# Disaster Utilities Supplies Planning Template for Hospitals

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## Contents

## 1. Introduction

Studies have suggested that during an earthquake a large percentage of deaths and injuries are caused by falling hazards and the hospital's functionality can severely be affected by such hazards. In a hospital setting, there are numerous critical equipment which are tall, heavy, on wheels etc. and can be severely affected due to earthquake shaking. Any damage to such equipment can render the entire facility dysfunctional.

Hospitals have a critical role in a post-earthquake scenario as a number of people with a range of injuries will be converging at the facility. In important hospitals, overflowing with patients and bystanders even in normal times, such an influx will be difficult to handle. More so when the facility itself is incapacitated by structural and non-structural losses. The first step towards keeping hospitals functional in a post-earthquake scenario will be to have the structural and non-structural hazards assessed and addressed.

The objective of this template is to provide guidance to health facilities on ensuring preparedness, safety and resilience of the critical utilities. The template facilitates the determination of a hospital's capacity to continue providing services following an adverse event, and guides the actions necessary to increase the robustness of critical systems for response in case of disaster emergencies. Throughout this document, the terms "utility" or "utilities" cover safety and preparedness capacity of three critical systems of the hospital. The three critical utility systems in this template include the following key elements:

- Water Supply System
- Electricity / Power Supply System
- Medical Gases/ Oxygen

The prime target audience of this document are the hospital administrators, maintenance teams, and Hospital DM Committees as a guide for the preparedness and resilience of critical systems. The wider audience includes all stakeholders in the hospitals across many departments as well as medical and non-medical staff who can use the template to guide activities for making hospitals more resilient and better prepared for emergencies and disasters.

## Scope of the Template

UN-Habitat in collaboration with technical partner GeoHazards International (GHI) has carried out the initial assessment of the Mandalay General Hospital for non-structural hazards to work towards keeping the hospital functional in a post-earthquake scenario. The assessment is limited to the most critical functions of the hospital that will be called upon in the response phase of any disaster event. This included 1). Critical medical equipment in various departments such as emergency department, Operation theatre, ICUs Radiology, Endoscopy, Medical Record rooms, pathology labs etc. and 2). Critical utilities such as power, water and medical gas supplies etc. The assessment aims to understand the effects of future earthquake events in these critical areas of the hospital, the hazards in each location and the effects if the hazards are materialised.

## Limitations of the Template

The telecommunications, fire protection, waste management, and heating, ventilation and air conditioning (HVAC) systems are beyond the scope of this template. The template does not include the earthquake resistance of any of the buildings, structures or systems. It does not cover detailed structural or non-structural elements of hospital's buildings. It also does not cover a hospital's disaster management planning efforts.

## Importance of Hospital Functionality:

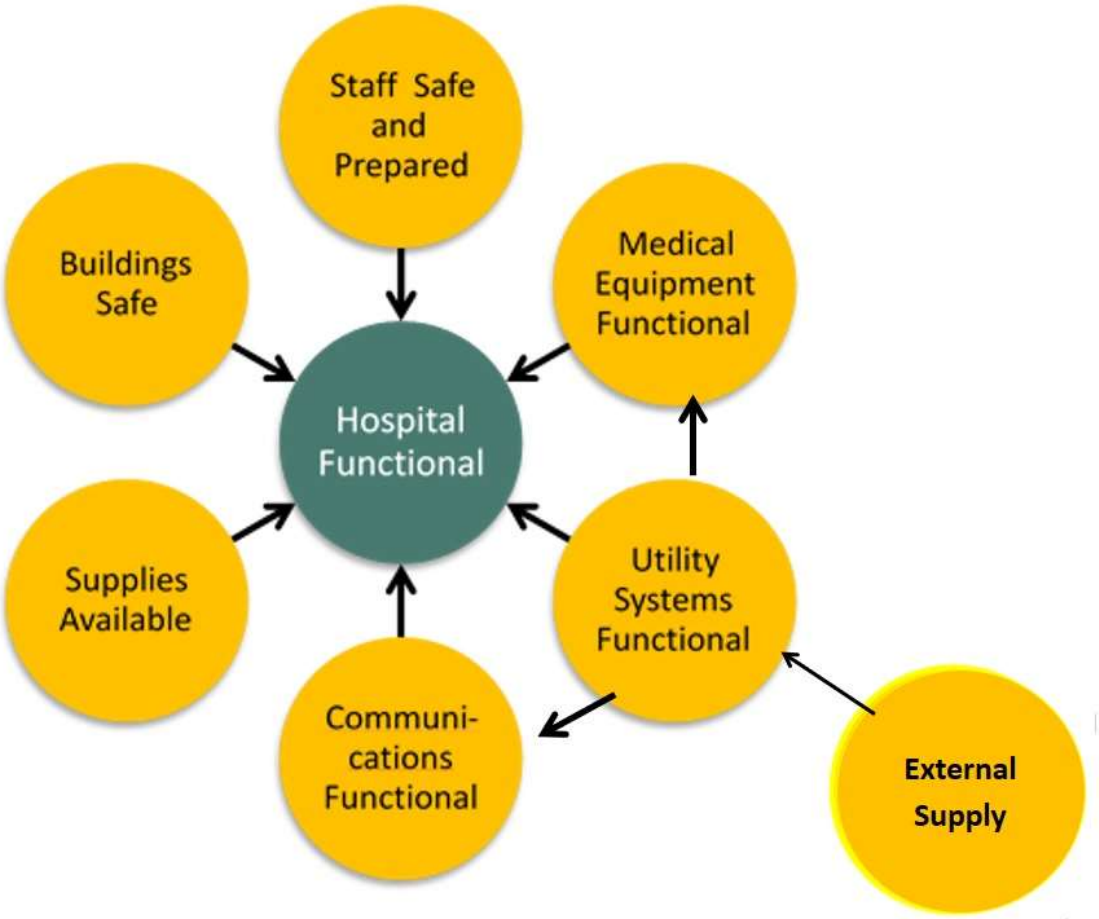
Health facilities, especially hospitals, are critical assets for communities both in normal times and in crises. Yet hospital functionality is among the first casualties of emergencies, making it impossible to provide health services when they are most needed. The World Health Organization (WHO) has defined a Safe Hospital as one that will not collapse in disasters, killing patients and staff; can continue to function and provide its services as a critical community facility when it is most needed; is organized, with contingency plans in place and health workforce trained to keep the network operational." The Sendai Framework for Disaster Risk Reduction 2015 – 2030 also makes specific references in para 33 (c) to "*Promote the resilience of new and existing critical infrastructure, including … hospitals and other health facilities, to ensure that they remain safe, effective* ***and operational*** *during and after disaster in order to provide live saving and essential services*"

