BAN: COVID-19 Response Emergency Assistance Project

ADB Project 54173-001| Loan 3918-BAN

ENVIRONMENTAL MANAGEMENT PLAN

Package

Package No. MYMEN/ICU/ADB/WD-8: Isolation Centers and Critical Care Units in 17 Medical College Hospitals (Lot 10: Installation of Medical Gas System at Mymensingh Medical College Hospital)

Implementing Agency

Health Services Division (HSD)
Ministry of Health and Family Welfare

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Prepared by Health Services Division (HSD) of the Ministry of Health and Family Welfare for the Asian Development Bank.

Table of Contents

List of Tables

List of Figures

1. PROJECT BACKGROUND

1. COVID-19 is a new disease with similar symptoms as influenza but different in terms of severity and community transmission[1]. The World Health Organization (WHO) declared the COVID-19 as a Public Health Emergency of International Concern on 30 January 2020 under the International Health Regulations (IHR) 2005 and recognized it as a pandemic on 11 March 20202[2]. On 23 March 2020, the Government of Bangladesh requested ADB for a support in its preparedness and response to the COVID-19 outbreak. Accordingly, ADB approved a loan of $100 million from its ordinary capital concessional resource for Loan 3918 –BAN (COL): COVID-19 Response Emergency Assistance Project (the project) on 30 April 2020. The loan agreement was signed on 13 May 2020 and became effective on 16 May 2020. The loan completion date is 31 October 2023. The Health Services Division (HSD) of the Ministry of Health and Family Welfare is the executing agency (EA) and the Directorate of Health Services (DGHS) is the implementing agency (IA) of the project.

2. The project will support the procurement of equipment and supplies, the upgrading of health and testing facilities, and build system and community capacities for surveillance, prevention and response to COVID-19. The project's outcome will be the improved Health and wellbeing of COVID-19 affected persons. The project will have three outputs: (i) Output 1: Immediate and urgent needs are met in prevention and control of COVID-19; (ii) Output 2: Infrastructure and related equipment are delivered to support and sustain prevention and management of COVID-19; and (iii) Output 3: Health system and community capacities in combatting COVID-19 are strengthened. In particular, the project will involve civil works supporting the upgrade/extension of existing facilities for the establishment of (i) screening and quarantine areas at points of entry; (ii) critical care and isolation units in existing healthcare facilities; (iii) microbiological diagnostics facilities in existing medical colleges and hospitals across the country.

2. SUBPROJECT DESCRIPTION

3. In order to ensure modern medical services to the people of Greater Mymensingh in the central part of Dhaka and to keep pace with the growing population, to acquire and implement plans to set up a medical college and hospital in Mymensingh. The foundation stone is laid. In the building of the then Mats (in the academic year 1961-62) 50 students were admitted in the first year of MBBS: Medical College was started. Later, the government decided to suspend the activities of Mymensingh Medical College and set up a 1000-bed hospital at the acquired site. Construction of a 1000-bed hospital at the acquired site. Construction of a 1000-bed hospital at the site began in 2006 and was completed on 2012.This is largest hospital in the Mymensingh Division & only referral hospital (Level 3) in greater Mymensingh area serving health care services for about 60 million populations. The hospital is situated in Charpara which is within the city corporation area 125 kilometers North-West from capital city Dhaka.

4. Land area of the hospital campus is 21.29 Acres. Hospital building area is about 3, 60,000 Sq. ft. Total 30 departments are running in the College and Hospital. Six female hostel, seven boys hostel, two internee hostel, one Nurses Training Centre, One Nuclear Medicine Centre, One Morgue, Staff Quarters, Mosque and a playground are there in the campus.

5. Mymensingh Medical College Hospital (MMCH) is start conducting coronavirus test from 1st April 2020. The test lab was formally inaugurated at the Microbiology department on 1st April2020. The treatment of the Coronavirus patient also started in the hospital. There are some waste collection bins placed inside the hospital but it is recommended to enhance the number and to use separate and labelled colored bins to store the medical wastes as well as to handle them with care and to dump in marked places through securing proper safety measures.[3]

[1] WHO Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus. https://www.who.int/health-topics/coronavirus#tab=tab_1.
[2] WHO. International Health Regulations (2005). 3rd Ed. https://www.who.int/ihr/publications/9789241580496/en
[3] https://mmch.gov.bd/mmch_information.php?id=1.

6. Under this sub project, Installation of Medical Gas System at Mymensingh Medical College Hospital. The respective medical authority will provide necessary support and supervision and the monitoring process will be done through Public Works Department (PWD). A small amount of waste materials will be produced during the construction period and medical wastes will be produced during the operation phase of the ICU. The handling procedures of these medical wastes along with other waste are included in Appendix 2. Also, Environmental Screening Checklist has been developed along with the Environmental Code of Practices (ECoP) for effective mitigation measures.[4]

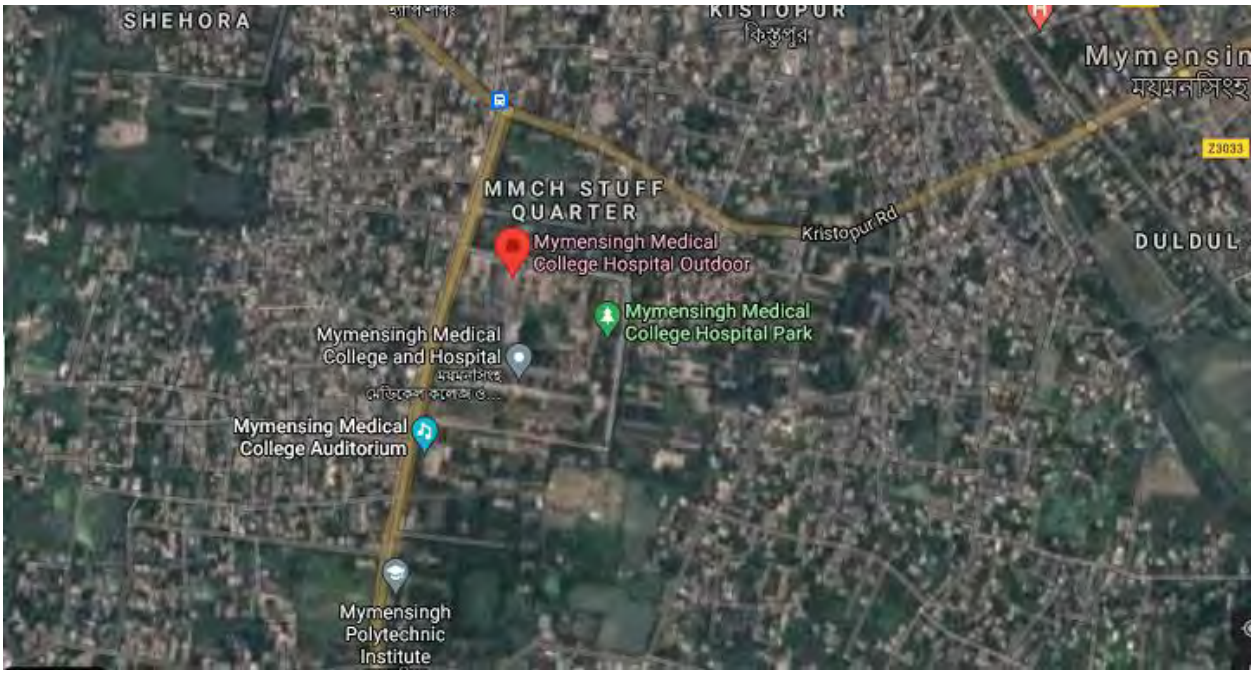


Figure 1: Mymensingh Medical College Hospital (MMCH)

3. BASELINE INFORMATION

7. **Climate.** The climate of Mymensingh is moderate, much cooler than Dhaka, as it is closer to the Himalayas. The monsoon starts in May or June and continues till August. It rains heavily and sometimes for days and weeks. During the monsoon, the temperature varies between 15 and 20 degrees.[5]

8. **Air Quality and Noise Level.** Emission of huge quantity toxic elements with black smoke from unfit vehicles and noise pollution are increasing day by day in Mymensingh district. According to a recent investigation, 80 percent of air pollution is caused by emitting huge quantity of toxic smoke from unfitness vehicles like cars, buses, trucks, taxies, minibuses, trains and others. Black smoke from unfitness vehicles contains Sulphur dioxide, carbon monoxide and nitrogen oxides that are harmful to the ecological balance and also for the human body, said environment specialists. Besides, noise pollution has become another phenomenon for the environment across the district. It is also increasing at an alarming rate. Noise pollution includes noise of cars, buses, and trucks, motor vehicles, loudspeakers use in different cultural and social programme, and many others high-intensity sound from different medium which is extremely harmful to the environment.

9. **Drinking Water Quality.** A study was conducted to assess some chemical properties and heavy metals of surface waters collected from different sources at Bangladesh Agricultural University Campus and Mymensingh Sadar Upazila for common use. Twelve water samples were collected from 4 different locations during February to April 2011 for analyzing their chemical quality parameters. The recorded values of pH, EC (Electrical Conductivity), TDS (Total Dissolved Solid), DO (Dissolved Oxygen), As, Pb and Fe were found to range from 6.153 to 7.043, 0.194 to 0.679 mS/cm,106.333 to 389.333 ppm, 4.433 to 4.9 ppm,

[4] Mymensingh Medical College Hospital Authority.
[5] https://en.wikipedia.org/wiki/Mymensingh.

