearing on the capacity of the hospital to deliver services in response to an emergency or disaster. Evaluators should determine the current workforce availability compared to service delivery requirements of all major departments (e.g. emergency medicine, surgery, internal medicine, orthopaedics, support services, security) during normal functioning (non-emergency). For example, if a department should have a staffing level of 10 staff and only 4 staff are available, the staff availability is 40%.



It is important to design a training plan for the hospital's staff that includes, among others, the following topics: knowledge of the hospital's disaster plan, treatment of mass casualties, vulnerability of the facility, mental health care, information management, damage assessment, fire prevention and suppression, etc.

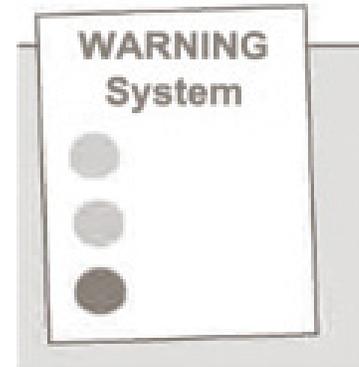
An emergency medical team trained in treating mass casualties must be able to rapidly organize the arrival of large numbers of victims. An administration team must be prepared to provide for a variety of immediate needs such as expanding treatment areas, procurement of supplies, etc. None of this will be possible without a training program that addresses the different phases of an emergency or disaster. Evaluators should confirm that there is an on-going training program. It is advisable to corroborate the level of training directly with staff.

**Safety ratings for item No. 83:** *Low = Less than 50% of staff is available to run each department adequately and trained to respond in disaster situations; Average = Between 50% and 80% of the staff are available and trained to respond in disaster situations; High = 80% -100% of staff are available and trained.*

## 84. Emergency warning system defined and tested

**Recommended evaluation methods: interview, review of documentation and inspection.**

Emergency warnings are used to launch specific actions to address a given situation. In the health sector they are generally identified by colors that advance from green to red. Knowledge of the system will allow each member of staff to know what to do in a given event.



Evaluators should confirm that the facility has an emergency warning system and that staff have been trained to respond appropriately. Staff should be trained with the documented procedures at least annually.

**Safety ratings for item No. 84:** *Low = Emergency warning system does not exist or there is no documentation for system; Average = Emergency warning system is in place but personnel have not been trained in system; High = Emergency warning system is in place and personnel have been trained in how to respond using the documented procedures at least annually.*

## 85. Alarm system defined and tested

**Recommended evaluation methods: interview, review of documentation and inspection.**

Alarms are a broadcast and/or lighted signal indicating the need for immediate actions such as evacuation, moving patients and staff, suspension of activities, failure of electrical systems, etc. The ability to identify different alarms and their meaning allows an appropriate response.



Emergency and disaster plans should include the codes for alarms for different situations, so that each person will know exactly how to proceed. Evaluators should confirm that the hospital has an alarm system in place and that all staff in the facility are trained to respond at least annually.

**Safety ratings for item No. 85:** *Low = Alarm system does not exist or there is no documentation about system; Average = Alarm system is in place but personnel have not been trained in system; High = Alarm system is in place and personnel have been trained in how to respond using the documented procedures at least annually.*

## 86. Hospital emergency and disaster response plan exercises, evaluation and corrective actions

**Recommended evaluation methods: interview and review of documentation (including exercise plans and reports).**

There should be regular emergency simulations and drills as a part of staff training in the hospital. These are fundamental for the personnel to practice assigned responsibilities and to adapt the disaster plan where necessary.



Evaluators should verify that the emergency/disaster response plan (including hazard-specific subplans) is tested regularly through simulations and drills and is evaluated and amended as appropriate. Exercises of the hospital emergency/disaster response plan should be held at least annually. Exercises of hazard-specific sub plans should be rotated into the annual exercise programme.

Evaluators should determine what process for the management of the exercises was followed – including development, conduct and evaluation. The process should have included a way to identify corrective actions, such as a post-exercise after action review, and to address the gaps noted in the exercise, including additional preparedness measures and training needs, and the revision of the emergency response plan. The expectation is not for simulations to always be successful: the aim is to find weaknesses in order to improve them.

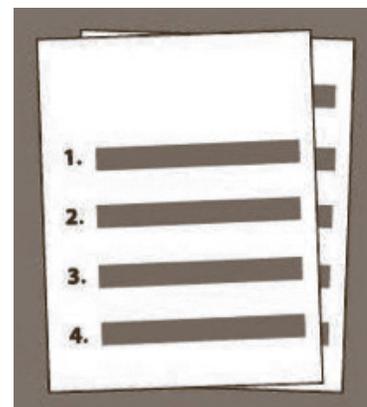
**Safety ratings for item No. 86:** *Low = Response plan and sub plans have not been tested; Average = Response plan or sub plans are tested, but are not tested at least annually; High = Response plan or sub plans are tested at least annually and updated according to the exercise results.*

## 87. Preparedness programme for strengthening emergency and disaster response and recovery

**Recommended evaluation methods: interview and review of documentation (including action plan and activity report).**

Evaluators should verify that the Hospital Emergency/Disaster Committee has a programme or action plan to strengthen the preparedness of the hospital for response and recovery to emergencies and disasters. The preparedness activities should be supported by a budget and included as part of the annual work programme of the hospital. Evaluators

should determine if preparedness activities are being implemented in accordance with the programme or action plan. Actions to strengthen preparedness may be included alongside measures to address facility risk assessment, hazard prevention and vulnerability reduction as part of an overall risk management programme.



**Safety ratings for item No. 87:** *A programme for strengthening preparedness, response and recovery does not exist or, if it exists, no preparedness activities are being implemented; Average = A programme for strengthening preparedness, response and recovery exists and some activities are being implemented; High = A programme for strengthening preparedness, response and recovery is being fully implemented under the leadership of the Hospital Emergency/Disaster Committee.*

### 4.3 Availability of medications, supplies, instruments, and equipment for disaster situations

Submodule 4.3 consists of 7 items (88 – 94).

Evaluators should cross-check the list of available supplies with those that are essential in emergencies.

#### 88. Medications and supplies for emergency response

**Recommended evaluation methods:** interview, review of documentation and inspection.

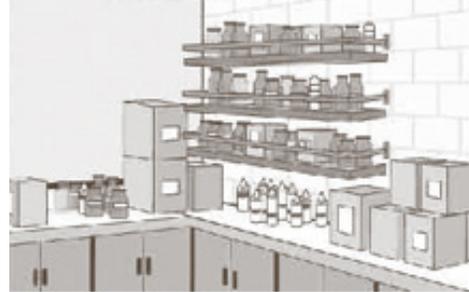
Evaluators should verify the availability of medicines for emergencies. The World Health Organization (WHO) list of essential drugs can be used as a reference or the one that is used in the country.

**Safety ratings for item No. 88:** *Low = There is no reserve or there is no documentation demonstrating reserve; Average = Medication reserves are not sufficient for 72 hours; High = There are sufficient reserves for emergency response for at least 72 hours.*

## 89. Tools and sterilized equipment for emergency response

**Recommended evaluation methods: interview and inspection.**

Evaluators should verify the existence and maintenance of specific tools and sterilized equipment for the critical care of patients in the hospital. It is important to ensure that the hospital has enough tools and sterilized supplies to meet the demand for critical care patients and the response to emergencies or disasters.



**Safety ratings for item No. 89:** *Low = There are no reserves or there is no documentation regarding emergency supplies; Average = Reserves are not sufficient for 72 hours; High = Reserves are in place for emergency response for at least 72 hours or more.*

There should be enough sterilized supplies for the treatment of patients.

