BAN: COVID-19 Response Emergency Assistance Project

ADB Project 54173-001| Loan 3918-BAN

ENVIRONMENTAL MANAGEMENT PLAN

Package

Package No. RAJ/ICU/ADB/W-01: Construction of Isolation unit & critical care unit/ICU at Rajshahi Medical Collage Hospital, Rajshahi. [Sub-head: Installation of Medical Gas System at Rajshahi Medical College Hospital, Rajshahi]

Implementing Agency

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

August 2021

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Table of Contents

List of Figures

List of Tables

I. 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. 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 is aligned with the overall goal of the government's National Preparedness and Response Plan (NPRP). 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 combating 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.

[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.

II. SUBPROJECT DESCRIPTION

3. In order to ensure modern medical services to the people of Greater Rajshahi region in the Northern 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 Rajshahi. The foundation stone is laid. In the building of the then Mats (in the academic year 1958) 43 students were admitted in the first year of MBBS: Medical College was started. Later, the government decided to suspend the activities of Rajshahi Medical College and set up a 530-bed hospital at the acquired site. Construction of a 530-bed hospital at the site began in 1963 and was completed in1965.

4. As it is essential to transform this hospital into a medical college hospital for the clinical training of the students studying in this college, this hospital with 530 beds was renamed as "Rajshahi Medical College Hospital" without any infrastructural changes. The infrastructural development work of establishing a full-fledged Medical College Hospital has been completed and handed over on 24 July 2008. Later it was upgraded to 862 beds in 2012 respectively. This is one of the largest hospitals in the Rajshahi Division &only referral hospital (Level 3) in greater Rajshahi area serving health care services for about 60 million populations. The hospital is in the centre of Rajshahi town and 280 kilometers North-West from capital city Dhaka.

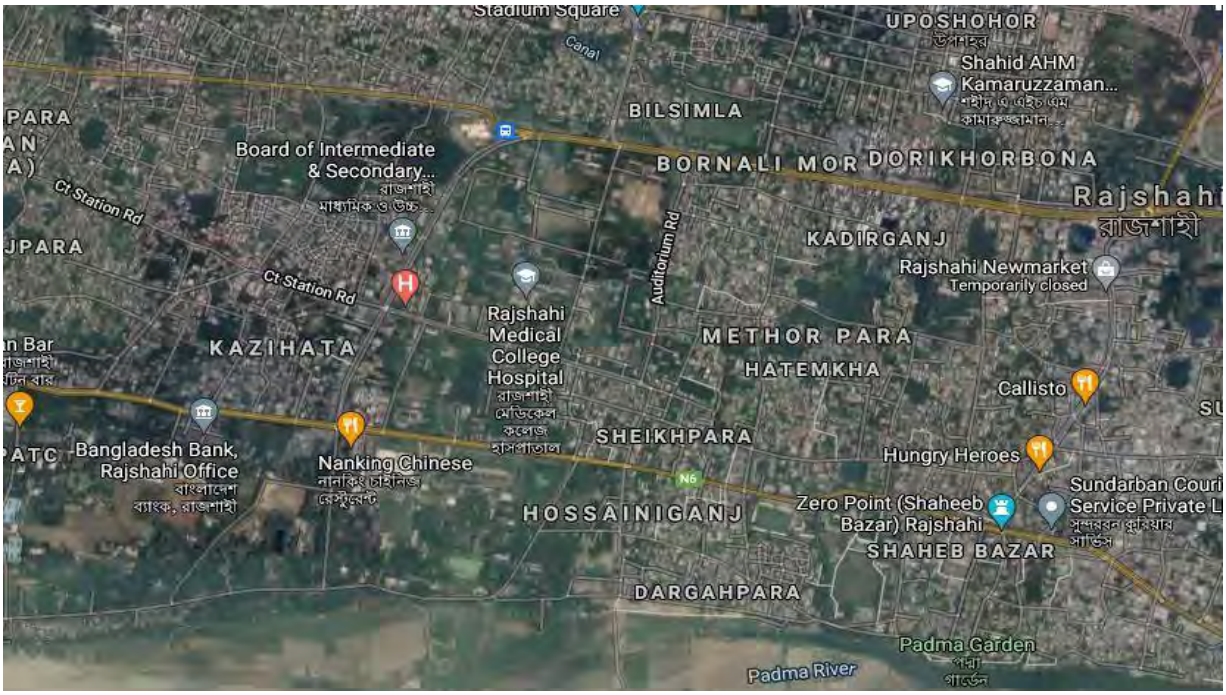


Figure 1: Rajshahi Medical College Hospital

5. Land area of the college campus is 90 Acres. Now 800 students are enrolled of which 512 are female & 288 are male. College building area is about 30 Acres. and hospital building area is about 60 Acres. Total 30 departments are running in the College and Hospital. Two female hostels, two 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[3].