If a major community hospital is out of service during and after an emergency, it leaves the dependent community without health care adding to the number of lives and limbs lost in the emergency. The loss of essential services during emergencies and disasters severely lessens the possibility of saving lives and reducing other health consequences. Thus, it is critical that hospitals continue to function during and after disastrous events since the community rushes to the nearest hospital for medical assistance when emergencies occur, expecting it to remain functional. The hospital's ability to cope with the mass casualty incident will not be based just on its preparedness and planning, but also on the functionality of the critical departments in the facility. Hence, it is important to assess and improve the level of safety and functionality the hospitals will be able to provide before a disastrous event occurs. Hospital assessments aim to identify elements that need improvement in the hospital, and to prioritize interventions that are essential for keeping the hospital functional so that the mortality, morbidity, disability and other social and economic costs associated with emergencies and disasters can be reduced.

In hospitals that are important to the community it serves, one of the key aspects in disaster risk reduction will be the importance of keeping the hospital functional after a disastrous event.

## 2. Ingredients of Hospital functionality

As the figure above denotes, for a hospital to remain functional in a post disaster scenario especially to respond to a mass casualty situation, several aspects have to remain functional. The buildings have to remain safe and unaffected. The staff should be safe and prepared to take care of the in patients and to receive mass casualty situations. Critical medical equipment should not be affected by earthquake shaking and be functional. This will also depend on the functionality of the critical utilities- Electric supply, water supply and Medical gases supply. In an earthquake, it is usually seen that the external supply (electrical, water, etc.) lines fail and the hospital will have to depend




**Elements of a functional hospital**

on back-up systems and internal storages. These systems are also interdependent- water supply and oxygen production typically depend on electric power. With grid power out, electric power will depend on the fuel available on site for the generators or on solar arrays if adequately available. The two other components that affect the hospital's functionality are the availability of medical supplies and the back-up communications to help in managing the response to a disaster.

### Building Safety:

It is obvious that the safety of hospital buildings will be a critical first step in keeping hospital functional in emergencies. Even though a hospital is a critical facility, not all buildings within a hospital contribute equally to the functionality of a hospital in a post disaster scenario. Depending on the priority of the hospital services (such as Emergency Department, Operation Theatres (OTs), Intensive Care Units (ICUs) etc), buildings that house these services will be more critical than others.

### Staff Preparedness:

The importance of staff preparedness in keeping hospitals functional after emergencies cannot be understated. A Hospital Disaster Management Committee (HDMC) with representation from all critical departments including the maintenance department should be in place. The HDMC should develop the Hospital Disaster Management Plan (HDMP) and organise training programs for all staff members to enable a uniform understanding of the plan. The process should begin with a clear understanding of the various hazard events that could affect the area and cause a high patient surge at the hospital, including those that affect hospital operations internally. Regular simulation exercises or preparedness drills can test the efficacy of the HDMP.

### Functionality of Hospital Equipment

Even a hospital with buildings that remain safe in disastrous events and with well-prepared staff members will still not be able to give optimal medical assistance to the affected communities if the critical medical equipment is not functional after the event. The equipment can be directly affected by a flood or earthquake or could stop functioning because of the loss of critical utilities supporting it such as electricity, water, or medical gases supply. In the past too, there are instances where hospitals lost functionality due to the falling of equipment as a result of earthquake shaking. Hence, the hazards caused by objects falling in earthquake shaking must also be considered in earthquake safety assessments. Hospitals are prone to several non-structural hazard risks that can cause injuries or losses in future earthquakes unless these are addressed.