## 90. Life support equipment for emergencies

**Recommended evaluation methods: interview and inspection.**

Depending on the hospital's level of complexity, evaluators should ascertain the presence, location, number, and conditions of life support equipment for critical patients (resuscitation equipment, ventilators, monitors, etc.). The hospital should consider placing such equipment in areas such as: emergency services, intensive care, surgical area, orthopedics, neonatology, gynecology and obstetrics, among others.

**Safety ratings for item No. 90:** *Low = The facility does not have this equipment; Average = Equipment is available but there is only enough for regular, daily use; High = Facility has sufficient equipment for use in an emergency or disaster.*

## 91. Personal protection equipment and isolation for infectious diseases and epidemics

**Recommended evaluation methods: interview, review of documentation and inspection.**

Evaluators should verify the availability of personal protection equipment for staff working in areas at high risk of exposure to infectious diseases mainly in laboratories, and contaminated areas and places where potentially infectious or biohazardous agents can be found. Evaluators should check whether isolation areas are established. Evaluators should verify

the level of the demand for personal protective equipment at the maximum capacity of the hospital, taking into account the types of services provided by the hospital and the additional capacity required to respond to emergencies and disasters. Evaluators should check that the availability of disposable personal protective equipment (such as gloves, disposable clothing, face masks, safety glasses, among others) is sufficient for this maximum demand for at least 72 hours to ensure that the hospital can sustain the provision of services in an emergency or disaster. Evaluators should check arrangements and timing for the resupply of personal protective equipment. Staff should be trained regularly to maintain and update skills in applying personal protection and procedures for conducting isolation of patients.

**Safety ratings for item No. 91:** *Low = No personal protective equipment is available for immediate use by hospital staff, or no isolation area exists; Average = Supply is available for immediate use, but is sufficient for less than 72 hours of maximum hospital capacity, isolation areas are established, staff training and testing of procedures are not conducted annually; High = Supply is guaranteed for at least 72 hours of maximum hospital capacity and alternate sources are in place for resupply, isolation areas are established, staff training and testing of procedures are conducted at least annually.*

## 92. Infection surveillance, prevention and control procedures

**Recommended evaluation methods:** interview, review of documentation (including procedures and reports) and inspection.

Evaluators should verify that an infection prevention and control programme – including related policies, procedures and measures – is in place. The programme should address standard precautions, hospital-based surveillance and measures for highly infectious diseases. These procedures should be linked to the surveillance system of the health area where the hospital is located. There should be an active programme of staff training in infection prevention and control procedures. Additional resources should include the availability of supplies for emergency situations, including epidemics and pandemics, and extra cleaning staff.

**Safety ratings for item No. 92:** *Low: Policies and procedures do not exist; standard precautions for infection prevention and control are not followed routinely; Average = Policies and procedures exist, standard precautions are routinely followed, personnel have been trained, but the level of resources required for emergency and disaster situations, including epidemics, is not available; High = Policies and procedures exist, infection prevention and control measures are in place, personnel have been trained, and resources are available to implement measures at maximum hospital capacity in emergency and disaster situations.*

### 93. Food and drinking water during an emergency

**Recommended evaluation methods: interview and review of documentation (including procedures).**

Evaluators should verify that procedures are in place to ensure provision of food and water to patients and personnel during an emergency. Evaluators should confirm that there are measures for supplying and storing food and drinking water during the emergency and that funds for food are included in the budget. They should consider the extra food and water requirements of hospital and ambulance staff, patients and volunteers who are mobilized for the emergency or disaster.

**Safety ratings for item No. 93:** *Low = Procedures for food and drinking water for emergencies are non-existent; Average = Procedures exist, food and drinking-water is guaranteed for less than 72 hours; High = Food and drinking-water for emergencies is guaranteed for at least 72 hours.*

### 94. Duties assigned to personnel for emergency or disaster response and recovery

**Recommended evaluation methods: interview and review of documentation (including procedures).**

The emergency/disaster response plan includes specific instructions for assigning duties to existing staff and to personnel external to the hospital who are mobilized during the emergency. Evaluators should verify that all staff have, or will receive, written instructions (e.g. action card, job action sheet) and training and/or exercises on duties to be performed during an emergency.

As the turnover of staff in hospitals is rapid, a plan should also be in place to train hospital personnel continually on the emergency/disaster response plan and on their roles when it is activated. Training of staff for emergencies and disasters should also be a regular part of orientation for new staff.

**Safety ratings for item No. 94:** *Low = Emergency assignments do not exist or are not documented; Average = Duties are identified, some (but not all) personnel receive written assignments or training; High = Written duties are assigned, and training or an exercise is conducted for all personnel at least annually.*

# Annex|1

## Form 1

### General information about the hospital

(This must be completed by the hospital, preferably by the disaster committee of the hospital being evaluated.)

Notice:

This version of the form is for reference only. To complete the evaluation and provide necessary information, print Annex 1 from the *Forms for the evaluation of medium and small hospitals* document.



1. **Hospital Name:** .....
2. **Address:** .....
3. **Phone** (include city code): .....
4. **E-mail:** .....
5. **Total number of beds** (if not applicable put "0"): .....
6. **Bed occupancy rate in normal situations** (if applicable): .....
7. **Description of the institution** (general features, institution to which it belongs, type of hospital, position in the network of health services, type of structure, population served, area of influence, service and administrative personnel, etc.):  
.....  
.....
8. **Physical Distribution:** List and briefly describe the main buildings in the hospital. Provide a diagram in the box below showing physical distribution of the services and the hospital's surroundings. Use additional pages, if necessary.  
.....  
.....

9. **Capacity of the hospital:** Hospital capacity: Indicate the total number of beds and the capacity to expand service in emergencies, according to the hospital’s organization (by department or specialized services).

Department or Service	Number of beds	Additional capacity	Remarks
Emergency			
Pediatrics			
General Medicine			
Gynecology/Obstetrics			
Others (Specify)			
Total			

If the hospital does not have patient beds, insert “0” for number of beds, but indicate whether it is possible to accommodate cots or stretchers for patient observation.

10. **Areas that can be used to increase functional capacity:** Indicate the features of areas and spaces that can be used to increase the hospital’s capacity in case of an emergency or disaster. Specify square meters, available services and any other information that can be used to evaluate its suitability for emergency medical services.

Location	Area (m <sup>2</sup> )	Water		Power		Telephone		Remarks
		Yes	No	Yes	No	Yes	No	

Note: Specify how each space can be adapted for different uses (for example, patient care, triage, outpatient care, observation, etc.).

11. **Additional information:**

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# Annex|2

## Form 2

### Checklist for evaluation of the safety level of the hospital

Notice:

The evaluation team leader should distribute a copy of the checklist to each evaluator. Do not use the following version (Annex 2), which only serves as a reference tool. To complete the checklist and provide necessary information, print Annex 2 from the *Forms for the evaluation of medium and small hospitals* document.