Table 1: Existing Facility of RMCH[4]

Source of Electricity	National Grid
Source of water supply	Own piped supply
Toilet type	Sanitary
Toilet adequacy	Adequate with male and female privacy
Fuel source	Natural piped national gas
Autoclave System	Hospital's centralized autoclave system
Waste Disposal System	Hospital's own waste management (pit)

[3]https://en.wikipedia.org/wiki/Rajshahi_Medical_College.
[4]http://facilityregistry.dghs.gov.bd/org_profile.php?org_code=10001560.

6. Rajshahi Medical College Hospital (RMCH) is start conducting coronavirus test from 01 April 2020. The test lab was formally inaugurated at the Microbiology department on 01 April 2020. The treatment of the Coronavirus patient also started in the hospital and 12 physicians, and 18 Doctors have been trained in this regard[5]. Under this subproject, Installation of Medical Gas System at Rajshahi Medical College Hospital, Rajshahi will be established in Rajshahi 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). This subproject includes Installation of Medical Gas System. 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.

[5]The Daily Star, 01 April, 2020 "Coronavirus Test at RMCH Starts from 01st April".

III. BASELINE INFORMATION

7. **Climate:** The district bears a moderate and pleasant climate. The temperature, humidity and coldness of the district are not high. The summer season commences from April and continues up to the end of June. The rainy season comes at the end of June and stays up to September. The winter season starts from the middle of November and lasts up to the end of February. The minimum and maximum mean temperature during winter varies from 9c to 14.0○ c. During summer the minimum and maximum mean temperature, vary from 25.5○ c to 38.7○ c. The rainfall is heavy during July to September. The annual rainfall of the district recorded in 2011 was 1862 millimeters. The level of humidity was about 77 % in April and about 88 % in July.[6]

8. **Water Quality.** The main cause for concern in drinking water is nitrate, which can interfere with the oxygen carrying capacity of the blood and can have serious implications for infants. Fortunately, nitrogen is not present in the ground water in this form at any significant level and at 0.4 and 0.2 mg l-1 is well below the Bangladesh and WHO standards of 10 and 50 mg l-1 respectively. Of the metals analyzed, iron, arsenic, chromium, lead and nickel where near or exceeded either the Bangladesh or WHO guideline values in one or more wells. The arsenic levels in the wells were close to the permissible limits for drinking water but did not exceed them. The chromium levels in the ground water sampled were double both the Bangladesh and WHO drinking water quality guidelines. Lead levels were very high at 10 times the Bangladesh guidelines and 50 times the WHO guidelines. The groundwater samples showed Coliform contamination, which means that they do not conform to the Bangladesh and WHO guidelines of 0 CFU/100 ml; however, they did not show any fecal contamination despite the fact that across Bangladesh 54 per cent of hand pumped tube wells were found to have fecal contamination[7].

9. **Air Quality and Noise Level.** The city area is endowed with educational institutes, residential areas, hotels, community centers, restaurants, banks, pharmacies, office building, health clinics, etc. From the study it is seen that most of the places exceed the optimum maximum level of sound pollution ranged from 70-90 dB. It is also seen that the values of sound level at all hospitals (ranged from 65-80 dB), schools & colleges (ranged from 64-85 dB), and residential areas (ranged from 55-65 dB) exceeds the maximum permissible values. Four major cities, Rajshahi, Dhaka, Khulna and Chittagong, in Bangladesh have been suffering under severe impact of air pollution for many years particularly by particulate matter (PM). PM samples were collected within the period from September 2010 to July 2012 at four continuous air monitoring stations (CAMS) located at Farm Gate in Dhaka, Sapura in Rajshahi, Baira in Khulna and a TV station, Khulshi in Chittagong. PM sampling was performed using dichotomous samplers, collecting samples in two sizes: PM2.5 and PM2.5-10. Samples were collected on 37 mm Teflon filters. These filters were weighed for PM mass, analyzed for BC by transmissometer and elements by XRF. However, the mean concentrations in Rajshahi were higher than the other major cities. The highest PM2.5 concentration was found in Rajshahi, and this value was detected when transboundary pollutant transport was expected to be high[8].