0.064 to 1.756 ppb, 0.00053 to 0.00083 ppm and 0.567 to 1.795 ppm, respectively. pH and TDS of the surface water were within the standard value but other parameters such as As, Pb, and Fe were significantly higher than the standard for drinking water. The correlation analysis among chemical and heavy metal properties indicated that all the parameters had significant contribution to pollute the water except DO. The correlation between TDS and EC was strongly significant (r = 0.99**). pH showed positive significant correlation with EC and TDS. Fe showed negative (r = -0.636) significant correlation with As. The above findings show that the surface water in Mymensingh area is being gradually polluted by unplanned discharge of chemicals and heavy metals contained effluents. It might be concluded that the water is not so harmful yet for irrigation, aquaculture and livestock usage.[6]

10. The city has a total of 221 healthcare facilities -- 131 hospitals and clinics and 90 diagnostic centres, according to the civil surgeon's office.[7]A study finds that total 1500-2000kg day-1 waste materials have been measured in Mymensingh municipality where the total wastes generated from Dhaka City were 3000-4000kg day-1 (Rashid et al., 2006). Mymensingh Medical College and Hospital is the biggest government owned hospital in Mymensingh municipality. During the field survey, various hospital wastes was observed such as pathological wastes, textile stained with blood, cotton pads, used syringes, broken bottles and glass, paper, cans and other metals, vegetables/rubbish and sharp instruments (syringe- needles, surgical blades and blood lancets) etc. Some of the wastes are blood stained. All the HCE produce used syringes, broken bottles and glass, textile stained with blood and papers. The Study measured about 75% was non-infectious wastes and about 25% was infectious wastes per day. [8]

4. ENVIRONMENTAL MANAGEMENT PLAN

11. Environmental Management Plan is an instrument for implementing the mitigation plan for the proposed subproject. The plan provides guidance regarding environmental and social issues/parameters, location, frequency, and means of management and mitigation. An Environmental Management Plan (EMP) specifies the means through which adverse environmental and social impact of the project associated with pre-construction, construction, and operational activities of the subproject are either avoided or mitigated. This EMP will be implemented for impact management during project construction and operation.

12. The basic objective of the EMP is to manage the adverse impacts of proposed project interventions in a way that minimizes the adverse impact on the environment and people at the subproject sites. The specific objectives of the EMP are to –

- Identification of the environmental impacts and recommended mitigation and enhancement measures;
- Define the responsibilities of the subproject proponents in accordance with the three project phases (design, construction and operation);
- Facilitate the implementation of the mitigation measures by providing the technical details of each project impact;
- Define a monitoring mechanism and identify monitoring parameters to ensure that all proposed mitigation measures are completely and effectively implemented;
- Providing a cost estimate for EMP implementation.

13. The Contractor will be required to prepare a site specific EMP based on this EMP and submit to PIU for Approval; carry out all of the monitoring and mitigation measures set forth in the approved SEMP. The SEMP will be implemented for impact management during subproject construction and operation.

14. **Implementation Arrangements:** MOHFW will be the executing agency (EA) while DGHS will be the implementation agency (IA). The project is expected to be completed by April 2023. A project implementation unit (PIU) will be set up in DGHS to provide the technical, administrative, and logistical

[6] https://www.banglajol.info/index.php/AGRIC/article/view/26563.
[7] https://www.thedailystar.net/city/news/blatant-disregard-rules-1859191.
[8]https://www.researchgate.net/publication/282892660_Hospital_Waste_Generation_and_Management_in_Mymensingh_Municipality.

support necessary for implementation. An inter-ministerial Project Steering Committee is to be constituted under the project of DGHS under the chairmanship of the Secretary, MOHFW, will provide guidance on policy directions and oversee the overall project implementation. The PIU will work directly with the government entity involved in each activity, such as but not limited to: (i) the COVID-19 Emergency Operation Center (EOC) in preparedness and response; (ii) the various coordination committees at Divisional, District, City Corporation and Upazila levels for civil works activities; and (iii) the Institute of Epidemiology, Disease Control and Research (IEDCR) and other relevant institutes under DGHS in contact tracing support and surveillance strengthening activities. The PIU will conduct regular monitoring and evaluation activities and hold quarterly reviews of progress against the indicators. For technical oversight and hands-on support to the PIU for ensuring environmental safeguards, an intermittent environmental specialist will be appointed throughout project implementation up to completion.

15. The contractor will designate their environmental staff who will be responsible in overseeing the implementation and compliance to the EMP during construction phase and maintain a record of complaint/grievance submitted at the project level through the contractor including any actions taken to address the issue. Contractors will also follow the guidelines for COVID-19 preparedness provided in Appendix 3.

16. **Grievance Redress Mechanism (GRM):** MOHFW will ensure that affected persons will have the chance to express their legitimate grievances or to file a complaint about the project by setting up a Grievance Redress Mechanism (GRM) as soon as the loan becomes effective. The GRM shall resolve complaints in a time-bound and transparent manner. The GRM process will be aligned with the process adopted by MOHFW, while ensuring compliance with the policy principles of ADB SPS 2009. Any cost related to the implementation of the GRM will be part of the administration cost borne by MOHFW. Grievances filed and resolved will be thoroughly documented and included in the monitoring reports submitted to ADB.

17. Complainants or affected persons can seek redress to their complaints in three levels: Level 1: The complaint will be resolved at the activity level through the Site Engineer or Representative by the Contractor within one to two working days and advise the Complainant accordingly. Level 2: The GRM Focal Person will assist the complainant in elevating the complaint to the PIU. The PIU will address the grievance within 7 days through continuous interactions with the complainant to answer queries and resolve the complaint. Level 3: In the event the complainant is not satisfied with the decision after the GRM, the Complainant can access the ADB's Accountability Mechanism (ADB's Office of Special Project Facility or Office of Compliance Review).

Table 1: Environmental Management Plan for Isolation Unit and CCU at MMCH

IEC	Potential Impact	Mitigation Measures	Monitoring Method		Responsibility	
			Method of Collecting and Reporting Data	Location and Frequency	Implementation	Supervision
CONSTRUCTION PHASE						
Waste Management for Construction and COVID Waste	• Soil, water and air pollution from the improper management of wastes and excess materials from the construction sites. • The discarded PPE has posed serious health hazards and can spread the contagion among cleaners and walkers.	• Develop a waste management plan including COVID waste by the help of the environmental consultant and later to update the plan, if required. • Use of colored bins (like yellow) and to put medical wastes in 2-3 layered plastic bag. These wastes need to disinfectant first using chlorine or any other germicides and then safely transport them through marked vehicles in a marked place. • Waste segregation, packaging, collection, storage disposal, and transport will be conducted in compliance with GOB, ADB and WHO COVID-19 Guidelines. • Train on correct use and disposal of PPEs and check that they understand. • Construction wastes (such as piece of rod, wood, bamboo, tin sheet, brick etc.) shall be kept in designated area and sprayed water mist to reduce the dust. • Use PPE for staff handling any hazardous materials seepage of hazardous chemicals in case of any accidental spills. • Do not burn/throw in any wastes to the waterbodies/drains. • The PIU will audit any off-site waste disposal required on a monthly basis and institute any remedial measures required to ensure compliance.	• Record of waste type and quantity and the disposal method	Construction camp and work sites during construction period	Contractor	PIU and Environmental Consultant (ES)
Management of Workers Facility	• Lack of proper facilities such as water supply and sanitation facilities may pose health hazards to workers.	• Ensure sufficient stock of soap, sanitizer, washing facility and safe water at work site. Also, provision of an appropriate number of toilets and hand-washing points. • At the entrance of the worksite every personnel must wash their hands for 20 second with maintaining a distance of at least 6ft from each other. • Check the availability of medical kits at the site on weekly basis. • Preparation of daily routine checkup including temperature screenings of the workers and staff.	• Visual inspection &consultation with worker; • Health checkup record.	Construction camp site during construction period	Contractor	PIU and ES
Drinking Water Quality	• Groundwater at shallow depths may be contaminated with arsenic and other parameters and hence not suitable for drinking purposes.	• Provide the drinking water that meets national standards. • Select aquifers for drinking water free from arsenic and other contaminants. • Tube wells will be installed with due regard for surface environment, protection of groundwater from surface contaminants, and protection of aquifer cross contamination. Sanitary waste should be adequately disposed-off to avoid groundwater contamination.	• Record of water-borne diseases	Regular monitoring the drinking water source during construction period	Contractor	PIU and ES
Drainage Congestion	• Waterlogging due to improper management of drainage for rainwater/liquid waste or wastewater.	• Regularly inspect and maintain all drains to assess and alleviate any drainage congestion problem. • Stockpile materials away from drainage lines. • Reconstruct internal roadside drains immediately if damaged by any activities.	• Visual inspection & consultation with hospital staff and visitors.	In the project area during construction period	Contractor	PIU and ES
Dust/Air Quality Management	• Dust generation from construction sites, material stockpiles specially earth material stockpiles and access roads is a nuisance in the environment and can be a health hazard.	• During pneumatic drilling/wall destruction dust shall be suppressed by ongoing water spraying and/or installing dust screen enclosures at site. • Water spraying the material stockpiles and access roads when and as required basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (especially during the dry period and high winds). • Cover haul vehicles carrying dusty materials moving outside the construction site.	• Visual inspection &consultation with hospital staff, doctors, patients and their relatives	On the worksite Weekly monitoring during construction period	Contractor	PIU and ES