**1. Hazard levels as determined by geographic location of the hospital (mark appropriate box with an “X”).**

1.1 Hazards (Consult hazard maps)	Hazard level				Comments
	No Hazard	Hazard level			
		Low	Average	High	
<b>1.1.1 Geological phenomena</b>					
<b>Earthquakes</b> Using the geologic analysis of the soil and history of earthquakes in the area, identify the hazard level of the hospital to earthquakes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Volcanic eruptions</b> Based on the history of similar events in the area, proximity to volcanoes, and volcanic activity, identify the hazard level of the hospital to lava, pyroclastic flows, and ash fall.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Landslides</b> Based on inspections of the hospital’s surroundings, prior events, and information from the hazard map, identify the hazard level of the hospital to instable slopes in the area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Tsunamis</b> Refer to hazard maps and prior events in the area to determine the hazard level of the hospital to tsunamis.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>1.1.2 Hydrometeorological phenomena</b>					
<b>Hurricanes</b> Based on the history of hurricanes in the area and using available wind hazard maps, indicate the hazard level for the hospital to hurricanes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Torrential rains</b> Based on the history of such events and available hazard maps, rate the hazard level for flooding due to intensive rainfall for the hospital.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Storm surge or river flooding</b> Based on previous events that did or did not cause flooding in or around the hospital, rate the hospital’s level of exposure to storm surge or river flooding.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Landslides</b> Refer to geological maps and inspections of the hospital’s surroundings to rate its level of exposure to landslides caused by saturated soil.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<b>1.1.3 Social phenomena</b>					
<p><b>Population density</b> Rate the hospital's exposure to hazard as influenced by the type of population it serves, its proximity to major population concentrations, and prior events that have affected the hospital.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Displaced populations</b> Based on information collected, rate the hospital's exposure to hazard in terms of people who have been displaced as a result of war, socio-political circumstances, or due to population migrations.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Others (specify)</b> If other social phenomena affect the safety of the hospital (such as workers' strikes, protests, proximity to high security prison, etc.), specify them and rate the level of hazard for the hospital.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>1.1.4 Environmental health phenomena</b>					
<p><b>Epidemics</b> With reference to any past incidents at the hospital and specific pathogens, rate the hospital's exposure to hazards related to epidemics.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Contamination (systems)</b> With reference to any past incidents involving contamination, rate the hospital's exposure to hazards from contamination of its systems.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Infestations</b> With reference to the location and past incidents at the hospital, rate the hospital's exposure to hazards from infestations (flies, fleas, rodents, etc.).</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Others (specify)</b> With reference to any past incidents at the hospital, specify and rate the hazard of any other environmental phenomena not included above.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>1.1.5 Chemical and/or technological phenomena</b>					
<p><b>Explosions</b> After inspecting the hospital's surroundings, reviewing any prior events, and consulting a variety of sources, rate the hospital's exposure to explosion hazards.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Fires</b> After inspecting the hospital's surroundings, reviewing any prior events, and consulting a variety of sources, rate the hospital's exposure to fire hazards.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>Hazardous material spills/leaks</b> Rate the hospital's exposure to hazardous material spills or leaks after inspecting the hospital's surroundings, reviewing any prior events, and consulting a variety of sources. Take into account both storage and transport routes for hazardous materials.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Others (specify)</b> Indicate the hazard level of other chemical or technological hazards in the area where the hospital is located.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>1.2 Geotechnical properties of soils</b>					
<p><b>Liquefaction</b> Refer to the geotechnical soil analysis and other evidence from the area to rate the hospital's level of exposure to hazards from saturated and loose subsoil.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Clay soils</b> Refer to soil maps and evidence from buildings at the site to rate the hospital's exposure to hazards from sensitive or soft clay soils.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>Unstable slopes</b> Refer to geologic maps and evidence from the area to rate the hospital's exposure to hazards from the presence of unstable slopes.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

**Comments about Section 1.** The evaluator should use the space below to comment on the results of this section, and provide his/her name and signature.

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Name of evaluator(s) .....

Signature of evaluator .....

**2. Safety level as determined by structural aspects of the health care hospital (mark the corresponding safety level with an “X”)**

2.1 Degree of safety in relation to the history of the hospital	Safety level			Comments
	Low	Average	High	
<p><b>1. Prior major structural damage or failure of the hospital building(s)</b>  <i>Safety ratings: Low = Major damage and no repairs; Average = Moderate damage and building only partially repaired; High = Minor or no damage, or building fully repaired.</i></p> <p><i>IF SUCH AN EVENT HAS NOT OCCURRED IN THE VICINITY OF THE HOSPITAL, LEAVE BOXES BLANK AND PROVIDE COMMENT.                      IF DAMAGE HAS OCCURRED DUE TO A LESSER EVENT THAN THE DESIGN LEVEL THEN RATE AS LOW SAFETY.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>2. Hospital built and/or repaired using the current safety standards</b>  <i>Safety ratings: Low: Current safety standards not applied; Average = Current safety standards partially applied; High = Current safety standards fully applied.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>3. Effect of remodelling or modification on the structural behaviour of the hospital</b>  <i>Safety ratings: Low = Major remodelling or modifications have been carried out with major compromising effect on the performance of the structure (e.g., removing a load-bearing wall, opening for a new window, etc.); Average = Moderate remodelling and/or modifications with minor effect on the performance of the structure (e.g., openings for doors and small windows); High = Minor remodelling and/or modifications; no modifications were carried out; or major remodelling and/or modification enhancing the structural behaviour or having no negative effect.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>2.2 Building integrity</b>				
<p><b>4. Condition of the building</b>  <i>Safety ratings: Low = Cracks on the ground and first floors; Major deterioration caused by weathering or normal ageing; Average = Some deterioration caused only by weathering or normal ageing; High = No deterioration or cracks observed.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>5. Condition of construction materials</b>  <i>Safety ratings: Low = Rust with flaking; cracks larger than 3 mm (concrete), excessive deformations (steel and wood); Average = Cracks between 1 and 3 mm present (concrete), moderate and visible deformations (steel and wood) or rust with no flaking; High = Cracks less than 1 mm (concrete), no visible deformations; no rust. (This section depends on the experienced judgment of a structural engineer.)</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>6. Interaction of nonstructural elements with the structure</b>  <i>Safety ratings: Low = Partition walls rigidly attached to the structure, suspended ceilings or facades interacting with the structures, damage would have significant effect on the structure; Average = Some of the preceding nonstructural elements interacting with the structures, damage would not affect the structure; High = There are no nonstructural elements affecting the structure.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>7. Building proximity</b>  <i>Safety ratings: Low: There is almost no separation between buildings or separation is less than 25 mm (1 inch); Average = Separation is between 25 to 100 mm (1 to 4 inches); High = Separation is more than 100 mm (4 inches). Note: For adjacent buildings over 2-storeys, the safe separation should be determined by calculation by the Engineer.  For fire threat, consider the following: Low = separation between buildings is smaller than 5 m.; Average= separation is between 5 to 15 m.; High= separation is bigger than 15 m.  If both hazards exist, consider the worse case.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>8. Structural redundancy</b>  <i>Safety ratings: Low = Fewer than three lines of resistance in each direction; Average = Three lines of resistance in each direction or lines without orthogonal orientation; High = More than three lines of resistance in each orthogonal direction of the building.</i></p>				
<p><b>9. Structural detailing, including connections</b>  <i>Safety ratings: Low = No evidence of engineered building records, or built according to an old design standard; Average = Built according to previous design standards and no retrofitting work to a current standard; High = Built according to a current standard.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>10. Safety of foundations</b>  <i>Safety ratings: Low = No evidence that foundations were designed according to standards (foundation size, soil survey) and/or there is evidence of damage; no plans are available; Average = Little evidence (drawings, soil survey) that foundations were designed according to standards; and/or there is evidence for moderate damage; High = Strong evidence that foundations were designed according to standards with strong evidence of no damage.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>11. Irregularities in building structure plan (rigidity, mass, resistance)</b>  <i>Safety ratings: Low = Shapes are irregular and structure is not uniform; Average = Shapes on plan are irregular but structure is uniform; High = Shapes on plan are regular and structure has uniform plan, and there are no elements that would cause significant torsion.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>12. Irregularities in elevation of buildings</b>  <i>Safety ratings: Low = The presence of soft stories or two or more of the other condition conditions (discontinuity in elevation, concentration of masses, and short columns); Average = Presence of any one of these conditions, except soft storeys; High = None of these conditions are present.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>13. Structural integrity of roofs</b>  <i>Safety ratings: Low = Monopitch or flat light roofs, and/or large roof overhangs; Average = Pre-stressed concrete roof, gable roof with gentle slope, satisfactorily connected, no large roof overhangs; High = Reinforced cast in place on concrete roof deck or hipped light roof, satisfactory connections, no large roof overhangs.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>14. Structural resilience to hazards other than earthquakes and strong winds</b>  <i>Safety ratings: Low structural resilience to hazards present at the site of the hospital; Average = Satisfactory structural resilience (taking account of structural risk reduction measures in place); High = Good structural resilience (taking account of risk reduction measures in place).</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

**Comments about Section 2.** The evaluator should use the space below to comment on the results of this section, and provide his/her name and signature.