10. **Current situation of waste management:** The management of medical waste (MW) is of great importance due to its impact on human health and environment. The objectives of the study are to identify different types of wastes, its generation rate and assess the existing waste management in various HCEs. It was found that the surveyed HCEs generate a total of 1495 kg/day of MW; of which about 1328.6 kg/day (88.87%) are non-infectious and about 166.4 kg/day (11.13%) are infectious. The average waste generation rate for surveyed HCEs is 1.54 kg/bed/day or 0.30 kg/patient/day. It was found from the survey that there is no proper and systematic management of medical wastes. The study reveals that lack of awareness; financial support and willingness are responsible for improper management of MW. So, the RCC and HCEs authorities should adopt appropriate policy regarding this

[6] http://baec.portal.gov.bd/sites/default/files/files/baec.portal.gov.bd/page/1f00cd0e_737d_4e2e_ab9f_08183800b7a2/NSA_Vol-23-Paper%204.pdf.
[7] http://203.112.218.65:8008/WebTestApplication/userfiles/Image/District%20Statistics/Rajshahi.pdf.
[8] https://www.researchgate.net/publication/330674469_Assessment_of_Sound_Level_at_Different_Locations_of_Rajshahi_City.

issue and provide training program on relevant personnel who are engaged in medical waste management[9].

[9] https://www.banglajol.info/index.php/JESNR/article/view/22062.

IV. ENVIRONMENTAL MANAGEMENT PLAN

11. Environmental Management Plan (EMP) 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. The 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.

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 project phases (pre-construction, 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. For civil works, 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:** The Project implementation will be led by the Project Implementation Unit (PIU) that will be responsible for the procurement of consultants for carrying out the engineering designs for the proposed medical centers. The PIU will be headed by the Project Director (PD). The PIU will consist of an Environment and Social (E&S) Cell with qualified staff. This E&S Cell will assist the PIU on issues related to environmental and social management and oversee the Construction Supervision Consultant (CSC) and contractors and will compile quarterly monitoring reports on EMP compliance, to be sent to the Project Director and also shared with the Asian Development Bank (ADB), throughout the construction period. The E&S Cell will also provide training to the respective field personnel responsible for the monitoring of environmental compliance during both the construction and O&M phases of the project. The organogram of PIU is shown in Figure4. In addition, the respective authority will recruit a permanent Environmental, Health, and Safety Specialist, who will be responsible for overseeing the environmental mitigation measures during the operation and maintenance period. The overall responsibility of environmental performance including EMP implementation of the Project will rest with the PIU. The PIU will engage construction supervision consultants (CSC) to supervise the contractors including their execution of construction related environmental and social management requirements and measures. The CSC will ensure adherence to the design parameters including quality requirements, as well as all EMP measures related to construction. The E&S Cell will have adequate environmental and social specialists and maintain coordination and liaison with CSC for effective EMP implementation.

15. Similarly, the CSC will also have environmental and social monitors who will supervise and monitor the contractors for effective EMP implementation. The contractors in turn will also have HSE supervisors who will ensure EMP implementation during construction activities and will be tasked to develop necessary detailed HSE plans as per this EMP and oversee their implementation. However, this will not involve monitoring and evaluation of EMP due to limited nature of impacts.

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 Installation of Medical Gas System at RMCH

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 water bodies/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	• Water logging 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 road-side 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 are 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 hauls 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 DMCH; • 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-19 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-19 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	RMCH	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 these 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 in to water bodies 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	RMCH	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. • Provide regular OHS training to healthcare workers. • Provide incentives to staff and create a work-life balance in work schedule.	• Regular inspection and testing of all safety features and hazard control measures and personal protective features	Hospital area during operation period	RMCH	DGHS
Accidental Releases of Gas and Fluids	• Leakage of infectious or hazardous substances may pose serious health hazards and can spread the contagion among	• Develop an Emergency Response Plan and follow strictly during emergency incident. • Follow the suggested medical gas safety management plan as given in Annex 4.	• Record of regular inspection.	Hospital area during operation period	RMCH	DGHS

IEC	Potential Impact	Mitigation Measures	Monitoring Method		Responsibility	
			Method of Collecting and Reporting Data	Location and Frequency	Implementation	Supervision
	hospital staff and patients, cleaners etc.	• 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.				
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	RMCH	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. The EMP implementation cost for RMCH has been calculated and given in Table 3.