IEC	Potential Impact	Mitigation Measures	Monitoring Method		Responsibility	
			Method of Collecting and Reporting Data	Location and Frequency	Implementation	Supervision
		• Fit machinery/vehicles with appropriate exhaust systems and emission control devices.				
Noise and Vibration Management	• Noise may have an impact on workers, patients, hospital staffs, local residents etc.	• Appropriately site all noise generating activities to avoid noise pollution to workers, patients, hospital staffs, local residents etc. • Install temporary noise barriers by screen, tin, wood around generators to reduce noise levels. • Employ best available work practices on-site to minimize occupational noise levels. Use ear plugs in noisy areas of the construction activities. • Maintain all equipment in order to keep it in good working order in accordance with manufactures maintenance procedures.	• Visual inspection & consultation with hospital staff, doctors, patients and their relatives	On the worksite Weekly monitoring during construction period	Contractor	PIU and ES
Occupational Health and Safety (OHS)	• Construction works may pose health and safety risks to construction workers that may cause severe injuries and deaths. • Lack of first aid and health care facilities in the immediate vicinity. • Health risk of construction workers due to COVID-19.	• Develop and implement an Occupational Health and Safety Plan to ensure competent and consistent attention to worker health and safety throughout the construction phase. • Prepare the health and safety guidance for COVID-19 at work sites and get approval from PMU, and strictly follow the guidance at worksite; • Any worker showing symptoms of respiratory illness (fever, cold or cough) and has potentially been exposed to COVID-19 should be immediately removed from the site and tested for the virus at RMCH; • Workers involved for any short renovation activities at isolation area for COVID-19 will have WHO certified PPE and subsequently dispose the PPE in designated areas. • Provide PPE to workers such as safety shoes, safety helmets, face masks, hand gloves, protective clothing, goggles, full face eye shields, and ear plugs and monitor to maintain them. • Ensure hand washing and other sanitary stations are always supplied with clean water, soap, and disinfectant. • Provide safety measures as appropriate during works such first aid kits, restricted access zones, warning signs, overhead protection against falling debris, lighting system to protect community, hospital staff and patients against construction risks. • Simple poster/signage in Bangla explaining entry procedures. Signage available in hospitals to remind health personnel to wear masks if necessary and wash hands before entering/leaving. • Emergency preparedness and response procedures and equipment (warning signs, fire extinguishers, fire exit etc.). • Train all construction workers in OHS matters, and on the specific hazards of their work and maintain a register of the person present during the training. • Grievance Redress mechanism (GRM) developed to readdress complaints raised by community, health staff, patients and their relatives.	• Visual inspection & consultation with hospital staff, doctors, patients and their relatives • Record of accidents • Obtain record of training • Provision of regular temperature check, using disinfectants and also provision of time-to-time hand wash are required to limit the COVID-19 pandemic.	Contractor' site office and work site during construction	Contractor	PIU and ES
Site Reinstatement	• Damage due to debris, spoils, excess construction materials.	• Remove all spoils wreckage, rubbish, or temporary structures from the construction and camp sites. • All affected structures rehabilitated.	• Visual inspection & consultation with local people	At the end of construction period	Contractor	PIU and ES
OPERATION PHASE						

IEC	Potential Impact	Mitigation Measures	Monitoring Method		Responsibility	
			Method of Collecting and Reporting Data	Location and Frequency	Implementation	Supervision
COVID Waste Management	• COVID waste has posed serious health hazards and can spread the contagion among hospital staff, waste handlers and the community.	• Prepare medical waste management plan that will cover the waste generated from the response to the COVID-19 infection. The plan will follow ADB's guidance note on managing medical waste during COVID-19 pandemic as well as any other government regulations. • All medical waste produced during the care of COVID-19 patients must be considered as infectious waste and should be segregated and collected safely in designated colored coded containers. • Use of colored bins (like yellow) and to put Covid wastes in 2-3 layered plastic bag. These wastes need to disinfectant first using chlorine or any other germicides and then safely transport them through marked vehicles in a marked place. • Waste segregation, packaging, collection, storage disposal, and transport will be conducted in compliance with WHO COVID-19 Guidelines. • Train the staffs on color coding and handling of infectious Covid wastes.	• Visual inspection and consultation with hospital staff and cleaners. • Record of waste type and quantity and the disposal method.	Hospital area especially in COVID ward during operation period	MMCH	DGHS
Medical Waste Management	• Poor management of medical waste exposes healthcare workers, waste handlers and the community to infections, toxic effects and injuries. • Soil, water and air pollution from the improper management of wastes generated from the facility.	• Provision of color coded, covered receptacles in strategic positions of the facility for separate categories of waste and regular cleaning of waste bins. Labels showing the type of waste that should be disposed of in each container should be placed near to the bins to guide staff and reinforce good habits. • Medical wastes generated in the hospital will be treated by in-house facility and then this treated wastes will be disposed of as per a pre-determined SOP in accordance with international good practices. Transport the medical waste with covered vehicle. The records of waste disposal will be maintained as proof for proper management as designed. • Ensure necessary PPE (gown, gloves, face mask, goggles or face shield, gumboots) is provided to all staffs, as required and ensure them to wear PPE when handling and disposing waste according to national and WHO guideline. • Do not burn the wastes openly or throw into waterbodies or do not dispose on soil. • Audit for any off-site waste disposal will be required on a monthly basis and institute any remedial measures required to ensure compliance.	• Visual inspection and consultation with hospital staff and cleaners. • Record of waste type and quantity and the disposal method.	Hospital area during operation period	MMCH	DGHS
Medical Gas Safety Management	• Potential hazard gas leakage.	• If installation of medical gas pipe is connected to cylinder then the proper safety steps should be taken. • Covering gas cylinder storage system, proper labelling and color coding of gas cylinder, training program for hospital staff on cylinder safety should be taken.	• Regular inspection and testing of all safety features and hazard control measures and personal protective features.	Hospital area during operation period	MMCH	DGHS
Occupational Health and Safety including COVID H&S	• Needle-sticks, surgical cuts, and other injuries posing transmission risk of blood-borne diseases such as COVID-19, Hepatitis C, HIV-AIDS, etc. • Dermatitis and allergic reactions due to workplace exposures.	• Prepare a health and safety guidance for COVID-19 and strictly follow the guidance at the facility. • Refer to IFC EHS Guidelines for Healthcare Facilities (2007) and relevant national guidelines and protocols. • Implement suitable safety standards for all workers and facility visitors. • Mandatory use of personal protective equipment and safety gears, where required. • Arrangements for safe drinking water and sanitation facilities.	• Regular inspection and testing of all safety features and hazard control measures and personal protective features	Hospital area during operation period	MMCH	DGHS

IEC	Potential Impact	Mitigation Measures	Monitoring Method		Responsibility	
			Method of Collecting and Reporting Data	Location and Frequency	Implementation	Supervision
		• Provide regular OHS training to healthcare workers. • Provide incentives to staff and create a work-life balance in work schedule.				
Accidental Releases of Gas and Fluids	• Leakage of infectious or hazardous substances may pose serious health hazards and can spread the contagion among hospital staff and patients, cleaners etc.	• Develop an Emergency Response Plan and follow strictly during emergency incident. • Emergency preparedness and response procedures and equipment (warning signs, fire extinguishers, fire exit etc.). • Wear disposable gloves and, if aerosols are formed, glasses and a respirator for particles. • Cover the contaminated area with a disinfectant in a concentric way, starting at the edge and progressing towards the center of the contamination. • Avoid spraying or pouring the disinfectant from above, which can cause aerosols. • Mop up and dispose of all waste and contaminated material in the appropriate container (infectious waste). • Conduct monthly safety audit of facility to identify fire risks, electrocution hazards and other unsafe conditions, and assess adequacy of fire extinguishers and first aid provisions.	• Record of regular inspection.	Hospital area during operation period	MMCH	DGHS
Medical Gas Safety Management	• Haphazardly stored and lack of regular maintenance often create hazards. • Cylinders are often the same colour regardless of the contents and the labelling is often a poor quality and inconsistent. Because of this, there is a risk of the wrong cylinder being delivered accidentally to healthcare facilities. • Poorly trained staffs are not aware of the importance of ensuring the correct tanks are connected to the right lines and management of gas cylinders	• Develop a Medical Gas Safety Management Plan during the operation and follow strictly. • Follow the suggested medical gas safety management plan as given in Annex 4. • Regularly check and update the management plan as per the requirement. • Follow the Emergency Response Plan if required and maintain a direct communication channel with the emergency response team/in case of emergency. • Ensure labeling, safety signs and inspection for all the gas cylinders and locations. • Ensure regular training to the personnel engaged with the medical gas safety management.	• Record of regular inspection.	Hospital area during operation period	MMCH	DGHS

18. **EMP Budget:** The contractor should develop a site-specific Occupational Health and Safety Plan following ADB COVID-19 guidelines to ensure competent and consistent attention to worker health and safety throughout the construction phase and it is also suggested to maintain a medical waste management plan for the operation period. The possible mitigation measures of handling medical waste have also been suggested in the EMP. The EMP budget would also include the training cost. The contractor will arrange training for associated personnel and workers during construction phase. These training sessions will include knowledge on the environmental management system, health and safety, emergency response, etc. Estimated cost is to be included in the BOQ as non-competitive item. The EMP implementation cost for MMCH has been calculated and given in Table 2.