### Importance of Maintenance

The maintenance department is among the most important departments in the hospital as the functionality of all other departments depends on this department to provide critical utilities such as electricity, water and medical gases. However, in most Health facilities, the maintenance department is not given much importance.

In general, maintenance involves planning, programming and implementing the maintenance activity within a timeframe in accordance with technical requirements (according to the technical documents related to the equipment). The maintenance procedures also include supervision and verification to ensure that the activities are aligned

with the plan and are adequate for the type of system, infrastructure and surroundings. The role of this department in the Hospital Disaster Management Plan is often neglected as the risk of failure of utility services in disastrous events hardly feature in these. The maintenance departments will play a key role in the planning and managing utility services to critical functions of the hospitals after such events.

The department should develop plans to keep the utility systems functional after an earthquake in discussions with the Hospital Disaster Management Committee so that their plans aligns with the Hospital Disaster management Plan. Training and capacity building of the maintenance department will be one of the critical elements of maintaining functionality following an earthquake.

## 3. Utilities

One of the important factors affecting the functionality of a hospital is the functionality of the utility services within the hospital such as a) electric supply b) water supply and c) medical gases supply-especially oxygen. With less than 100% functionality of these three critical utilities the functionality of the hospital will be affected. Another factor to consider is the interdependence of these utilities, especially the dependency on electric power for pumping of water and for the production and distribution of oxygen supplies. The electrical power and the back-up facilities available within the hospital are among the key aspects in keeping hospitals functional. These utilities are dependent on external supply lines that often fail in earthquake shaking and this template provides guidance for organising the back up support available within the hospital only. The role of the maintenance department in keeping hospitals functional after disastrous events must be emphasised here.

### Electricity

Following a moderate or major earthquake, it is likely that the supply from the electrical grid will be disrupted; and grid power can possibly be lost for a significant period following a major earthquake. During the critical response period immediately following the earthquake, and perhaps for weeks afterward, the hospital will need to rely on backup power supplied by the emergency generators.

**Sources**: The failure of local grid power supplies can cause a “domino” effect in hospitals so that successive outages can occur. There is a need for redundancy in the access to external power supply, without counting on the hospital’s own emergency power-generating system. If possible, there should be more than one power supply entrance to the hospital from the local grid power supply, and additional entrances should be independent of each other and independent of the internal electricity system. Redundancy makes it more likely that the hospital can bypass damaged equipment connecting it to the local grid, and access grid power once it is restored.

Whether there is a single source of electricity or more, generator support becomes very important to keep the hospital functional if power supply from the main grid is lost after an earthquake.

**Generators**: Generators are the lifelines for keeping hospitals functional However, the generators and backup power systems in many hospitals are vulnerable to earthquake damage that could prevent them from supplying the hospital with power when it is needed most. Care must be taken to ensure that generators are completely equipped to resist the lateral forces on it during earthquake shaking.

The emergency generators that are not anchored are likely to slide off of vibration isolators. There is often a misconception that equipment such as generators are too heavy to move in earthquakes, but past events have shown that these can be displaced in ground shaking. The batteries that enable the generators to start if not anchored may fall or slide and become disconnected. Most hospitals do not store sufficient fuel to supply power for more than a few hours and fuel supplies will have to be replenished almost immediately after an earthquake, which may not be possible following an earthquake due to blocked roads, dysfunctional fuel stations etc. There is thus an urgent need to plan for keeping the critical services supported by generator power until the external supply is restored.

In normal times, many important hospitals being premier hospitals in the respective regions, electricity disruptions will be rare. The Electricity suppliers announce any shutdowns in advance and hence the hospital’s back-up power facilities may not have been truly tested

for emergency functionality. The back-up power supply systems should be tested at full load for at least three hours every month. Also, the generators are cooled with coolants, which must be added manually. If any generators are found to overheat during testing, provisions for cooling should be planned for. If generators do not start automatically and has to be started manually by a staff member, there has to be adequate planning for this.

To infer, a Disaster Power Supply Plan has to be developed keeping in mind several scenarios. This will enable the hospital to be well prepared with regard to the power back-ups.

## Water Supply

Availability of clean water is a critical component in keeping hospitals functional. Water is used in health facilities, both in a) Consumption and essential care activities (Handwashing, Drinking water, food preparation etc.) and b) Equipment and sanitary (Sterilisation, Decontamination, Dialysis, Flushing toilets, HVAC, Fire suppression, equipment cooling etc.) In a disaster situation, the availability of water is critical to ensure adequate hygiene and keep infections at bay. Morbidity and mortality due to compromised hygiene and sanitation is common in the post-disaster phase. In past earthquakes, it has been seen that water is more important than electricity to keep a hospital functional.

**Sources**: It is important that the hospital has access to multiple sources of water supply including Municipal sources. If local sources depend on electricity for pumping, it is imperative that dedicated alternate power supply is available to access the sources. The source, quality, and quantity of water needed to keep the hospital functional after emergencies needs meticulous planning involving the water supply (maintenance) department and the Hospital Disaster Management Committee.