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	270.00	2700
Helmet	Nos.	10	350.00	3500
safety shoes	Nos.	10	430.00	4300
safety Goggles	Nos.	10	280.00	2800
Hand Sanitizer (5 Liter)	Nos.	2	2600.00	5200
One time Face Mask	Nos.	2	500.00	1000
Thermometer for measuring Body Temperature	Nos.	1	1000.00	1000
Fire Extinguisher	Nos.	2	1299.00	2598
First Aid Box	Nos.	1	2500.00	2500
Sub-total excluding over-head & profit =				25598
Sub-total Including over-head & profit =				29053.73
Add VAT with adjustment factor (VAT-7.5% & Factor-1.08108)				2355.71
Total for item 1 including over-head, profit and VAT =				31,409.44
2. Engineers Health and Safety:				
Safety Vest	Nos.	3	270.00	810
Helmet	Nos.	3	350.00	1050
safety shoes	Nos.	3	1000.00	3000
safety Goggles	Nos.	3	500.00	1500
Hand Sanitizer (5 Liter)	Nos.	1.00	2600.00	2600
One time Face Mask	Box	1.00	500.00	500
Thermometer for measuring Body temperature	Nos.	1	1000.00	1000
First Aid Box	Nos.	1	2500.00	2500
Sub-total excluding over-head & profit				12960
Sub-total Including over-head & profit				14709.6
Add VAT with adjustment factor (VAT-7.5% & Factor-1.08108)				1192.67
Total for item 2 including over-head, profit and VAT =				15902.27
3.Training on Occupational Health & Safety, and COVID-19 Safety Protocol				
Train on correct use and disposal of personal protective equipment (PPE).	Nos.	1	10000.00	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)				920.27
Total for item 3 including over-head, profit and VAT =				12270.27
4.Water, Sanitation and Waste Disposal Management				
Supply of waste bins/pots for different wastes.	Nos.	2	2400.00	4800
Sub-total excluding over-head & profit =				4800
Sub-total Including over-head & profit =				5448
Add VAT with adjustment factor (VAT-7.5% & Factor-1.08108)				441.73
Total for item 4 including over-head, profit and VAT =				5889.73
			Grand Total =	65,471.71
Note: Considering Over-head 3.5%, Profit - 10%, VAT 7.5% (adjustment factor 1.08108)				

19. **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 EMP and progress toward the final outcome.

20. The PIU will be responsible in preparing the environmental monitoring reports to be submitted to ADB semi-annually during project implementation. An environmental consultant will be provided by the ADB to provide technical support to the PIU of the Project in ensuring compliance to ADB requirements and in preparing the environmental monitoring reports.

21. ADB will review the project performance based on the commitments by HSD, MOHFW has 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