Table 2: Cost Estimation for EMP Implementation

Mitigation and Monitoring Items	Unit	Total Unit	Cost/Unit	Total Cost
1. Workers Health and Safety				
Safety Vest	Nos.	10	270	2700
Helmet	Nos.	10	350	3500
Safety shoes	Nos.	10	430	4300
Safety Goggles	Nos.	10	280	2800
Hand Sanitizer (5 Liter)	Nos.	2	2600	5200
One time Face Mask	Box	2	500	1000
Thermometer for measuring body temperature	Nos.	1	1000	1000
Fire extinguisher	Nos.	2	1299	2598
First Aid Box	Nos.	1	2500	2500
Sub-total excluding over-head & profit =				25598
Sub-total Including over-head & profit =				29053.730
Add VAT with adjustment factor (VAT-7.5% &Factor-1.08108)				2355.705
Total for item 1 including over-head, profit and VAT =				31409.435
2. Engineers Health and Safety				
Safety Vest	Nos.	3	270	810
Helmet	Nos.	3	350	1050
Safety shoes	Nos.	3	1000	3000
Safety Goggles	Nos.	3	500	1500
Hand Sanitizer (5 Liter)	Nos.	1	2600	2600
One time Face Mask	Box	1	500	500
Thermometer for measuring body temperature	Nos.	1	1000	1000
First Aid Box	Nos.	1	2500	2500
Sub-total excluding over-head & profit =				12960
Sub-total Including over-head & profit =				14709.60
Add VAT with adjustment factor (VAT-7.5% &Factor-1.08108)				1192.669
Total for item 1 including over-head, profit and VAT =				15902.269
3.Training on Occupational Health and Safety, and COVID-19 Safety Protocol				
Train on correct use and disposal of personal protective equipment (PPE)	Nos.	1	10000	10000
Sub-total excluding over-head & profit =				10000
Sub-total Including over-head & profit =				11350
Add VAT with adjustment factor (VAT-7.5% &Factor-1.08108)				920.269
Total for item 1 including over-head, profit and VAT =				12270.269
4. Waste Management, Potable Water Supply and Sanitation Facility				
Supply of waste bins/pots for different wastes	Nos.	2	2400	4800
Cost for drinking water	Nos.	1000	2	2000
Cost for sanitation facilities (hand tube well, latrine etc.)	Nos.	1000	1	1000
Cost for safety notices/signboards/protocol at site	Nos.	100	5	500
Sub-total excluding over-head & profit =				8300
Sub-total Including over-head & profit =				9420.500
Add VAT with adjustment factor (VAT-7.5% &Factor-1.08108)				763.824
Total for item 1 including over-head, profit and VAT =				10184.324
			Grand Total =	69766.297
Note: Considering Over-head 3.5%, Profit - 10%, VAT 7.5%				

11. **Monitoring and Reporting:** The PIU of the project, under DGHS, will monitor the progress of EMPs implementation and the compliance performance of their contractors. The PIU will undertake site inspections and document review to verify compliance with the EMPs and progress toward the final outcome.

12. In the current crisis context, MOHFW do not have sufficient capacity and resources available to effectively oversee safeguards issues; the project therefore being supported MOHFW by recruiting an environmental safeguards specialist and a social safeguards specialist within the PIU to manage all environmental and social safeguards issues, reporting to the project director. These two specialists have overall responsibility for safeguards screening, implementation, monitoring and reporting, while the project director is accountable for the project's overall compliance during implementation. Safeguards documents will be reviewed and approved by the executing agency/implementing agency and ADB. The PIU will also obtain all clearances and fulfill any government safeguards-related requirements as applicable. The safeguards specialists will work in close collaboration with the 8 division-level project coordinators, as well as government representatives within the various coordination committees at divisional, district, city corporation and upazila levels, and defined project focal points at each site covered by the project and will coordinate with other relevant government departments to consult and/or obtain endorsement if necessary. Institutional roles and responsibilities are further detailed in the EARF and RIPPF.

13. ADB will review the project performance based on the commitments by HSD, MOHFW as agreed in the legal documents. Monitoring and supervising of environmental safeguards will be integrated into the project performance management system of ADB. The review of project performance will be conducted by ADB until the project completion report is completed. ADB will carry out the following monitoring actions to supervise project implementation:

- Conduct periodic site visits for projects with adverse environmental impacts;
- review the environmental monitoring reports submitted by MOHFW to ensure that adverse impacts and risks are mitigated as planned and as agreed with ADB;
- work with MOHFW and DGHS to rectify, to the extent possible, any failure to comply with their environmental commitments in the Loan Agreement, and exercise remedies to re-establish compliance as appropriate; and
- Prepare a project completion report that assesses whether the objective and desired outcomes of the project have been achieved.

APPENDIX-1: LAYOUT PLAN OF SUBPROJECT COMPONENTS

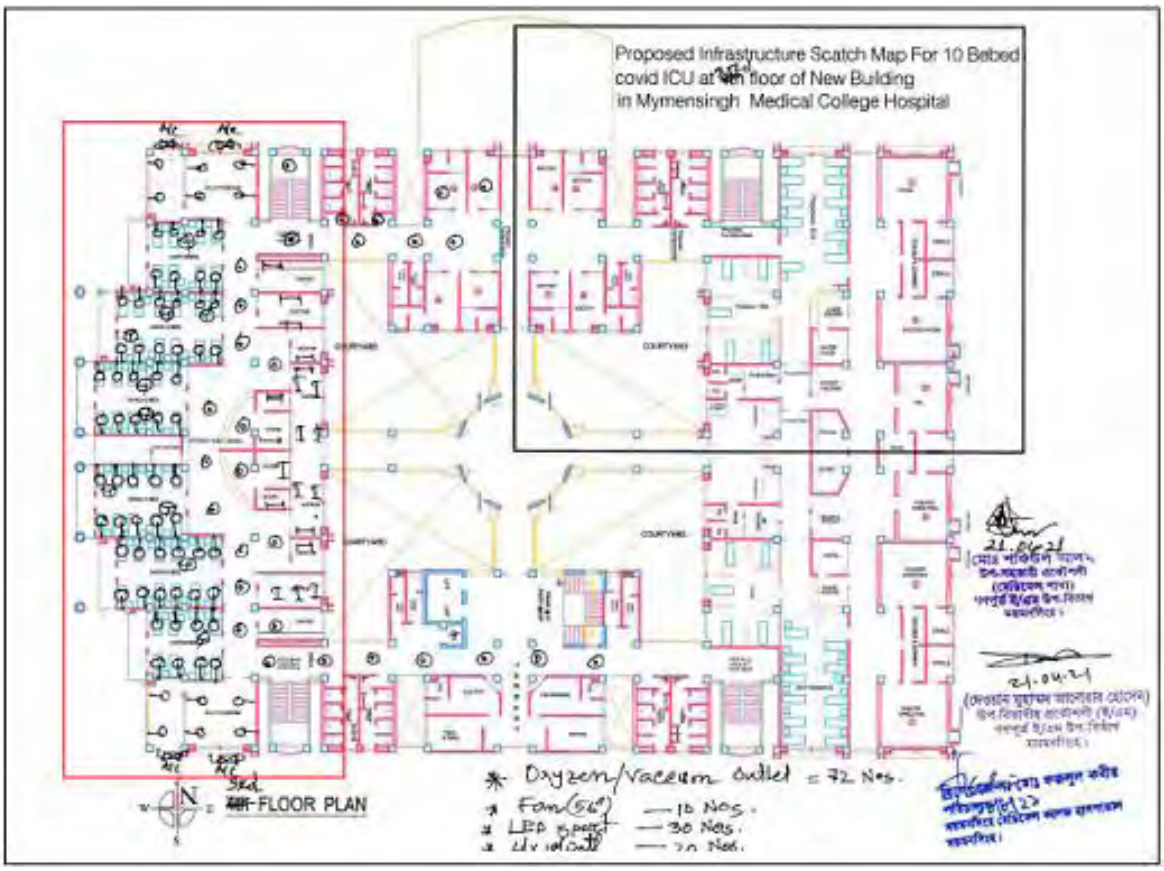


Figure: Construction of50 bed Isolation Units at Mymensingh Medical College Hospital