### Water Reserves

It is important for hospitals to have a permanent water reserve storage that is sufficient to provide water for at least 72 hours (or in accordance with official national guidance, if any) in addition to a water reserve for fighting fire. (In areas at risk of severe disruptions, for example due to main water supply lines being at risk of being severed by landslides or other ground failure, this amount of time may need to be increased.) WHO's Hospital Safety Index

recommends that this storage be equivalent to a minimum 80 gallons (300 litres) per bed per 24 hours, considering the actual bed capacity of the hospital. Thus, for 72 hours storage, hospitals must store 240 gallons (900 litres) for each bed capacity of the hospital. Typically, water storage could be in underground sumps or overhead tanks. The table at Appendix D can be used for comparing the total in-campus storage capacity (including all water tanks in the campus) against the expected demands (as recommended by WHO standards in HSI) and working out the shortfall in water storage.

APPENDIX D: Overall Hospital- Water Storage Demand and Capacity Table

| | A | B | | C | D | E | F | G | F |
|---|---|---|---|---|---|---|---|---|---|
| No. | Buildings | Storage tanks capacity attached to each buiding | | Total Capacity 'C' | Pumps have generator back up connection Yes/ NO | Total No. of Beds 'E' | Minimum Back up as per WHO HSI standards for 3 day back up(900 lit per bed) (F= 900 x E) Litres | Shortfall G= (F-Total C) Litres | Plan for meeting shortfall |
| | | Number of tanks | Capacity of each tank | | | | | | |
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| | Total Capacity of Water Storage C >> | | | | | | | | |

It is important to ascertain the safety of these and the distribution systems in earthquakes to ensure that these remain available. Earthquake safety of water reserves: Earthquake induced accelerations tend to be the maximum in higher places because the building (or the supporting structure) amplifies earthquake motions. Hence, there is every likelihood that the overhead water tanks (if these are not anchored) will be displaced, fall down from the top or break connecting (rigid) pipes, and lose the stored water. Any breakages in lines can result in the water storage draining away and undesirable water entry/flooding of some parts of the hospital.

Even though accelerations may be lesser at the ground level, unanchored tanks could move or fall, rigid connecting pipes can break and lose stored water. Post-earthquake reconnaissance reports have indicated that water sloshing in the tank during earthquake shaking is also a major cause of displacement and serious damage in water tanks. Rigid water pipes connecting places of unequal displacement such as at water tanks tend to break

and leak the stored water. In many hospitals, the water purification systems may not be anchored and can be damaged in earthquake shaking and can result in loss of potable water. Assessment and mitigation of the water reserves and distribution is an important first step in planning to keep the water supply systems available to help critical services continuity in hospitals after emergencies.

**Oxygen Supply:**

Oxygen supply is most critical in a post disaster situation and all efforts must be made to ensure the safety and adequacy of the storage within the campus. Among the first steps in planning to provide oxygen in post-emergency situations will be an assessment of the adequacy and safety of the storage facilities. It is important that there is an area designated solely for storage of oxygen tanks and/or cylinders and related equipment, and that only this equipment occupies the designated area. These areas should be well ventilated, well illuminated and clearly marked and labelled. Individual cylinders tend to fall over during shaking because they are tall and thin, and need to be restrained, both in storage and in the manifold (which can be inexpensively accomplished with chains). There should be a secure enclosure around the site, with signage indicating that the gases and equipment are dangerous. The location should be in an area unlikely to flood at a distance from any heat sources, and protected from falling objects. The site should be easily accessible for facilities, maintenance and fire response personnel. In case of piped gas supply in earthquake prone areas, there should be provisions for pipe sleeves while traversing walls and flexible piping over expansion-joints to avoid damages due to differential movement during earthquake shaking.

The WHO recommends that Hospitals with piped gas supply, the storage that should be available in the hospital campus should be a minimum storage sufficient for seven days of normal hospital usage. For a hospital using individual cylinders, a minimum storage sufficient for three days of normal hospital usage must be available in the hospital campus. The maintenance/ Medical gases team and the Hospital safety committee will work together to develop a plan to keep the supply consistent as needed through the emergency period.

## 4. Disaster Utility Supplies Planning Template

The Disaster Utilities Supplies Plan of the hospital will be a combination of the Disaster Utilities Supplies Plan- Electrical (DUSP-E), the Disaster Utilities Supplies Plan- Water (DUSP-W), and the Disaster Utilities Supplies Plan- Oxygen[1] (DUSP-O). The first three steps in the Template are common aspects on which the Plans for all three Utilities is based on.

### Step 1: Understanding Risk:

One of the first steps that the HDMC takes towards developing a Disaster Utilities Supplies Plan (DUSP) will be to understand the risk related to the hospital. A clear understanding of the possible hazards that can directly affect the safety of the hospital and those for which the hospital may be expected to provide health services in response to emergencies and disasters. Once the hazards are identified, the effects of these on the hospitals and the community around are also clearly understood. This could include identifying the areas that could be inundated within the hospital during a flood, the buildings that could be vulnerable in an earthquake, the effect of an earthquake on the equipment, the number of patients that can expected from the community in the event of a hazard affecting them etc.