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Name of evaluator(s) .....

Signature of evaluator .....

**3. Safety level as determined by nonstructural elements of the health care hospital (mark the corresponding safety level with an “X”)**

3.1 Lifelines	Safety level			Comments
	Low	Average	High	
<b>3.1.1 Electrical system</b>				
<p><b>15. Capacity of alternate sources of electricity (e.g. generators)</b>  <i>Safety ratings: Low = There is no alternative power source that can meet the needs of the hospital or the existing one is not working; Average = There is an alternative power source but does not supply all the critical areas or has fuel reserve to run less than 72 hours; High = There is an alternative power source that meets the needs of the entire facility and it is operational for more than 72 hours.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>16. Condition and safety of alternate source(s) of electricity</b>  <i>Safety ratings: Low = No alternate sources; generators and fuel reserve are in poor condition, there are no protective measures; Average = Generators are in fair condition, some measures provide partial protection and security to generator and fuel reserve; High = Generators are in good condition, well-secured and in good working order for emergencies, fuel reserves are protected in a safe zone.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>17. Condition and safety of electrical equipment, cables and cable ducts</b>  <i>Safety ratings: Low = Electrical equipment, power lines, outlets, cables and ducts are in poor condition, there are no protective measures; Average = Electrical equipment, power lines, outlets, cables and ducts are in fair condition; some measures provide partial protection and security; High = Electrical equipment, power lines, outlets cables and ducts are in good condition, well-secured and in good working order.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>18. Lighting system</b>  <i>Safety ratings: Low = Poor level of lighting; there are no protective measures; Average = Lighting is satisfactory in the critical areas; some measures provide partial protection; High = Good levels of lighting and protection measures in place.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>19. Emergency maintenance and restoration of electric power supply and alternate sources</b>  <i>Safety ratings: Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<b>3.1.2 Telecommunications system</b>				
<p><b>20. Effectiveness of the communication system</b>  <i>Safety ratings: Low = The communications system is in poor condition; or there is no system; Average = A basic communication exists and is in fair condition; High = A high communication system exists in a good condition.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>21. Alternate communications systems</b>  <i>Safety ratings: Low = Alternate communications systems do not exist, are in poor condition, or do not function; Average = Hospital-wide alternate communications system in fair condition, but is not tested on an annual basis; High = Alternate communication system in good condition and tested at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>22. Protection of communications equipment and cables</b>  <i>Safety ratings: Low = Equipment and cables in poor condition and/or are not protected, at high risk of failure due to hazards; Average = In fair condition, some measures provide partial protection; High = Good condition, communication equipment well-secured.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>23. Emergency maintenance and restoration of standard and alternate communications systems</b>  <i>Safety ratings: Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>3.1.3 Water supply system</b>				
<p><b>24. Water reserves for hospital services and functions</b>  <i>Safety ratings: Low = TSufficient for 24 hours or less, or water tank does not exist; Average = Sufficient for more than 24 hours but less than 72 hours; High = Guaranteed to cover at least 72 hours.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>25. Location of water storage tanks</b>  <i>Safety ratings: Low = The site is vulnerable with high risk of failure (e.g. structural, architectural and/or system vulnerabilities); Average = The site is exposed to moderate risk of failure (e.g. structural, architectural and/or system vulnerabilities); High = The site is not exposed to visually identifiable risks (e.g. structural, architectural and/or system vulnerabilities).</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>26. Alternate water supply to the regular water supply</b>  <i>Safety ratings: Low = Provides less than 30% of daily demand in an emergency or disaster scenario; Average = Provides 30–80% of daily demand in an emergency or disaster scenario; High = Provides more than 80% of daily demand in an emergency or disaster scenario.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>27. Safety of the water distribution system</b>  <i>Safety ratings: Low = Less than 60% of components are in operational condition; Average = Between 60% and 80% of components are in good condition; High = Over 80% of components are in good condition.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>28. Water quality control</b>  <i>Safety ratings: Low = Less than 60% are in good operational condition; Average = Between 60% and 80% are in good condition; High = Above 80% are in good condition.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>29. Emergency maintenance and restoration of water supply systems</b>  <i>Safety ratings: Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>3.1.4 Fuel storage (gasoline, LPG and others)</b></p>				
<p><b>30. Fuel reserves</b>  <i>Safety ratings: Low = Sufficient for 24 hours or less, or fuel tank does not exist, or fuel tank is unsecured; Average = Sufficient for more than 24 hours but less than 72 hours, or storage area is in fair condition but inadequate for major hazards; High = Guaranteed to cover at least 72 hours and tank storage area is in good condition and has adequate security and safety for major hazards.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>3.1.5 Medical gases (oxygen)</b>                  (Leave this section blank if hospital does not provide services requiring medical gases.)</p>				
<p><b>31. Medical gas reserves for adverse events</b>  <i>Safety ratings: Low = There is less than one day of reserve; Average = There are one to three days of reserve; High = There are at least three days of reserve.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>32. Safety of storage areas for medical gas tanks and/or cylinders</b>  <i>Safety ratings: Low = Medical gas tanks and cylinders in storage areas are poor condition; no protection measures, not secured; personnel are not trained to operate medical gas and fire extinguishing equipment; Average = Medical gas tanks and cylinders in storage areas are in fair condition, some measures provide partial protection; the quality of anchors and braces is inadequate; personnel are trained to operate equipment; High = Good condition, well-secured and protected, anchors are of good quality for major hazards; medical gas and fire extinguishing equipment operated by qualified personnel.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>33. Location of storage areas for medical gases</b>  <i>Safety ratings: Low = No sites reserved for medical gases, or sites for medical gases are at high risk of failure due to hazards; there are no protective measures, and storage is not accessible; Average = Reserved areas in fair condition and fair location; some measures provide partial protection; High = In good condition, well-secured and other protective measures are in place; storage is accessible.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>3.1.6. Sanitation system</b></p>				
<p><b>34. Safety of nonhazardous wastewater systems</b>  <i>Safety ratings: Low = System for nonhazardous wastewater disposal does not exist or is in poor condition; Average = System is in fair condition, but little or no evidence of compliance and maintenance; High = Wastewater disposal system is in good condition with good capacity and evidence of compliance and maintenance.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>35. Safety of hazardous and non-hazardous solid waste system</b>  <i>Safety ratings: Low = System for hazardous and/or nonhazardous solid waste disposal does not exist or is in poor condition; Average = System is in fair condition but little or no evidence of compliance and maintenance; High = Disposal system has good capacity and evidence of compliance and maintenance.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>36. Emergency maintenance and restoration of all types of hospital waste management systems</b>  <i>Safety ratings: Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<b>3.1.7 Storm drainage system</b>				
<p><b>37. Safety of the storm drainage system</b>  <i>Safety ratings: Low = Storm drainage does not exist, or it is in poor condition; Average = The storm drainage system is in average condition; High = Storm drainage system is in good condition and is regularly maintenance.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>3.2 Heating, ventilation, air conditioning (HVAC) and hot water, mainly in critical areas</b>				
<p><b>38. Condition and safety of HVAC components</b>  <i>Safety ratings: Low = HVAC equipment in poor condition, less than 60% pipes are in good condition; limited protective measures against hazards; not secured; Average = HVAC equipment in fair condition, but no regular maintenance; between 60–80% pipes are in good condition; some measures provide partial protection against hazards; High = Good condition, well-secured and protected from hazards; above 80% piping are in good condition and are well-secured.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>39. Emergency maintenance and restoration of HVAC systems</b>  <i>Safety ratings: Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>3.3 Furniture and fittings, office and storage equipment</b>				