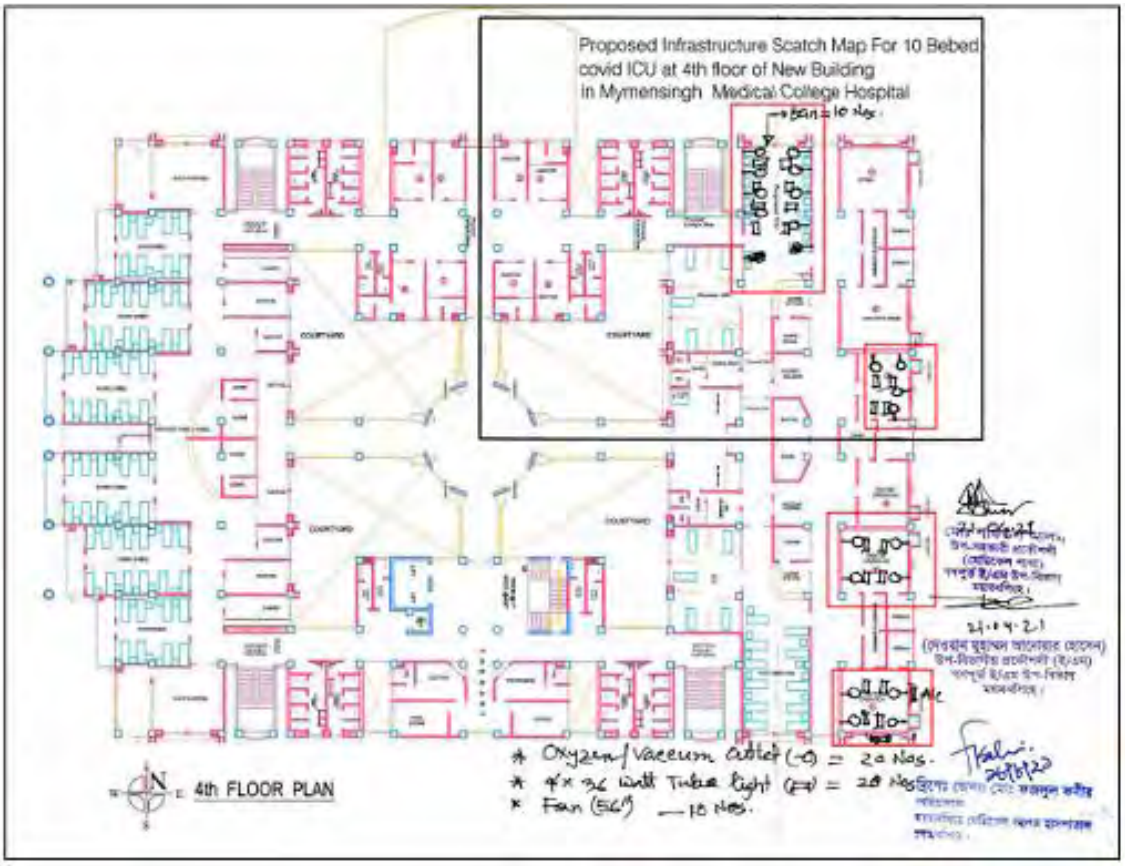


Figure: Construction of 10 bed ICU/CCUs at Mymensingh Medical College Hospital

APPENDIX-2: SAMPLE MEDICAL WASTE MANAGEMENT PLAN

OBJECTIVE

Medical Waste which is also referred as clinical waste has to be handled and disposed in a proper manner to eliminate the possibility of injury or infection and safeguarding the environment as a whole. The impacts associated with improper Medical Waste Management (MWM) can damage the environment and affect public heath directly and indirectly.

Medical wastes contain both general wastes (app. 75-80%) and infectious wastes (app. 20-25 percent). Medical Waste constitutes a public health hazard, if not managed properly. Although majority of the medical waste is no more dangerous than household/municipal waste, the hazardous waste, if exposed to the people or environment in an untreated form, pose various kinds of danger.

The main objective of the Medical Waste Management Plan (MWMP) is to organize disposal of all wastes generated during construction in an environmentally acceptable manner specially consider the following:

- Health hazards of the project personnel as well as community people should not be occurred;
- Manage the wastes in such a way that environment (specially air, water, surrounding environment etc.) will not be polluted;
- Odor means bad smell should not be generated;
- Always friendly environment at the construction sites and construction camps;
- Any waste should not be disposed into the river and any water bodies to avoid water pollution;
- Any waste should not be burnt

STRATEGIES FOR MEDICAL WASTE MANAGEMENT

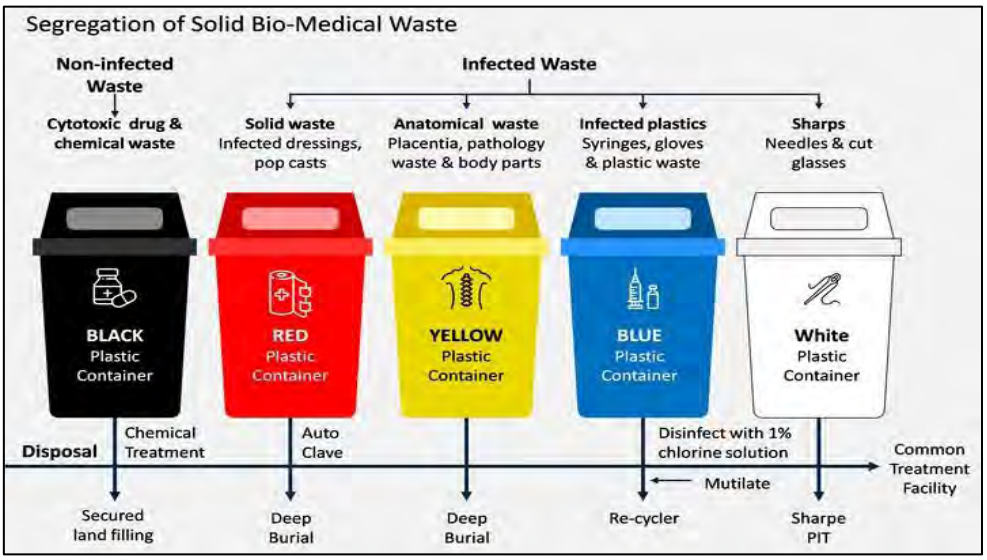
The major components of medical waste management include:

- Proper waste collection and segregation at source – use of standardized color-coded bins for different wastes;
- Waste streams - general, contaminated, cytotoxic/pharmaceuticals, body parts;
- Storage and transport - cold storage for contaminated waste and body parts, transport in safe and leak proof containers;
- Waste treatment – sterilization of contaminated waste (steam autoclave), incineration of cytotoxic, pharmaceuticals and body parts in incinerator meeting relevant standards and statues.

To perform a Medical Waste Management, several stages, need to be followed.

Stage 1: Collecting & Segregating

The biomedical waste has to be collected in containers that are resilient and strong from breakage during the handling process. Do not place sharps, used needles, syringes, or other contaminated tools in common waste disposal or recycle bin because the entire waste will be infectious by doing so. The segregation also needs to be performed between the liquid and solid biomedical waste products. Categorizing the medical waste with correct segregation to isolate and manage each waste in the proper way. For this purpose, the segregations come in colored waste containers, label coding and plastic bags. The simplest way to identify the different types of waste is to collect the various types of waste in separate containers or plastic bags that are color-coded and/or marked with a symbol.



Stage 2: Storing & Transporting

Specific requirements for storage facilities, such as a secure area that is inaccessible to the general public, as well as separated it from areas for food consumption. The storage facilities also have to be accompanied with refrigerator or freezer unit that can be used with medical waste if necessary. Some facilities even provided special vehicles and protective devices to dispose, handling or transport the biomedical waste products. Remember to observe and keep maintaining the protective devices periodically so it won't be a source of transmitting the infections. Further recommendations should be followed by the ancillary workers in charge of waste collection:

- Wastes should be collected daily or as frequently as required and transported to the designated central treatment site.
- No bags should be removed unless they are labeled with their point of production (hospital and ward or department) and contents.
- The bags or containers should be replaced immediately with new ones of the same type.
- Special packaging requirements for off-site transport in general, the waste should be packaged according to the recommendations provided in sealed bags or containers to prevent spilling during handling and transportation. The bags or containers should be appropriately robust for their content (puncture-proof for sharps, for example, or resistant to aggressive chemicals). Bags and containers must be closed whenever they are two-thirds full. Never pile bags or empty them; grasp them from the top (never hold them against the body) and wear gloves.
- All waste bags or containers should be labeled with basic information on their content and on the waste producer. This information may be written directly on the bag or container or on preprinted labels, securely attached. For health care wastes, the following additional information should be marked on the label: waste category, date of collection, place in hospital where produced (e.g. ward), and waste destination.

Stage 3: Treatment of Medical Waste

Incineration at high temperatures (over 1000°C) is one of the few technologies with which all types of health-care waste can be treated properly and it has the advantage of significantly reducing the volume and weight of the wastes treated. There are simple incinerator models for treating small quantities of medical waste. Some are available on the market, and others have to be built with local materials on the spot according to relatively simple plans. These incinerators consist essentially of one or two combustion chambers (the primary and secondary chambers) and a discharge chimney. The combustion and air-borne emission control system is simple. If infectious medical waste is treated in small single-chamber or dual-chamber incinerators on site, fractions of waste such as drugs, chemicals, halogenated materials or wastes with high heavy metal content (such as batteries, broken thermometers, etc.) must not be treated in this type of facility.

Autoclaving is a thermal process at low temperatures where waste is subjected to pressurized saturated steam for a sufficient length of time to be disinfected (60 minutes at 121°C and 1 bar). Where prions (which cause Creutzfeldt- Jakob's disease) are present, a cycle of 60 minutes at 134°C is recommended, since they are exceptionally resistant. Efficiency tests (biological or thermal) must in any case be carried out regularly. Autoclaving is environmentally safe but, in most cases, it requires electricity, which is why in some regions it is not always suitable for treating wastes Small autoclaves are frequently used for sterilizing medical equipment, but the models used for treating healthcare wastes can involve relatively complex and expensive plants (with internal mixing, shredding and drying systems) requiring meticulous design, proper sorting and a high level of operating support and maintenance. Furthermore, the effluents must be disposed of carefully and properly monitored. And lastly, large autoclaves may require a boiler that generates several types of emissions, which have to be monitored. Once wastes have been processed in an autoclave, they are no longer infectious materials: they can be landfilled with municipal refuse. Autoclaving is often used for pre-treating highly infectious waste before it is transported outside the hospital. This thermal process needs electricity and high installation cost.