### Step 2: Understanding Critical Services of the hospital:

Once the hospital has identified the risks that can affect the hospital and the community it serves, the next step for the HDMC would be to identify the critical services in the hospital. These services/departments will have to remain functional during and after disastrous event for the hospital to cater to the needs of the community in the aftermath.

The Emergency Department, Operation theatres, Central Sterile Supply Department (CSSD), Intensive Care Units, Labour and Delivery / Obstetrics (ongoing essential service), Radiology, Disaster stores (if present), onsite utilities, Blood bank, Backup generator are some of the departments/services that are normally identified as critical in many hospitals. However, the decision to consider departments/ services as critical will remain with the HDMC.

### Step 3: Identification of the critical buildings:

After determining the departments /services that are critical, the HDMC initiates discussions with the Maintenance department team. As some members of the Maintenance department

[1] The most common medical gas, Oxygen is used as an example here. The DUSP-O can be used to formulate plans for other medical gases in the hospital.

are members of the HDMC, the team is already aware about the process. The next step is to identify the buildings that house these critical departments. The Disaster Utility Supplies Plan (DUSP) will be built around this subset of buildings in the campus. The DUSP will consist of separate plans for Electricity supply, Water supply, and Oxygen supply.

## Disaster Utilities Supplies Planning (Electricity): DUSP (E)

The following steps 4E till 8 E are to be completed by the Maintenance Team-Electrical (MTE).

### Step 4-E - Understanding responsibilities of MTE

Developing a clear understanding of the responsibilities of the MTE with regard to the critical services selected by the HDMC.

Electricity is perhaps more important utility service as it the other services often depend on electricity for functionality. For example, bore well motors and water pumps depend on electricity for pumping purposes, Oxygen plants and reticulation systems depend on electricity. The DUSP (E) should not be limited to the critical services, but also the utilities that depend on electric power, and also external lighting. (External lighting becomes important in evacuation areas and external triage / treatment areas if so covered in the HDMP).

Soon after the discussions with the HDMC to finalise the list of critical buildings to be given priority in the post disaster period, the Maintenance Team-Electrical (MTE) must undertake an assessment of the capacities of the department and 1. Understand Demand 2. Understand departmental Capacities 3. Identify and address gaps in capacities, trying to answer the following questions.

a) What will be the demand on the MTE during/after emergencies?

b) What level of capacities (generators, UPS systems, staff, planning, exercises) does the department need have to be prepared?

c) What are the current capacities to provide uninterrupted power to the critical buildings?

d) What gaps exist between the demand and the capacities?

e) How can the department address the capacity gaps?

### Step 5-E - Understanding Demand:

Once the HDMC decides on the critical equipment, services, and buildings that will need to be provided with power, the Maintenance Team -Electrical (MTE) should begin the process of understanding the electrical load details that will have to supplied, equipment and staff that will be required for the same.

### Step 6-E - Understanding Capacities:

The MTE will then understand the current capacities of the alternate power sources (generators, renewable sources, UPS systems) to the selected buildings and understand the current existing capacities of the system. A detailed inventory of hospital equipment that are supplied with back-up power and which are not, if any, within the buildings (e.g. In many hospitals, elevators are not connected to back-up power).

The next item in understanding capacities is to have a clear understanding of the fuel consumption rates of the generators (connected with these buildings) while on their rated load, a conservative estimate of when refuelling will be necessary, and the fuel storage capacities available for refuelling. The table below (Appendix A) may be used to identify demand, capacities, and shortfalls in generator fuel supply.

Generator Fuel Demand and Capacity Table

| A | B | C | D | E | F | G | I | I | J |
|---|---|---|---|---|---|---|---|---|---|
| Critical Services selected by HDMC | Critical Buildings where Services in A are housed | Generators serving the buildings in B | Auto Start (AS) or Manual Start(MS) | Fuel consumption on full load 'X' ( Litres /hour) | Storage capacity available near Genset 'Y' (Litres ) | Hours the Genset will run with current fuel storage= Y/X | Fuel requirements for 72 hours 'Z' | Shortfall = Z-Y | Plan for meeting shortfall |
| EXAMPLE | Emergency | Genset 1 | AS | 8 | 100 | 12.5 | 576 | 476 | |
| | | | | 10 | 100 | 10 | 720 | 620 | |
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### Step 7-E - Identifying and addressing gaps:

The MTE notes any shortfalls in the capacities to deal with the demand on the system and develops an immediate term plan of action for meeting the demand. The plan will also include

recommendations for addressing any identified vulnerabilities in the system. A load-shedding scheme in which less vital systems are powered down (load shed) to provide power to more critical systems within the selected buildings will also be worked out by the MTE to meet any contingencies.

This is also the ideal time to carry out a detailed vulnerability assessment of the electrical system in these buildings with respect to all the hazards likely to affect the buildings to ensure that these will remain functional following disastrous events.