<p><b>40. Safety of shelving and shelf contents</b>  <i>Safety ratings: Low = Shelving is not safely located (or in seismic and wind-prone areas not attached to walls in more than 20% of cases); Average = Shelving is safely located (and attached to walls in seismic and wind-prone areas) and contents are secured in 20–80% of cases; High = More than 80% of shelving and the contents of shelves are safely located, attached to walls, and contents are secured.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>41. Safety of office equipment (computers, printers, etc.)</b>  <i>Safety ratings: Low = No measures to protect office equipment from hazards are in place; Average = Office equipment are in safe locations, some measures offer partial protection from hazards; High = Office equipment are in safe locations, well-secured and good protective measures in place.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>42. Protection of furniture and fittings</b>  <i>Safety ratings: Low = Furniture and fittings are not anchored and wheels on furniture are not locked; Average = Some furniture and fittings are anchored and wheels on furniture are locked in some cases; Good = Furniture and fittings are anchored and wheels on furniture are locked.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>43. Protection of warehouses and storage from adverse events</b>  <i>Safety ratings: Low= These areas are not protected; Average = Only half of the areas are protected; High = All of these areas are protected.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>3.4 Medical and laboratory equipment and supplies used for diagnosis and treatment</b>				
<p><b>44. Protection of medical and laboratory equipment</b>  <i>Safety ratings: Low = 20% or less of equipment is protected; Average = Between 20% and 80% of equipment is protected; High = More than 80% of equipment is protected.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>45. Condition of medical and laboratory equipment</b>  <i>Safety ratings: Low = Equipment is lacking or 20% or less of equipment is in good condition; Average = Between 20% and 80% of equipment is in good condition but not regularly maintained; High = More than 80% of equipment is in good condition and is regularly maintained.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>3.5. Architectural components</b>				
<p><b>46. Condition and safety of doors, exits and entrances</b>  <i>Safety ratings: Low = Doors, exits and entrances in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; entrance width is less than 115 cm; Average = In fair condition, subject to damage but damage would not impede the function of this and other elements, systems or operations; or entrance width is less than 115 cm; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations; and entrance width is equal to or larger than 115 cm.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>47. Condition and safety of windows and shutters</b>  <i>Safety ratings: Low = Windows and shutters in poor condition, subject to damage and leakage which would impede the function of this and other elements, systems or operations (e.g. weak protective glazing); Average = In fair condition, subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations; protective glass (e.g. polycarbonate glazing, blast film) has been added in critical wards.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>48. Condition and safety of other elements of the building envelope (e.g. outside walls, facings)</b>  <i>Safety ratings: Low = Building envelope in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>49. Condition and safety of roofing</b>  <i>Safety ratings: Low = Roofing is in poor condition or damage would affect the performance of the hospital; Average = Roofing is in average condition or damage would not affect the performance of the hospital; High = Roofing is in good condition or there is no or minor potential for damage that could affect performance of the hospital.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>50. Condition and safety of parapets and other outside elements (railings, cornices, ornaments, etc.)</b>  <i>Safety ratings: Low = Parapets and other outside architectural element(s) in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition; subject to damage but damage to element(s) would not impede the function of this and other elements, systems or operations; High = In good condition; no or minor potential for damage that would impede the function of this and other elements, systems or operations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>51. Safe conditions for movement outside the hospital buildings</b>  <i>Safety ratings: Low = Obstacles or damage to structure or road and walkways will impede vehicle and pedestrian access to buildings or endanger pedestrians; Average = Obstacles or damage to structure or road and walkways will not impede pedestrian access, but will impede vehicle access; High = No obstacles, or potential for only minor or no damage that will not impede pedestrian or vehicle access.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>52. Safe conditions for movement inside the building (e.g. corridors, stairs)</b>  <i>Safety ratings: Low = Obstacles and damage to element(s) will impede movement inside the building and endanger occupants; Average = Obstacles or damage to elements will not impede movement of people but will impede movement of stretchers, wheeled equipment; High = No obstacles, potential for no or minor damage which will not impede movement of people or wheeled equipment.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>53. Condition and safety of internal walls and partitions</b>  <i>Safety ratings: Low = Internal walls and partitions in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, element(s) are subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>54. Condition and safety of false or suspended ceilings</b>  <i>Safety ratings: Low = False or suspended ceilings in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, element(s) subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.</i></p> <p><i>IF THE HOSPITAL DOES NOT HAVE FALSE OR SUSPENDED CEILINGS, LEAVE BOXES BLANK AND PROVIDE COMMENT.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>55. Condition and safety of the fire protection system</b>  <i>Safety ratings: Low = No system has been installed, or it is expired, or inaccessible; element(s) are subject to damage, and damage would impede the function of this and other elements, systems or operations; Average = Partially installed, or partially inaccessible; element(s) are subject to damage but damage would not impede function; High = System fully installed and regularly maintained; no or minor potential for damage that would impede the function of this and other elements, systems or operations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>56. Emergency maintenance and restoration of the fire protection system</b>  <i>Safety ratings: Low = Documented procedures and maintenance/inspection records do not exist; Average = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, but resources are not available; High = Documented procedures exist, maintenance/inspection records are up to date, personnel have been trained, and resources are in place for implementing emergency maintenance and restoration.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>57. Condition and safety of stairways and ramps</b>  <i>Safety ratings: Low = In poor condition, subject to damage or there are obstacles, which would impede the function of this and other elements, systems or operations; Average = In fair condition, subject to damage but damage and obstacles would not impede the function of this and other elements, systems or operations; High = In good condition, no obstacles, potential for no or minor damage that would impede the function of this and other elements, systems or operations.</i></p> <p>IFTHERE ARE NO STAIRS AND RAMPS, LEAVE BOXES BLANK AND PROVIDE COMMENT.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>58. Condition and safety of floor coverings</b>  <i>Safety ratings: Low = Floor coverings in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, subject to damage but damage would not impede function; High = Seamless flooring in good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>59. Hospital access routes</b>  <i>Safety ratings: Low = Access routes subject to obstacles and damage that would impede access and the function of other elements, systems or operations; Average = Access routes subject to some obstacles and damage that would not impede access and function; High = No or minor potential for obstacles or damage that would impede access and the function of other elements, systems or operations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>60. Emergency exits and evacuation routes</b>  <i>Safety ratings: Low = Exit and evacuation routes are not clearly marked and many are blocked; Average = Some exit and evacuation routes are marked and most are clear of obstacles; High = All exit and evacuation routes are clearly marked and free of obstacles.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>61. Condition and safety of other architectural elements</b>  <i>Safety ratings: Low = Other architectural element(s) in poor condition, subject to damage which would impede the function of this and other elements, systems or operations; Average = In fair condition, element(s) are subject to damage but damage would not impede the function of this and other elements, systems or operations; High = In good condition, no or minor potential for damage that would impede the function of this and other elements, systems or operations.</i></p> <p>IF THE HOSPITAL DOES NOT OTHER ARCHITECTURAL ELEMENTS, LEAVE BOXES BLANK AND PROVIDE COMMENT.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