Microwaving is another emerging technology to treat biohazardous waste, including material from healthcare facilities. Use of radiation to heat materials and destroy pathogens, can be combined with shredding to make material safe for disposal without modification. In microwave systems, disinfection occurs through the action of moisture and low heat. Microwave units usually operate at a frequency of 2450 MHz and the energy generates hot water and steam. It can be installed indoor with solid floor and require large electricity supply. It has the advantage of significantly reducing the volume and weight of the wastes treated up to 60-80% where autoclave can reduce to 50%.

Stage 4: Disposal of Medical Waste

Disposal in a sanitary landfill or waste burial pit: The disposal of untreated health-care waste in an uncontrolled dump is not recommended and must only be used as a last resort. It can be disposed of in a sanitary landfill, subject to certain precautions: it is important that health-care waste be covered rapidly. One technique is to dig a trench down to the level where old municipal refuse (over three months old) has been buried and to immediately bury health-care waste that is discarded at this level under a 2-metre layer of fresh municipal refuse. The following are the essential factors that must be taken into consideration in the design and use of a sanitary landfill

- access must be restricted and controlled;
- competent staff must be available;
- the discarding areas must be planned;
- the bottom of the landfill must be waterproofed;
- the water table must be more than 2 meters below the bottom of the landfill;
- there must be no drinking water sources or wells in the vicinity of the site;
- chemicals must not be disposed of on these sites;
- the waste must be covered daily and vectors (insects, rodents, etc.) must be controlled;
- the landfill must be equipped with a final cover to prevent rainwater infiltration; leachates must be collected and treated.

Purpose-built burial pit could also be used, preferably on the hospital site. Ideally, the pit should be lined with low permeability material such as clay to prevent the pollution of shallow groundwater and should be fenced in so as to prevent scavenger access. Health-care wastes must be buried immediately under a layer of soil after each unloading operation. It is suggested that lime be spread on the waste for added health protection (in the event of an epidemic, for example) or to eliminate odor. The pit should be sealed once it has been filled.

Disposal of liquid wastes in the sewage: There are two recommended ways to handle medical waste fluids: i. Collect fluids in a leak proof container and solidified for autoclave treatment; ii. Thermally (autoclave) fluids then they be disposed into the sanitary sewer system. An extra precaution should be performed before pouring treated fluids in sewer because they may clog and leak.

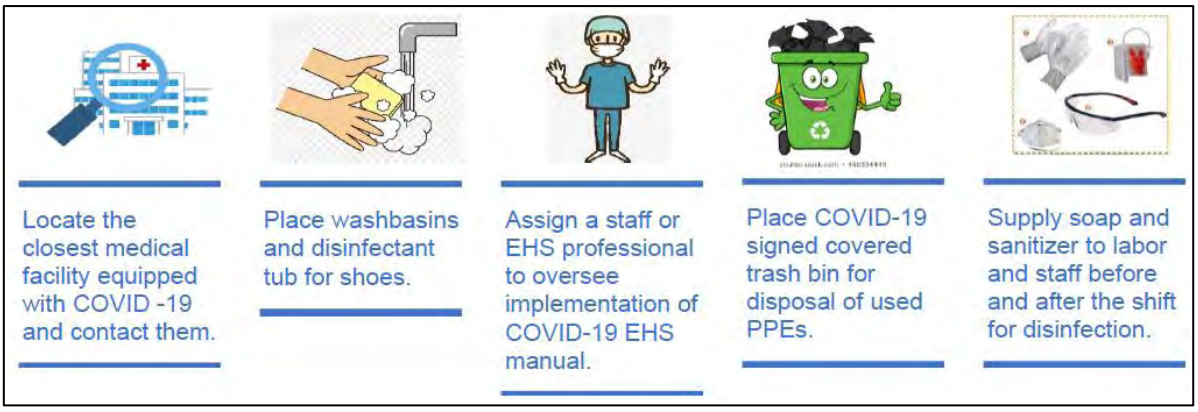
Spill contingency plan: Surfaces contaminated with spilled or leaked biomedical waste must be decontaminated with a solution of industrial strength detergent to remove visible soil before being disinfected by one of the following methods:

- Steam for a minimum of 30 seconds.
- Rinse for at least three (03) minutes with a hypochlorite solution containing 100 parts per million (ppm) available free chlorine (note: one tablespoon per two (02) gallons of water is approximately 100 ppm available free chlorine), or rinse for at least three (3) minutes with an iodine solution containing 25 ppm available iodine.
- Use a chemical germicide that is registered by the Environmental Protection Agency (EPA) as a hospital disinfectant, following recommended dilutions and directions. Liquid waste created by these chemical disinfecting operations shall be disposed of into the sanitary sewage system.
- Employees cleaning spills of biomedical waste must wear appropriate personal protective equipment such as, but not limited to, gloves, gowns, laboratory coats, face shields or masks and eye protection. Spills should be reported to the respective Health and Safety Officer.

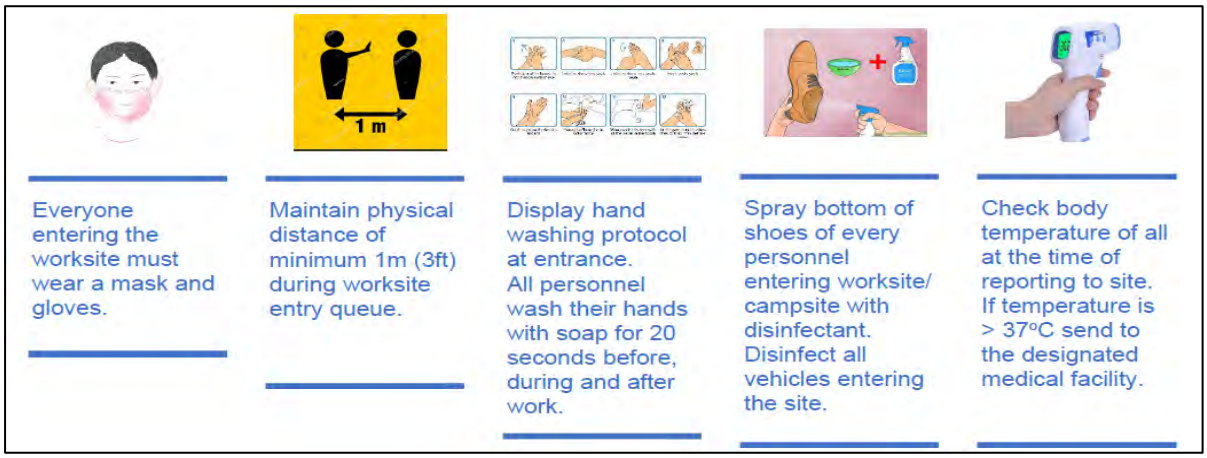
APPENDIX-3: COVID HEALTH AND SAFETY PLAN FOR THE CONSTRUCTION WORK

The contractors shall at all times be responsible to take all reasonable precautions to maintain the health and safety of personnel and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. ADB prepared a COVID-19 Health and Safety Advisory Guidance for Construction Workforce, which may be further updated as the COVID-19 situation evolves. The ADB guidance includes the protocols on the following:

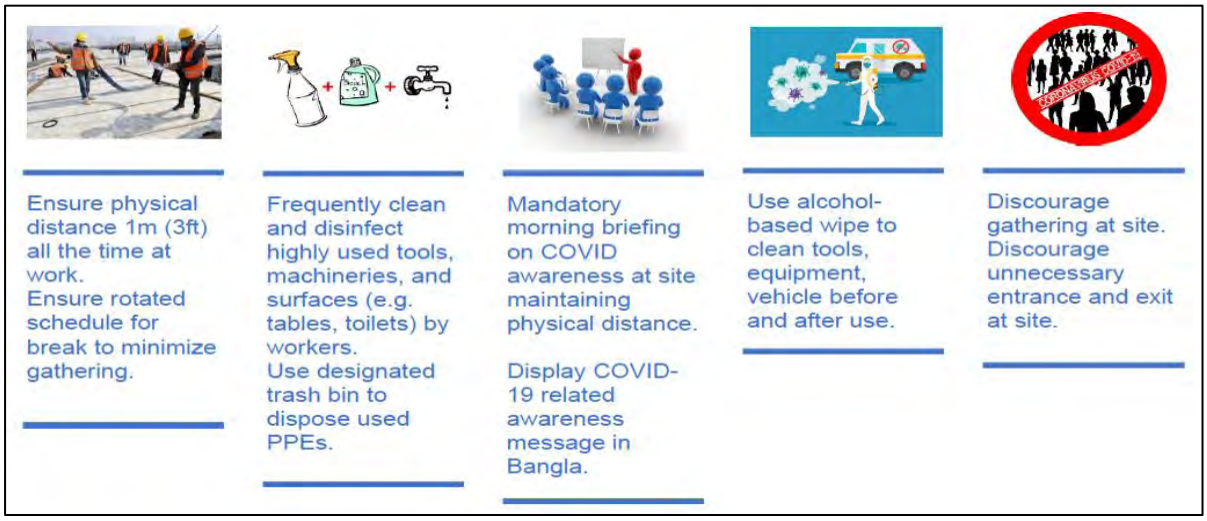
A. Prerequisites for Reopening Worksite: Plan to open/reopen worksite at limited scale (i.e. only essential works at worksite). Map essential/unavoidable works that must be attended at this moment. Identify and engage essential labor force initially. Increase labor force step by step as necessary. Do not engage labor until: i. Conduct risk assessment of worksite and prepare plan as per H&S guideline; ii. Avoid labor intensive works as much as possible; iii. Ensure all to use the Personal Protective Equipment (PPE) as appropriate; iv. Engage health and safety supervisor to implement COVID-19 guideline; v. Engage health worker for daily temperature check and record for workers; vi. Ensure all equipment and vehicles used are routinely disinfected; vii. Provide thermometer, soap, sanitizer, disinfectant, PPE at worksite/camp; viii. Place adequate washbasins, disinfectant tub, dispenser for sanitizer; ix. Engage contractor's EHS staff or assign an existing staff to handle COVID-19 in case if detected; x. Post enough COVID-19 awareness posters throughout the worksites; and xi. Maintain COVID-19 weekly monitoring and reporting mechanism at worksite; including any necessary actions to be taken.