- The generators and the batteries (which enable them to start) must be anchored to prevent sliding or falling, which may lead to loss of functionality.
- The hospital must store fuel enough to supply power for 72 hours and fuel supplies will have to be replenished in case of prolonged power outages. Generator coolants have to be stocked.
- Ensure the presence of at least one staff member of electrical department to be available round the clock to attend to generators that need to be started manually.
- All critical departments and water supply pumps must connect to generator backup
- Ensure proper earthquake-safe anchoring of electrical equipment and locate them in areas not susceptible to water logging.
- The maximum flood level as on date maybe marked near important electrical installations.
- As per the anticipated need for fuel, new storage tanks may have to be commissioned.

A training needs assessment will also be conducted within the MTE to identify training needs of team members.

### Step 8-E - Additional items

A few additional items that can be initiated during DUSP-E include: a)The formulation of the DUSP (E) is an ideal opportunity to put in place special provisions for regular preventive maintenance of all components of the system including Generators, switchgear, UPS systems etc. It is also advisable to have an additional generator (preferably mobile) to provide redundancy that will allow the facilities to take single units offline for preventive maintenance

without affecting operations. b) The MTE must also coordinate with the external power supply providers to arrange for provisions of adequate early warnings in case of planned shutdowns. This will help set up a trigger mechanism for activating the DUSP-E in consultation with the HDMC for planned and unplanned power outages. c) The communication channels among members of the MTE and with the HDMC become critical and the HDMC must include a communications plan in the HDMP. d) The training needs assessment for the MTE carried out in the previous step will be converted to a training plan for the team.

## Disaster Utilities Supplies Planning (Water Supply): DUSP (W)

The following steps 4W till 8W are to be completed by the Maintenance Team-Water (MTW).

### Step 4-W - Understanding responsibilities of MTW

Developing a clear understanding of the responsibilities of the MTW with regard to the critical services selected by the HDMC.

Water supply is a very important utility service in hospitals as it is used for sanitation purposes as well as consumption. Many health facility administrators have mentioned that it may be as important as electricity in the day to day functioning of hospitals. It is important that the DUSP (W) should address the sanitation/ sterilisation needs, the human consumption needs, as well as the firefighting needs.

Soon after the discussions with the HDMC to finalise the list of critical buildings to be given priority in a post disaster scenario, the Maintenance Team-Water (MTW) must undertake an assessment of the capacities of the department and 1. Understand Demand 2. Understand departmental Capacities 3. Identifying and addressing gaps in capacities, trying to answer the following questions.

a) What will be the demand on water supply during/after emergencies?

b) What level of capacities (sources, storage tanks, water pumps, staff, planning, exercises) does the department need to have to be prepared?

c) What are the current capacities to provide uninterrupted water supply to the critical buildings?

d) What gaps exist between the demand and the capacities?

e) How can the department address the capacity gaps?

### Step 5-W - Understanding Demand:

Once the HDMC decides on the critical equipment, services, and buildings that will need to be provided with water, the Maintenance Team -Water (MTW) should begin the process of understanding the details of the quality and quantity of water that will have to supplied, equipment and staff that will be required for the same. This will have to be done through a process of a water audit of each of the critical buildings. In most hospitals in our region, small local filters provide drinking water at drinking water points within buildings. Local Fire safety codes provide guidance on the water storage required for Fire-fighting for each building and can be calculated by the MTW.

A key component of a water audit is to understand the water usage under normal operating conditions and to identify essential functions and minimum water needs for each of these. Develop working estimates of the quantity and quality of water required to continue operation of the essential functions and to meet the emergency demands. This will require the MTW to observe the quantum of usage in the critical buildings closely over several days (if required by water meter readings/ water tank observations), to develop working estimates of the quantity and quality of water required to continue operation of the critical functions and to meet the emergency demands of each of the selected buildings.

### Step 6-W - Understanding Existing Capacities:

The MTW will then understand the current capacities of the existing water supply system. The team will identify available alternative water supply sources, including quantity available, how the water will be stored (rooftop tanks/ sumps etc), how, if necessary, it will be treated and/or tested for safety, how it will be distributed, what conditions may exist or occur to limit or prevent its availability, and how these conditions will be addressed. The MTW will also determine how water usage in these buildings can be optimised by restricting non-emergency water use and plugging leaks, overflow etc. MTW also records the components of the water supply system that are dependent on electricity, but not connected to generators. This is also

the ideal time to carry out a detailed vulnerability assessment of the water supply system in these buildings with respect to all the hazards likely to affect them.

The vulnerability assessment will assess the redundancy of the sources of water, their dependency on off-site electricity, safety of the distribution network with adequate flexible connections, the safety of storage tanks and if there are provisions in place for filling of water tanks through water tankers/ alternate sources. As mentioned before, it is important for hospitals to be able to access a permanent water reserve storage that is sufficient to provide water for at least 72 hours (or in accordance with official national guidance, if any) in addition to a water reserve for fighting fire. The table below (Appendix B) may be used to identify demand, capacities, and shortfalls in water storage capacities.

| Appendix B- Critical Services -Water Storage Demand and Capacity Table | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | I |
| Critical Services selected by HDMC | Critical Buildings where Services in A are housed | Demand of water supply per day in each building | Storage tanks capacity attached to each buiding | Pumps have generator back up connection Yes/ NO | Number of days supply in storage | Shortfall | Plan for meeting shortfall |
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## Step 7-W - Identifying and addressing gaps:

The MTW notes any shortfalls in the capacities to deal with the demand on the system and develops an immediate term plan of action for meeting the demand. It will be important to make recommendations for addressing any vulnerabilities identified in the system through the previously recommended vulnerability assessment.