**Comments about Section 3.** The evaluator should use the space below to comment on the results of this section, and provide his/her name and signature.

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Name of evaluator(s) .....

Signature of evaluator .....

**4. Safety level as determined by functional aspects of the health care hospital (mark the corresponding safety level with an “X”)**

4.1 Organization of the hospital's disaster committee	Safety level			Comments
	Low	Average	High	
<b>62. Hospital Emergency/Disaster Committee</b> <i>Safety ratings: Low = Committee does not exist, or 1–3 departments or disciplines represented; Average = Committee exists with 4–5 departments or disciplines represented, but is not fulfilling functions effectively; High = Committee exists with 6 or more departments or disciplines represented and is fulfilling functions effectively.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>63. Committee member responsibilities and training</b> <i>Safety ratings: Low = Committee does not exist or members are untrained and responsibilities not assigned; Average = Members have received training and have been officially assigned; High = All members are trained and are actively fulfilling their roles and responsibilities.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>64. Emergency Operations Centre (EOC)</b> <i>Safety ratings: Low = The EOC is not designated or is in an unsafe or insecure location; Average = The designated EOC is in a safe, secure and accessible location, but would have limited operational capacity immediately in an emergency; High = The EOC is in a safe, secure and accessible location with immediate operational capacity.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>65. External stakeholder directory and other contacts</b> <i>Safety ratings: Low = Directory of external stakeholders does not exist; Average = Directory exists but is not current (more than 3 months since it was updated); High = Directory is available, is up to date and is held by key emergency response staff.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>66. Action cards available for all personnel</b> <i>Safety ratings: Low = Action cards do not exist; Average = There are cards but personnel are not familiar with them; High = All staff members have cards and know their contents.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>4.2 Hospital emergency or disaster response plan</b>				
<b>67. Hospital emergency or disaster response plan</b> <i>Safety ratings: Low = Plan is not documented; Average = Documented plan is complete, but is not easily accessible, not up to date (more than 12 months since the last update); High = Plan is complete, easily accessible, reviewed/updated at least annually, and resources are available to implement the plan.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>68. Hospital hazard-specific sub plans</b>  <i>Safety ratings: Low = Hazard-specific response sub plans are not documented; Average = Documented plans are complete but not easily accessible, not up to date (more than 12 months since last review/ update); High = Documented plans are complete, reviewed/updated at least annually, and resources are available to implement the plans.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>69. Strengthening of hospital's essential services</b>  <i>Safety ratings: Low = Actions are not included or are addressed only in document; Average = Actions are included but resources are not available; High = Actions are included, resources available and have been completely implemented.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>70. Procedures to activate and deactivate plans</b>  <i>Safety ratings: Low = Procedures do not exist or exist only as a document; Average = Procedures exist, personnel have been trained, but procedures are not updated or tested annually; High = Up-to-date procedures exist, personnel have been trained, and procedures have been tested at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>71. Special administrative procedures for disasters</b>  <i>Safety ratings: Low = No procedures exist or are addressed only in document; Average = Procedures are included in plan, but the administrative process is slow; High = Procedures are included and personnel are familiar with how to implement them.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>72. Financial resources for emergencies and disasters</b>  <i>Safety ratings: Low = Emergency budget or mechanism to access emergency funds is not in place; Average = Funds are budgeted and mechanisms are available but cover less than 72 hours; High = Sufficient funds are guaranteed for 72 hours or more.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>73. Expansion of usable space for mass casualty incidents</b>  <i>Safety ratings: Low = Space for expansion has not been identified; Average = Space has been identified; equipment, supplies and procedures are available to carry out the expansion and staff have been trained, but testing has not been conducted; High = Procedures exist and have been tested, personnel have been trained, and equipment, supplies and other resources are available to carry out the expansion of space.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>74. Procedures for admitting and treating patients during emergencies</b>  <i>Safety ratings: Low = Procedures do not exist or exist only as a document; Average = Procedures exist, personnel have been trained but would not be available at all times; High = Procedures exist, personnel have been trained, and resources are available to implement procedures at maximum hospital capacity for emergency and disaster situations at all times.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>75. Triage, resuscitation, stabilization, and treatment</b>  <i>Safety ratings: Low = Designated triage location or procedures do not exist; Average = Triage location and procedures exist and personnel have been trained, but procedures have not been tested for emergency and disaster situations; supplies cover less than 72 hours maximum hospital capacity; High = Location and procedures exist and have been tested, personnel have been trained, and resources are guaranteed for at least 72 hours to implement at maximum hospital capacity in emergency and disaster situations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>76. Transportation during an emergency</b>  <i>Safety ratings: Low = Transport logistics not considered in the plan; ambulances and other vehicles and modes of transportation are not available; Average = Transport is considered in the plan, some vehicles are available, but not in sufficient numbers for a major emergency or disaster; High = Transport logistics considered in the plan and there are enough resources (owned by the hospital and/or agreements).</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>77. Coordination mechanisms and cooperative arrangements with local healthcare network and other agencies</b>  <i>Safety ratings: Low = No arrangements exist; Average = Arrangements exist but are not fully operational; High = Arrangements exist and are fully operational.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>78. Linkage with local emergency response plan</b>  <i>Safety ratings: Low = The plans are not linked or there is no documentation that demonstrates linkage; Average = Plans are linked but not operational; High = Plans are linked and operational.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>79. System for referral of patients</b>  <i>Safety ratings: Low = Procedures do not exist or exist only as a document; Average = Procedures exist and personnel have been trained, but procedures have not been tested for emergency or disaster situations; High = Procedures exist and have been tested, personnel have been trained, and resources are available to implement measures at maximum hospital capacity in emergency or disaster situations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>80. Procedures for communicating with the public and media</b>  <i>Safety ratings: Low = Procedures do not exist, no spokesperson nominated; Average = Procedures exist and nominated spokespersons have been trained; High = Procedures exist, nominated spokespersons have been trained, and procedures have been tested at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>81. PMobilization and recruitment of personnel during an emergency or disaster</b>  <i>Safety ratings: Procedures do not exist or exist only in a document; Average = Procedures exist and personnel have been trained, but the human resources for an emergency situation are not available; High = Procedures exist, personnel have been trained, and the human resources are available to meet anticipated needs in an emergency.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>82. Evacuation plan</b>  <i>Safety ratings: Low = Plan does not exist or exists only as a document; Average = Plan exists and personnel have been trained in procedures, but tests are not conducted regularly, and/or evacuation routes are not adequate; High = Plan exists, personnel have been trained, and evacuation drills are held at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>83. Staff availability and preparedness</b>  <i>Safety ratings: Low = Less than 50% of staff is available to run each department adequately and trained to respond in disaster situations; Average = Between 50% and 80% of the staff are available and trained to respond in disaster situations; High = 80% -100% of staff are available and trained.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>84. Emergency warning system defined and tested</b>  <i>Safety ratings: Low = Emergency warning system does not exist or there is no documentation for system; Average = Emergency warning system is in place but personnel have not been trained in system; High = Emergency warning system is in place and personnel have been trained in how to respond using the documented procedures at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>85. Alarm system defined and tested</b>  <i>Safety ratings: Low = Alarm system does not exist or there is no documentation about system; Average = Alarm system is in place but personnel have not been trained in system; High = Alarm system is in place and personnel have been trained in how to respond using the documented procedures at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>86. Hospital emergency and disaster response plan exercises, evaluation and corrective actions</b>  <i>Safety ratings: Low = Response plan and sub plans have not been tested; Average = Response plan or sub plans are tested, but are not tested at least annually; High = Response plan or sub plans are tested at least annually and updated according to the exercise results.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>87. Preparedness programme for strengthening emergency and disaster response and recovery</b>  <i>Safety ratings: Low = A programme for strengthening preparedness, response and recovery does not exist or, if it exists, no preparedness activities are being implemented; Average = A programme for strengthening preparedness, response and recovery exists and some activities are being implemented; High = A programme for strengthening preparedness, response and recovery is being fully implemented under the leadership of the Hospital Emergency/Disaster Committee.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>4.3 Availability of medications, supplies, instruments and equipment for disaster situations</b>				
<p><b>88. Medications and supplies for emergency response</b>  <i>Safety ratings: Low = There is no reserve or there is no documentation demonstrating reserve; Average = Medication reserves are not sufficient for 72 hours; High = There are sufficient reserves for emergency response for at least 72 hours.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>89. Instruments and sterilized equipment for emergency response</b>  <i>Safety ratings: Low = There are no reserves or there is no documentation regarding emergency supplies; Average = Reserves are not sufficient for 72 hours; High = Reserves are in place for emergency response for at least 72 hours or more.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>90. Life support equipment for emergencies</b>  <i>Safety ratings: Low = The facility does not have this equipment; Average = Equipment is available but there is only enough for regular, daily use; High = Facility has sufficient equipment for use in an emergency or disaster.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>91. Personal protection equipment and isolation for infectious diseases and epidemics</b>  <i>Safety ratings: Low = No personal protective equipment is available for immediate use by hospital staff, or no isolation area exists; Average = Supply is available for immediate use, but is sufficient for less than 72 hours of maximum hospital capacity, isolation areas are established, staff training and testing of procedures are not conducted annually; High = Supply is guaranteed for at least 72 hours of maximum hospital capacity and alternate sources are in place for resupply, isolation areas are established, staff training and testing of procedures are conducted at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<p><b>92. Infection surveillance, prevention and control procedures</b>  <i>Safety ratings: Low = Policies and procedures do not exist; standard precautions for infection prevention and control are not followed routinely; Average = Policies and procedures exist, standard precautions are routinely followed, personnel have been trained, but the level of resources required for emergency and disaster situations, including epidemics, is not available; High = Policies and procedures exist, infection prevention and control measures are in place, personnel have been trained, and resources are available to implement measures at maximum hospital capacity in emergency and disaster situations.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>93. Food and drinking water during an emergency</b>  <i>Safety ratings: Low = Procedures for food and drinking water for emergencies are non-existent; Average = Procedures exist, food and drinking-water is guaranteed for less than 72 hours; High = Food and drinking-water for emergencies is guaranteed for at least 72 hours.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<p><b>94. Duties assigned to personnel for emergency or disaster response and recovery</b>  <i>Safety ratings: Low = Emergency assignments do not exist or are not documented; Average = Duties are identified, some (but not all) personnel receive written assignments or training; High = Written duties are assigned, and training or an exercise is conducted for all personnel at least annually.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