B. Worksite Entrance Protocol: Everyone entering the worksite must wear a mask, gloves and hard shoes. Strictly follow and implement the EHS manual at worksite. The entrance of the worksite/camp site every personnel must wash their hands for 20 second with maintaining a distance of at least 1m (3 ft) from each other.



C. Worksite Management Protocol: A designated EHS and medical person should stay all time during work. The EHS/Medical person should also monitor campsite. He/she will be in charge of ensuring physical distances (minimum 1m) among workers, disinfecting surfaces that are commonly used and investigate worker's/site personnel health and safety.



D. Camp Management Protocol:

1. Provide soap, sanitizer, washing facility and safe water at the workers' dwelling. Encourage frequent hand washing.
2. Ensure separate covered waste bin for disposal of used PPEs.
3. Protect against heat, cold, damp, noise, fire, and disease-carrying animals.
4. Maintain good housekeeping and social distancing in kitchens, meal rooms, canteens.
5. Ensure personal distance at least 1m (3ft) during lunch, dinner and prayer.
6. Ensure ample ventilation at the camp.

E. Work at Site Awareness: Train workers on how to properly put on, use/wear, and take off protective clothing and equipment. The on-site EHS/Medical person should be in-charge of these trainings. These trainings must maintain the WHO's social distancing protocol. Make these trainings mandatory at worksites. Provide 10-15 minutes of a workday for such 'training and encouragement' activities.

Contractor should develop a preparedness and response plan by following the ADB guideline to prevent COVID-19 infection in the workplace. The preparedness plan will be submitted to PMU for approval. In addition to the ADB guideline, the government's Technical Guidance for Social and Institutional Containment and Prevention of Pandemic COVID-19 Infection issued on 11 May 2020 has also to be complied with.

APPENDIX-4: MEDICAL GAS SAFETY MANAGEMENT PLAN

Introduction: Various kinds of Gases are used in medical facilities for treatment purpose. Their contribution helps saving life in hospitals, clinics and other medical facilities. But these gases can also be dangerous if not handled properly. Compressed gas cylinders are dangerous, heavy, sometimes awkward to move and store. Improper handling could result in serious injuries and a broken valve could quickly turn the cylinder into a devastating torpedo. So, it is necessary to properly know about the storage, handling and uses of medical cases so that risk of hazardous events can be minimized or reduced to zero.

Figure: some of the tools to use for storage and carrying of gases cylinder.

Types of Hazards form Gas cylinders: Improper handling of gas cylinders may lead to devastating hazardous events. There are two types of hazards associated with medical gas equipment:

1. General fire & explosions, and
2. Mechanical issues such as physical damage to compressed gas cylinders.

Fire and explosions can be caused by incidents involving oxygen, which is the most common gas used in health care facilities, and nitrous oxide, which is used frequently as an inhalation anesthetic. These gases are oxidizers that, when present in sufficient quantity and concentration, form one side of the "fire triangle." When the other two sides of the triangle, heat and fuel, are added, fire and/or explosion can take place. In most of the case the hazard is intensified because many materials commonly available in health care facilities that are not flammable in normal room air become flammable (for extremely flammable) when the concentration of oxygen is raised above that in room air. Nitrous oxide is not an oxidizer at room temperature, but it dissociates and forms oxygen under elevated temperatures that might be present during a fire.

Fire explosion | Mechanical Damage

Compressed gas cylinders that sustain mechanical damage can also cause hazard. Gases inside cylinders are generally under high pressures, and the cylinders often have significant weight. The cylinders can cause injuries directly due to their weight and inertia. Damage to the regulators or valves attached to a cylinder can allow the escaping gas to propel the cylinder violently in a dangerous manner. The pin-index safety system and gas regulators can also suffer physical damage and cause hazards to patients if the wrong gas is delivered.

Cylinder Storage: Pressure cylinders are cylinders having contents of various chemical composition under pressure in liquid or gaseous state. Pressure cylinders possess huge potential energy, which can lead to disasters on enormous scale, for both the lives and properties, if not managed with appropriate safety measures during transportation, unloading, storage, handling and use.

Always do these:

- Store cylinders upright with valve protection caps and valve outlet seals in place.
- Secure cylinders when in transit, storage, or use.
- Store cylinders in specific areas designated for that purpose.
- Separate full and empty cylinders.
- Store cylinders in a well-ventilated, away from combustible materials, dry, cool and secure area protected from the weather.
- Always maintain a minimum of 20 feet distance between flammable gas cylinder and oxygen cylinder or the storage area should be separated, at a minimum, by a fire wall five feet high with a fire rating of 0.5 hours.
- Ensure that there is adequate separation from combustibles as specified by national regulations.
- Keep check on the atmosphere in areas where gases may vent and collect.
- FIFO (first-in, first-out) inventory system should be used to prevent full containers from being stored for long periods of time.
- Store only the amount of compressed gas required for the specific application.
- Prohibit use of naked flames and smoking etc., in storage spaces, whether indoor or outdoor, shall be prohibited.
- All doors or gates giving direct access to the cylinder storage shall open outwards.
- Cylinders should be stored away from emergency exits and heavily travelled areas.
- Protect cylinders from damp or wet ground.
- Cylinder storage should be provided with adequate but restricted access.
- Cylinders should be inspected visually on a routine basis, or weekly to avoid any indication of leakage or other problems.

Never do these:

- Never Permit storage temperature to exceed 52°C (125°F).
- Never Store oxygen cylinder, full or empty in the same vicinity as inflammable gases.
- Never Store cylinders on upper floors or below ground level.
- Never Allow smoking or open flames in oxidizer or flammable gas storage areas.
- Never Store grease and oily materials around oxygen; nor should oil or grease be applied to fittings.
- Expose cylinders to corrosive materials such as ice melting compounds

Special Regulations for cylinder storage

Separate Empty Cylinders from Full Cylinders: The difference between a full cylinder and an empty cylinder is whether or not it has been open. The cylinder is considered empty once its valve has been opened; regardless of the number of contents it has remaining. For efficient storage, it is recommended that you physically separate empty cylinders (opened) from full cylinders (unopened).

Minimize Fire Risk: If you want to minimize a potential fire risk, then it is highly recommended that you limit the number of medical gas cylinders in the storage area of the hospital. An oxygen enriched environment can be created by a full (unopened) cylinder with a malfunctioning valve. Nitrous oxide or oxygen should never be stored in the same room with combustible gases unless there is at least 20 feet distance between them or there is a one-hour rated fire resistant partition. According to NFPA guidelines, you should limit the number to 12 cylinders (300 cubic feet) of nonflammable medical gas.

Store Cylinders in Compatible Groups: Storing cylinders in compatible groups is very important as it helps prevent various hazards. If the cylinders are stored in an outside area of the hospital, then there must be a minimum distance of 20 feet from combustible material and flammable gases. Keep oxygen cylinders at least 20 feet away from flammable gas cylinders. If for some reason you cannot do this, then use a non-combustible barrier for separation. The barrier must be at least 5 feet high and have at least a one-hour fire rating. The same goes for keeping corrosives away from oxidizers or flammables. This does not apply when the gas cylinders are stored indoors in gas cabinets.

Take Advantage of Cylinder Racks: To make sure that the medical gas cylinders are stored safely and prevent them from tipping or falling over, you should take advantage of cylinder stalls and racks. A wide range of sturdy and quality gas cylinder racks are available on the market. Buying them and keeping the cylinders within them will drastically reduce the risk of them falling over and causing injury.