- The water pumping systems should be connected to generators to ensure uninterrupted water supply even during power outages.

- The water tanks must be anchored to resist seismic shaking, and the effects of sloshing during shaking. These must be connected with the distribution systems through flexible connections. Otherwise, rigid connections could break, discharging the stored water.

- Surface water tanks and sumps must not be located in areas prone to flooding/water logging to avoid contamination.

An optimisation scheme in which the water supply to less vital systems are restricted to provide water to more critical systems within the selected buildings will also be worked out by the MTW to meet any contingencies. A training needs assessment will also be conducted within the MTW to identify training needs of team members.

### Step 8-W - Additional items

A few additional items that can be initiated during DUSP-W include: a) A renewed focus on preventive maintenance may be brought in. The formulation of the DUSP (W) is an ideal opportunity to put in place special provisions for regular preventive maintenance of all components of the water supply system including bore-wells, water pumps, generators associated with the water supply system, cleaning of sumps and overhead water tanks etc. It is also advisable to have an additional water pumps (preferably mobile) to provide redundancy that will allow the facilities to undertake preventive maintenance on pumps etc. without affecting operations. b) The MTW must also coordinate with all the water supply providers to arrange for provisions of adequate early warnings in case of planned shutdowns. This will help set up a trigger mechanism for activating the DUSP-W in consultation with the HDMC for planned and unplanned water supply disruptions. c) The communication channels among members of the MTW and with the HDMC become critical and the HDMC must include a communications plan in the HDMP. d) The training needs assessment for the MTW carried out in the previous step will be converted to a training plan for the team.

## Disaster Utilities Supplies Planning (Oxygen): DUSP (O)

The following steps 4 O till 8 O are to be completed by the Maintenance Team-Oxygen (MTO).

## Step 4-O - Understanding responsibilities of MTO

Developing a clear understanding of the responsibilities of the MTO with regard to the critical services selected by the HDMC. Of all the available medical supplies, medical oxygen remains among the most critical consumable resource in hospital emergencies, and the statistic has only been reinforced by the ongoing Covid-19 pandemic. The pandemic has also brought more focus on the need for self-sufficiency of hospitals in oxygen, with several more oxygen plants being installed in 2020-21 than in the years preceding. However, many of these plants have not been installed taking the local hazards into consideration in site selection and installation. Hence it is important that the formulation of the DUSP-O include an assessment of the vulnerabilities of the medical gas supply system.

Soon after the discussions with the HDMC to finalise the list of critical buildings to be given priority in a post disaster scenario, the Maintenance Team-Oxygen (MTO) must undertake an important self-examination of the demands on and capacities of the department in order to 1. Understand Demand 2. Understand Capacities 3. Identifying and addressing gaps in capacities, trying to answer the following questions to be able to manage the oxygen/medical gases supplies in disaster scenarios.

a) What will be the demand on oxygen supply during/after emergencies?

b) What level of capacities (sources, storage tanks, reticulation systems, staff, planning, exercises) does the department need to have to be prepared to provide medical gases to the critical services/buildings?

c) What are the current capacities to provide uninterrupted medical gases supply to the critical buildings?

d) What gaps exist between the demand and the capacities?

e) How can the department address the capacity gaps?

## Step 5-O - Understanding Demand:

Once the HDMC decides on the critical services and buildings that will need to be provided with medical gases, the Maintenance Team -Oxygen (MTO) should begin the process of understanding the details of the Oxygen/medical gases that will have to supplied, and the equipment and staff that will be required for the same. This will have to be done through a process of an oxygen audit of each of the selected critical buildings. The MTO should verify the level of demand for medical gases at the maximum capacity of the types of services selected by the HDMC and the additional capacity required to respond to emergencies and disasters. The covid-19 pandemic response would have given hospitals a clear idea of the surge requirements for oxygen in emergencies. They should also check that the availability of oxygen/medical gases will cover maximum demand for at least 7 days without dependency on external suppliers to ensure that the hospital can provide services in emergencies. This means that even if the oxygen usage is doubled, there would still be over 3 days' supply of oxygen available within the campus. Evaluators should check the reserve capacity of each type of medical gas used in the hospital.

A key component of an oxygen audit is to understand the usage under normal peak operating conditions (including during the Covid-19 surge) and to identify essential functions and minimum oxygen needs for each of these. Develop working estimates of the quantity of oxygen required to continue operation of the essential functions and to meet the emergency demands. This will require the MTO to work closely with caregivers who use the oxygen supply to observe the usage over several days (if required by meter readings where present or usage of cylinders), to develop working estimates of the quantity of oxygen required to continue operation of the critical functions and to meet the emergency demands of each of the selected buildings.