**Comments about Section 4.** The evaluator should use the space below to comment on the results of this section, and provide his/her name and signature.

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Name of evaluator(s) .....

Signature of evaluator .....

# Annex|3

## Form 3

Intervention plan to improve  
the level of safety

Notice:

This version of the form is for reference only. To complete the evaluation and provide necessary information, print Annex 3 from the *Forms for the evaluation of medium and small hospitals* document.



Name of hospital: .....

Location of hospital: .....

Date of evaluation: .....

Elements evaluated		Problems	Actions	Priorities*	Comments
<b>Structural elements</b>					
<b>Nonstructural elements</b>	<b>Essential services</b>	Electrical system			
		Telecommunications system			
		Water supply system			
		Fuel storage			
		Medical gases			
		Sewage system			
		Storm drainage			
	Heating, ventilation, air conditioning, hot water				
	Furniture and fittings, office equipment, and storage				
	Medical and laboratory equipment and supplies				
Architectural elements					
<b>Functional aspects</b>	Organization of disaster committee				
	Operational disaster plan				
	Contingency plans				
	Maintenance plans				
	Medications, supplies				

\* Priorities should be ranked between 1 (high priority) and 3 (low priority) depending on the need, importance of problem, and available resources.



# Annex 4

## Overview of the evaluation process

This tool is designed to facilitate the assessment of the safety in small and medium-size health hospitals impacted by natural and other hazards and to guide authorities in identifying priority areas that should be acted on to reduce vulnerability.

The application and use of the checklists included in the Annexes should encourage health personnel to see the hospital as their own work space, where they must continually work to improve conditions for their own safety and that of their patients.

The following provides an overview of the evaluation process:

### **Type of hospitals to assess**

This manual addresses medium and small hospitals, such as: primary hospitals (which provide basic specialties (obstetrics and gynecology, pediatrics, internal medicine and general surgery), hospitals that operate 24 hours per day and have inpatient services (in the case of medium-sized hospitals with 50 beds or less and in small hospitals with 20 beds or less).

This excludes medical offices, health centers, polyclinics that only provide outpatient services, and other hospitals that don't provide hospital services, such as clinical laboratories, diagnostic centers, etc.

The process explained in this manual should be distinguished from that outlined in the Hospital Safety Index, which is designed for the evaluation of larger, more complex hospitals.

### **The evaluation team**

An evaluation team must be formed to use this tool. Members should have received prior training and have detailed knowledge of technical issues and other hospital safety aspects

mentioned in the Hospital Safety Index. The team must also be available to visit different local hospitals.

The team should be multidisciplinary (including at least one engineer or architect, a physician or nurse, maintenance staff, and an administrator) and preferably represent different institutions such as health ministries, universities, civil protection, etc.

The team size will depend on the complexity of the hospital. It is recommended that there be a maximum of six people, who will tour the hospital accompanied by the administrator and/or maintenance manager.

### **Process for conducting the evaluation**

The first step in the process is to contact the hospital's management and to share with them issues related to the concept of hospital safety, the actual assessment of the hospital, and the methodology that will be used.

Once a date has been set for conducting the assessment, the team should request the hospital to make the following documents available:

- Detailed plans of the building;
- The disaster plan, if one exists;
- Documentation on the membership of the disaster committee;
- The hospital's maintenance plans.

On the day of the assessment the team should hold an introductory meeting with the hospital's administrators and disaster committee. At this meeting the evaluation form or checklist should be introduced. Following this, the team will take a complete tour of the hospital and make a photographic and written record of any findings.

### **Preparing the evaluation report**

After the evaluation, the entire team must meet to process the data, compare observations, propose a plan of action, and draft the final report.

The evaluation report should include:

- General background information about the hospital;
- Evaluation results for components (divided into structural, nonstructural, and functional elements), with a general description of the findings;

- General information sheet (Form 1, see Annex 1);
- Evaluation form (Form 2, see Annex 2);
- Intervention plan (Form 3, see Annex 3);
- Photographs.

### **The intervention plan**

An intervention strategy is developed in conjunction with the authorities and with the information gathered from the evaluation. This strategy should prioritize actions according to their importance, time, and available resources. A matrix for the intervention plan is provided (see Form 3 in Annex 3).

To complete this matrix, the evaluation team should provide specific interventions for each of the elements evaluated (structural, nonstructural, and functional). The form listing the specified actions should be submitted to the authorities of the hospital so that they can assign priorities.

The goal of this process is to help to direct resources to solving the problems that have been identified, and to carry out the interventions in the short, medium, and long term.



# Glossary of terms<sup>17</sup>

## **Accelerants**

Substances that act as catalysts in speeding a chemical reaction; commonly associated with starting or spreading fire.

## **Adverse event**

Changes in human, economic, social and environment systems, caused by natural phenomena, generated by human activity or a combination of both, that require an immediate response from the affected community. An adverse event can become an emergency or a disaster depending on the extent of damage and response capacity.

## **Base flood elevation (BFE)**

The water elevation is expected to rise during the base flood, which has a 1% chance of being equaled or exceeded in any given year.

## **Black water**

Waste water containing human fecal matter or urine (distinguished from grey water which is waste water that has been used for washing).

## **Brace**

Structure that supports a structural element (made of metal, wood, etc.)

## **Brake system**

System that keeps wheeled equipment or furniture from sliding.

## **Brick**

Masonry used in construction made of baked clay.

## **Check valve**

Mechanism that allows fluid to flow in only one direction, preventing the return or backflow of liquid in a water distribution or sewerage system.

## **Concrete**

A construction material made up of cement, aggregates such as crushed rock and sand, and water.

## **Critical care services**

Areas of a hospital that provide essential, life-saving services, that contain hazardous or harmful equipment or materials, or whose failure may generate chaos and confusion among patients or staff.

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17. This list of terms was compiled from various sources and adapted for the work of PAHO/WHO in technical assistance for disaster reduction.