Cylinder storage as per volume

Volumes Greater than 3000 ft3: This volume of gas must be stored in locations that include the following:

- Access to move cylinders and equipment on hand trucks Lockable doors or gates
- Minimum of two entries/exits (if outdoors and greater than 200 ft2)
- Enclosure of noncombustible construction (if outdoors)
- Interior finishes of noncombustible or limited combustible material (if indoors)
- Walls and floors with 1-hour fire resistance rating, and other openings with ¾-hour fire protection rating (if indoors)
- Heated by indirect means of Racks, chains, or other fastenings to secure cylinders from falling
- Electrical power from the essential electrical system
- Racks, shelves, and supports of noncombustible or limited-combustible material Electrical devices protected from physical damage
- Access for delivery vehicles and management of cylinders
- Regulation of temperature (less than 125°F; over 20°F for nitrous oxide and carbon dioxide)
- Prohibition of motor-driven machinery

Volumes Between 300 ft3 and 3000 ft3: This volume of gas must be stored in locations that are outdoors or in an interior enclosure of noncombustible or limited combustible construction. Indoor locations must include the following:

- Restriction of oxidizing gases from being stored with any flammable gas, liquid, or vapor
- Separation of oxidizing gases from combustibles or flammables by:
- A minimum distance of 20 ft A distance of 5 ft where the entire storage location is sprinklered
- A gas cabinet constructed per NFPA 30, Flammable and Combustible Liquids Code
- Regulation of temperatures
- Appropriate restraints
- Cylinder valve protection caps
- Smoking, open flames, electric heating elements prohibited from location and within 20 ft outside location

Volumes Less than 300 ft3: Cylinders containing this volume are not required to be stored in an enclosure. Precautions for handling the cylinders must still be observed.

Other important things to keep in mind during cylinder storage: In addition to the criteria for storage locations are numerous other precautions that must be observed in the use and handling of cylinders.

- Cylinders that are in use must be attached to a cylinder stand or to medical equipment designed to receive and hold cylinders.
- Small-size cylinders that are available for immediate use are not considered to be in storage.
- Cylinders cannot be chained to portable or moveable apparatus.
- Storage must be planned so that cylinders can be used in the order in which they are received
- Where empty and full cylinders are stored together, empty cylinders must be segregated from full cylinders.
- For cylinders with internal pressure gauges, the facility needs to establish a pressure at which the cylinders will be considered empty.
- Empty cylinders must be marked.
- Cylinders stored in the open (outdoors) need to be protected from weather extremes

Figure: Cylinder storage with protective chain

Signs and Labels

To keep personnel safe while they work in locations with increased hazards, appropriate signage is required. Precautionary signs must meet the following requirements:

- Signs must be displayed on each door or gate of the storage room or enclosure.
- Signs must be readable from a distance of 5 ft.
- If the facility does not prohibit smoking, additional precautionary signs indicating where oxygen is being administered must be provided.
- If the facility does prohibit smoking and signs are prominently spaced at all major entrances, the additional signage is not required.

Safety signs for Gas cylinders

Figure: Different types of safety signs for gas cylinders

Ventilation System

Ventilation is required for storage locations containing greater than 3000 ft3 of gas. This can be provided with natural or mechanical exhaust. The volume of fluid to be used in determining ventilation is the volume of the largest single vessel or the entire volume of connected vessels on a common manifold, whichever is greater.

Natural Ventilation

Must consist of two no closable louvered openings. These openings have the following requirements:

- Each opening must have an opening area of at least 24 in.2/1000 ft3 of the fluid stored and no less than 72 in2.
- One opening must be located within 1 ft of the floor, and one must be within 1 ft of the ceiling.
- Openings need to be located to ensure cross ventilation.
- Openings have to be direct to the outside atmosphere without ductwork.

Mechanical Ventilation

Mechanical ventilation must include the following:

Continuous ventilation to maintain negative pressure in the space

- Rate of 1 cfm/5 ft3 of fluid designed to be stored in the space
- No less than 50 cfm
- No more than 500 cfm
- Inlets that are unobstructed and draw from within 1 ft of the floor
- Exhaust fans supplied with power from the essential electrical system
- Dedicated exhaust not required, but the system cannot connect to spaces that contain flammable materials

- Exhaust duct of noncombustible construction
- Make-up air that is provided by one of the following
- Noncombustible ductwork transferred from adjacent spaces, outside, or from spaces that do not include flammable or combustible material.
- A corridor under the door up to 50 cfm or 15 percent of the room exhaust per NFPA 90A, standard for the Installation of Air-Conditioning and Ventilating Systems (whichever is greater)

Any building ventilation system that does not contain flammable or combustible

Cylinder Moving

The majority of incidents and injuries involving gas cylinders occur during handling or transportation. To help prevent incidents during moving cylinders the following steps can be taken: -

- Handle cylinders with care and avoid dropping or hitting them against anything.
- Follow proper procedures and use the right equipment, including safety glasses, heavy-duty gloves and protective footwear.
- Ensure safety measures, such as caps or guards, are securely installed.
- Use a cart or hand truck instead of dragging or rolling cylinders.
- Use proper cradles, nets or platforms if using a crane.
- Avoid lifting cylinders by their caps or guards or with magnets or slings, which can damage the valves.

Set Cylinders Apart by Labeling and Proper Organizing

Clearly labeling and properly organizing medical gas cylinders will eliminate mistakes when staff members of the hospital are in a hurry. Set cylinders apart via proper labeling and organizing, it will help the staff easily identify empty, partial, and full cylinders and eliminate any room for mistakes that could result in serious harm.

Color Coding of Gas cylinders

Gas cylinders are widely used in medical facilities. It is important to use and know about the color code because most of the gas cylinders don't have any written information about their contents, Color codes are given for safety purpose and to prevent mix-ups in handing. Beside color codes are easy to notice during an emergency situation.

Colour coding is helpful in identification of gas cylinders and lines even by laymen if they are familiarized with such Colour codes. Almost all countries follow their own guidelines but efforts have been made to prescribe universal colour coding. British Compressed Gases Association introduced cylinder identification and colour coding scheme through BS EN 1089 – 3 which has been harmonised in the European Union. The colours used for medical gases are harmonised on the basis of ISO 32 standard.

The colour coding is applied to the shoulder or the curved portion of the cylinder and it identifies the property of the gas inside the cylinder.

- Yellow– toxic
- Red– flammable
- Light blue – oxidizing
- Bright Green– inert

A gas cylinder having two concentric colour bands indicates a combination of properties. The body of the cylinder can be of any colour of manufacturer's choice but it should not lead to confusion regarding risk associated with the gas as indicated by the shoulder colour.

For the purpose of easy identification and the shoulder colours can refer to the gas inside the cylinder. Some typical examples are:

- Maroon – acetylene
- Grey – carbon dioxide
- Brown-helium
- Red – hydrogen
- Blue – Nitrous oxide
- Black – nitrogen
- White – oxidant.

In addition to the colour coding it is helpful if a label is a fixed which bears the name of the gas inside the cylinder.

COLOR OF CYLINDER

GAS	USA	INTERNATIONAL
oxygen	Green	White
Carbon dioxide	Gray	Gray
Nitrous oxide	Blue	Blue
helium	Brown	Brown
Nitrogen	Black	Black
air	Yellow	White & black

Figure: General Color codes for Cylinders

It is important for all laboratories to prominently display colour code charts in workplace as well as in gas storage space so as to familiarize the workers with associated hazards of gases and their potential hazards.

Figure: Color coded Gas Cylinders

Color codes are specific for different gases. Gas cylinders may be colored with one or more colors accordingly to gas filled in them. Upper curved part of the cylinder is known as shoulder and the lower as the body. Different color combinations of shoulder and body are used for various different gases. Color codes of a gas cylinder may differ from country to country

General Concept for coding is given below:

Table: Color codes for different gases

Srl	Gas Cylinder	Color	
		Shoulder	Body
01	Air	Grey	Grey
02	Ammonia	Red	Yellow & Black
03	Carbon di oxide	Silver	Black
04	Chlorine	Yellow	Yellow
05	Helium	Brown	Brown
06	Hydrogen	Red	Red
07	Nitrogen	Black	Grey
08	Oxygen	white	Black

The color of the gas cylinder indicates the hazard but not the filled gas, Poisonous and corrosive gas cylinders have yellow color while red colored cylinders indicate the inflammable gas in them. Oxidizing gas cylinders are light blue in color and inert gas cylinders are bright green.

Safety training

Safety training for the stuffs is a compulsory program that must be performed by appropriate authority. Workers must know details about the handling, storing, moving and uses of the cylinders for best performance output and avoiding hazards. The following scopes must be included in medical gas cylinder uses and safety training programme.

- Legalization and Responsibilities related to the use of Gas cylinders
- Safety and storage of cylinders
- Preparation and use of cylinders
- Resuscitation equipment
- Equipment selection – regulators, flowmeters
- Signage
- Risk Assessment
- Safe handling of medical gas cylinders
- Bulk oxygen storage systems
- Safe operation of gas cylinders
- Use of Oxygen
- Use of analgesic gas
- Prescribing and Administration

Gas property	colour	
Toxic and/or corrosive	Yellow	
Flammable	Red	
Oxidising	Light Blue	
Inert [1]	Bright Green	

Basic Trainings

- Correctly be able to identify gas cylinders
- Recognize how different cylinders operate
- Have an awareness about flammability hazards
- Be able to identify correct gas control equipment
- Be aware of safe cylinder management
- Be able to undertake risk assessments when using gas cylinders
- Recognize the hazards of using incorrect manual handling techniques
- Understand the importance of appropriate storage facilities in line with safe working practices
- The basic principles of oxygen administration and use.
- Identify various medical gas cylinders and understand the different types of medical gas supply systems.
- Recognize the parts of a cylinder, including labelling and content
- Carryout the correct procedures to safely operate the various sizes of cylinders
- Describe the steps involved in changing an oxygen gas cylinder with video support
- Identifying defective cylinders and gas transmission system.
- Understanding Color coding or label
- Cylinder handling, Carrying and Understanding etc.

Proper training and awareness will help workers gaining knowledge about safe handling of hazardous gases which eventually reduce any unwanted accidents and bring positive impact in the medical technology.