**Step 6-O - Understanding Existing Capacities:**

The MTO will then understand the current capacities of the existing Oxygen supply system. The team will identify available alternative supply sources (possibly from services that have not been considered critical) that can be redirected, including quantity available, how and where the oxygen is stored, how it will be distributed, what conditions may exist or occur to limit or prevent its availability, and how these conditions will be addressed.

The MTO will also determine how oxygen usage in these buildings can be optimised by restricting non-emergency use and maintaining the system better, etc. MTO also records the components of the oxygen supply system that are dependent on electricity, but not connected to generators.

As mentioned before, it is important for hospitals to be able to access an in-campus oxygen reserve storage that is sufficient to provide supply for at least 72 hours (or in accordance with official national guidance, if any).

The table below (Appendix C) may be used to identify demand, capacities, and shortfalls in Oxygen supply capacities.

| APPENDIX C- Critical Services -Oxygen Supply Demand and Capacity Table | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | I |
| Critical Services selected by HDMC | Critical Buildings where Services in A are housed | Demand of Oxygen supply per day in each building C | Oxygen Plant supplying capacity to each buiding D | Supply to Building through cylinders | Total supply to each building | Shortfall | Plan for meeting shortfall |
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| TOTAL CAPACITIES >> | | | | | | | |

## Step 7-O - Identifying and addressing gaps:

The MTO notes any shortfalls in the capacities to deal with the demand on the system and develops an immediate term plan of action for meeting the demand.

This is also the ideal time to carry out a detailed vulnerability assessment of the medical gases supply system in these buildings with respect to all the hazards likely to affect them. The vulnerability assessment will assess the redundancy of the sources of oxygen, their dependency on off-site electricity, safety of the distribution network with adequate flexible connections, especially while traversing expansion joints and in between buildings, the safety of storage tanks and if there are provisions in place for separate back-fill lines that can be

used to attach to alternate sources such as a bulk oxygen tanker, provided they are accessible following a hazard affecting the hospital.

- The oxygen/medical gases supply systems should be connected to generators to ensure uninterrupted supply even during power outages.
- The Oxygen plants and storage tanks must be anchored to resist seismic shaking. These must be connected with the distribution systems through flexible connections.
- Where gas cylinders are used, these need to be anchored with frames and chains in storage and also when attached to manifolds..
- The medical gas lines passing through places of differential movement during earthquakes, such as expansion joints, or between buildings should have flexibility to accommodate movement.
- Medical gas lines passing through walls should be passing through larger sleeves and not be embedded in walls.
- Oxygen plants, storage tanks, and cylinder storage areas, must not be located in areas prone to flooding/water logging.

The MTO will make recommendations for addressing any identified vulnerabilities in the system. A training needs assessment will also be conducted within the MTO to identify training needs of team members.

**Step 8-O – Additional items**

A few additional items that can be initiated during DUSP-O include: a) A renewed focus on preventive maintenance may be brought in. The formulation of the DUSP-O is an ideal opportunity to put in place special provisions for regular preventive maintenance of all components of the medical gases supply system. b) The MTO must also coordinate with all the external oxygen suppliers to ensure adequate early warnings in case of planned shutdowns of their units. This will help set up a trigger mechanism for activating the DUSP-O in consultation with the HDMC for planned and unplanned oxygen/medical gases supply disruptions. c) The communication channels among members of the MTO and with the HDMC become critical and the HDMC must include a communications plan in the HDMP. d) The

training needs assessment for the MTO carried out in the previous step will be converted to a training plan for the team.

## 5. The way forward

Myanmar is highly vulnerable to a wide range of hazards, including earthquakes, floods, cyclones, storm surges, landslides, rock falls and tsunamis. Hazardous events can affect communities, often with very little notice. Hospitals are lifelines of the community that need to be prepared not just to remain safe during and after disastrous events, but to maintain functionality. This is especially true of the critical services that the hospitals provide that protect lives, limbs, and health of the communities they serve.

Functionality does not happen by chance, but has to be meticulously planned for by several teams within the hospital. Among the most important contributors to functionality will be the continued supply of the hospital's lifelines, electricity, water and medical gases. The guidance provided in the preceding sections will help dedicated teams including the Hospital Disaster Management Committee (HDMC), the Maintenance teams (MTE, MTW, and MTO) to develop a Disaster Utilities Supplies Plan (DUSP) with sub-sections for their respective service. Taking proactive measures to ensure the continuous availability of electricity, water supply and medical gases will go a long way in keeping the hospital functional and ensure smooth management of mass casualty events. The HDMC and the maintenance teams have to work hand in glove and prepare the Disaster Utility Supply Plans (DUSP) by listing out the possible hazards at various critical locations, identifying interventions, prioritising them and adopting necessary mitigation measures.

It is imperative that hospitals in Myanmar initiate the process of planning for functionality with the development of their DUSPs, which must be a critical component of their Hospital Disaster Management Plans (HDMP).

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