### **Deflection**

An often imperceptible displacement, normally vertical, of structural horizontal elements such as beams or slabs in response to vertical loads. This can be caused by the weight of the element itself or because of live loads in a building (for example, equipment on a roof or number of people on a staircase).

### **Development**

The cumulative and sustainable increase of quantity and quality of goods, services, and resources of a community along with social changes aimed at maintaining or improving the safety and the quality of human life without compromising the resources of future generations.

### **Diaphragm**

A horizontal structural system, such as the slab or roof, which transfers lateral loads (usually caused by earthquakes or wind forces) to shear walls and frames. Where there is equal stiffness among all elements attached to the diaphragm, equal horizontal displacement can be expected.

### **Disaster**

An event or combination of events that causes serious disruption in people's lives and wellbeing, having a negative impact on the goods, services, economic resources, social systems, and the environment. Disasters may be caused by natural phenomena, generated by human activity, or by the combination of both. Disasters may exceed the response capacity of the affected community.

### **Disaster (or adverse event) cycle**

Prevention: Risk is zero

Mitigation: Reduced risk

Preparedness: Improve response capacity

Response: Humanitarian assistance

Rehabilitation: Temporary or provisional recovery

Reconstruction: Complete recovery

### **Disaster management**

A systematic process that includes planning, organization, administration, and control of all disaster related activities. Disaster management is achieved through prevention, mitigation, preparedness, response, rehabilitation, and reconstruction activities.

### **Disaster risk reduction**

Set of measures aimed at minimizing damage caused by adverse phenomena to such a level that the affected community can meet needs using its own resources, without outside assistance. This is achieved by eliminating (preventing) or reducing (mitigating) the hazard, the vulnerability, or both, and increasing the community's ability to respond (preparedness).

### **Drift**

Lateral displacement of a building generally caused by seismic activity or wind.

### **Emergency ( see "disaster")**

The affected community generally has the resources to respond to an emergency.

### **Essential services (also, lifelines)**

Basic services that allow a health care hospital to function, including drinking water supply, medical gases, power, communications, sanitation, etc.

**Floor plan configuration**

The architectural arrangement of spaces in the floor plan of a building.

**Geology**

The science and study of the physical matter and energy that constitute the earth.

**Hazard**

A risk factor that represents the potential for a phenomenon or event of natural origin, generated by human activity, or a combination of both to occur in a specific place with a given intensity and duration.

**Longitudinal reinforcement**

Steel placed longitudinally in structural concrete elements to improve the load-bearing capacity of beams, slabs, and columns.

**Masonry wall**

Block construction which may be of brick, adobe, concrete (including pre-formed, hollow blocks), or mud/cement blocks. Mortar used to join blocks consists of lime, sand, cement and water.

**Medical gases**

Includes oxygen, anesthesia, nitrogen, etc.

**Mitigation of damage**

Activities that aim to lessen the likelihood of damage resulting from hazards. Mitigation of damage is achieved by reducing the hazards, vulnerability, or both. In general, one cannot mitigate natural hazards such as earthquakes and hurricanes.

**Mortar joint**

Space between masonry bricks or blocks filled with mortar or grout, a mixture of cement, sand, and water. Sand gives volume to the mixture and the cement bonds particles. Mortars have different hardness depending on the proportions of sand, cement, or lime.

**Nonstructural components**

Elements that do not form part of the support system of the structure. These include architectural elements (such as cladding, interior partitions, ceilings), equipment (such as industrial, medical, and laboratory equipment and furnishings), and systems that are essential for the hospital's operation (such as power system, water distribution and drainage, heating and cooling systems, staircases, etc.).

**Nonstructural detailing**

The combination of measures derived from theory, experience, and observation that aim to protect and improve the behavior of nonstructural components of a building.

**Overlap**

Extend two elements, such as fiber cement sheets of a roof, so that one covers part of the other both lengthwise and crosswise.

**Partitions**

Lightweight elements used to divide rooms or spaces in a building.

### **Plumbing**

Installation of systems for water supply and for draining waste water.

### **Preparedness**

Actions and measures taken to increase the capacity to effectively anticipate, respond to, and recover from damage caused by adverse events. Preparedness is achieved by developing disaster response plans, training concerned personnel, and establishing necessary resources to carry out response activities.

### **Prevention**

Actions aimed at avoiding damage as a consequence of adverse phenomena. Prevention is achieved by eliminating the hazard, the vulnerability, or both.

Punching shear failure: Failure of concrete slabs subjected to high localized forces. In flat slab structures this occurs at column support points.

### **PVC pipe**

Rigid and highly resistant plastic pipe made of polyvinyl chloride. It is commonly used for piping in drinking water distribution and sanitary sewers.

### **Reconstruction**

Complete repair of physical, social, and economic damage to a level of safety that is higher than existed prior to an event. Reconstruction incorporates disaster risk reduction measures when restoring damaged infrastructure, systems, and services.

### **Rehabilitation**

Provisional or temporary restoration of essential services (lifelines) in a community affected by a disaster. Rehabilitation is achieved by providing services at pre-disaster levels.

### **Reinforced concrete**

Cement, sand, aggregates, and water are mixed to become a permanently hardened material, which is very resistant to compression. Reinforcement bars of steel are incorporated into the concrete (lengthwise or crosswise) to resist the tension forces in the element.

### **Relationship between risk, hazard, and vulnerability**

Risk is the result of the interaction of hazard and vulnerability. This is a dynamic and complex relationship that changes according to the probability of an adverse event occurring at a given time and place with a given magnitude, intensity, and duration, and the predisposition of people, infrastructure, services and goods to be affected by said phenomenon. This relationship can be expressed in the formula  $R = H \times V$ , where R is risk, H is hazard, and V is vulnerability.

### **Response**

Actions taken in emergencies or disasters, or when damage is imminent, to save lives, reduce suffering, and limit economic and social losses by mobilizing humanitarian assistance to cover essential needs of the affected population.

### **Risk**

Probability of social, environmental, and economic damage occurring in a specific community and in a given period of time with a magnitude, intensity, cost, and duration determined by the interaction between hazard and vulnerability.

**Rubber joint**

Gasket or connection made of synthetic rubber which adapts to movement and tolerates high temperature.

**Safe hospital**

A health services hospital that remains accessible, is able to function at full capacity, and can depend on its own infrastructure during and after an adverse event.

**Septic tank**

Pit or tank that collects sewage, which decomposes through anaerobic digestion.

Sewage inspection chambers: Concrete structures installed in strategic areas of the sewage system and accessed by manholes, making it possible to inspect and repair connections, valves, etc.

**Sewerage inspection chambers**

Concrete structures installed in strategic areas of the sewerage system and accessed by manholes, making it possible to inspect and repair connections, valves, etc.

**Structural components**

Supporting or load bearing elements of a building, including the columns, beams, load bearing walls, foundations, slabs, etc.

**Structural detailing**

The combination of measures derived from theory, experience, and observation that aim to protect and improve the behavior of structural components of a building.

**Topography**

The study of the location of natural or man-made features on the earth.

**Truss**

Support structure of metal or wood generally used in roofing, consisting of a bottom chord, top chord, vertical studs, and diagonal bracing.

**Uninterruptible Power Supply (UPS)**

Backup equipment, typically powered by batteries, that provides immediate protection from electrical outage. The battery runtime is short (15 to 30 minutes), but sufficient to backup computerized data or establish an alternative power source.

**Unreinforced masonry structures**

Masonry structures that are unreinforced or are not attached to columns and beams. Masonry types include adobe, brick, cement block, rammed earth, blocks with mud and cement mixture, and stone walls.

**Vulnerability**

The risk factor for a person, object, or system exposed to a hazard. This corresponds to the predisposition or level of susceptibility to damage resulting from that hazard.

**Water table**

Depth underground at which point the ground is totally saturated with water.



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