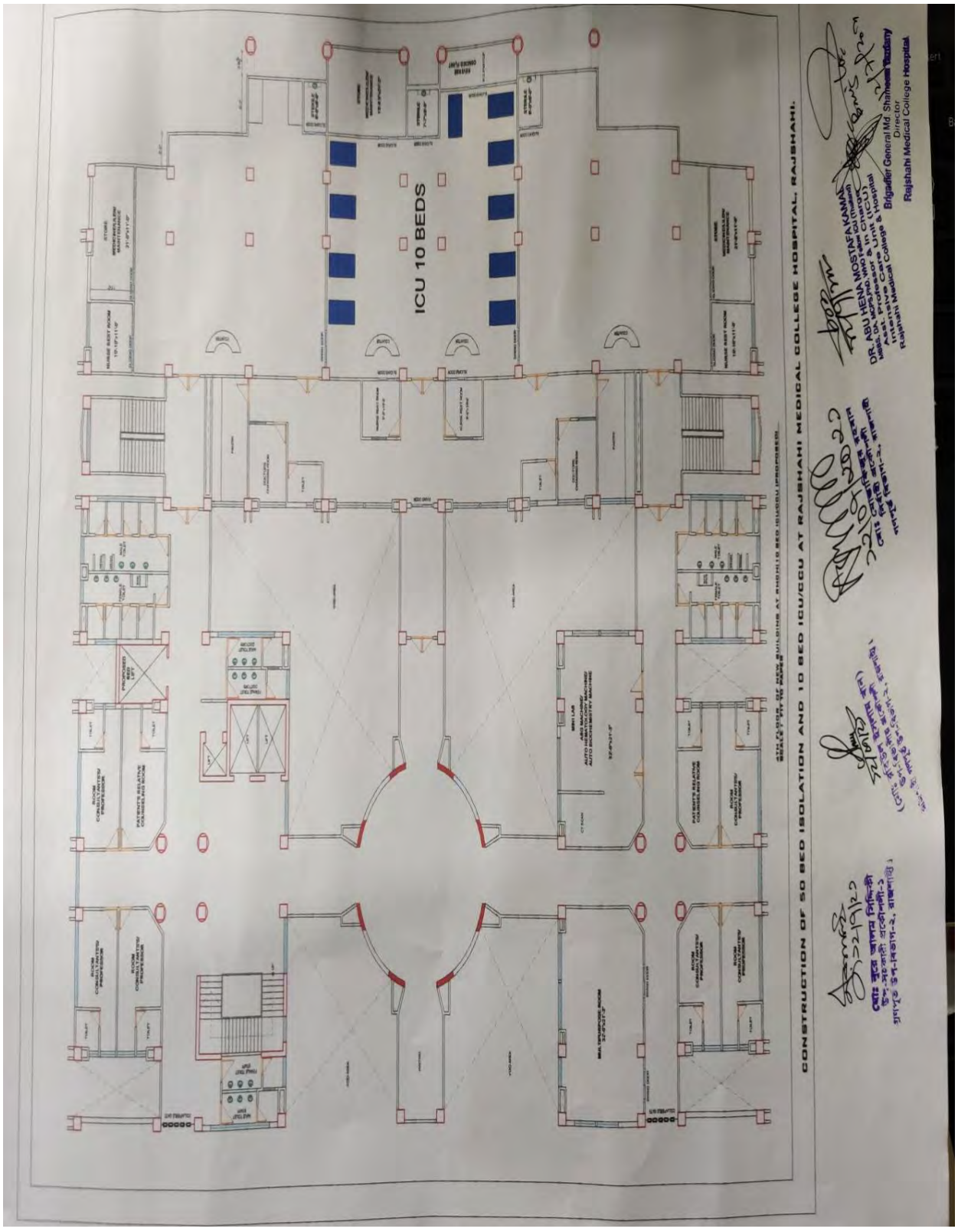


Figure: Proposed Plan for Installation of Medical Gas System at Rajshahi Medical College Hospital, Rajshahi at RMCH (4th floor)

APPENDIX- 2: SAMPLE SOLID 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%). 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

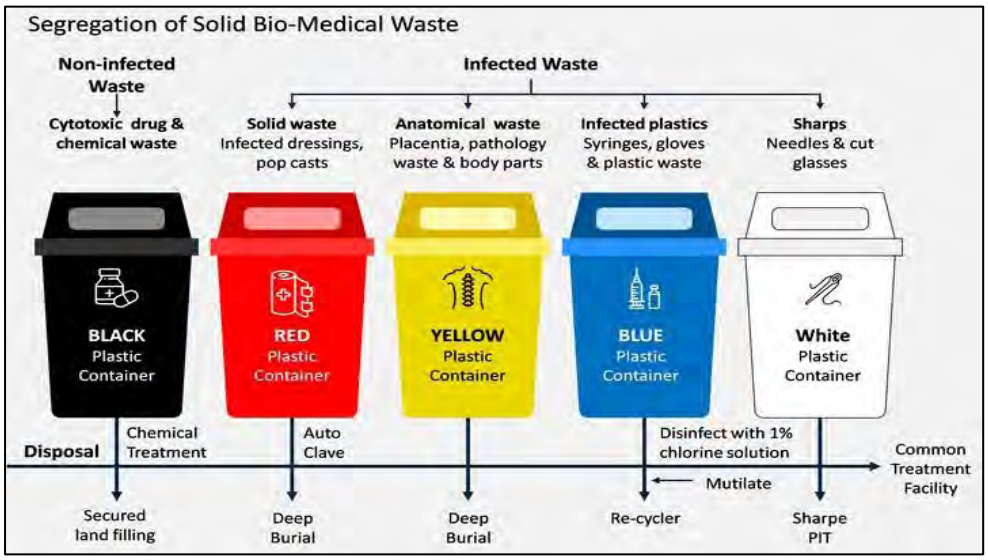
The major components of medical waste management include:

- 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 cytotoxics, 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 and 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- Jacob'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 land filled 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 bio-hazardous 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; lichgates 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 are 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:

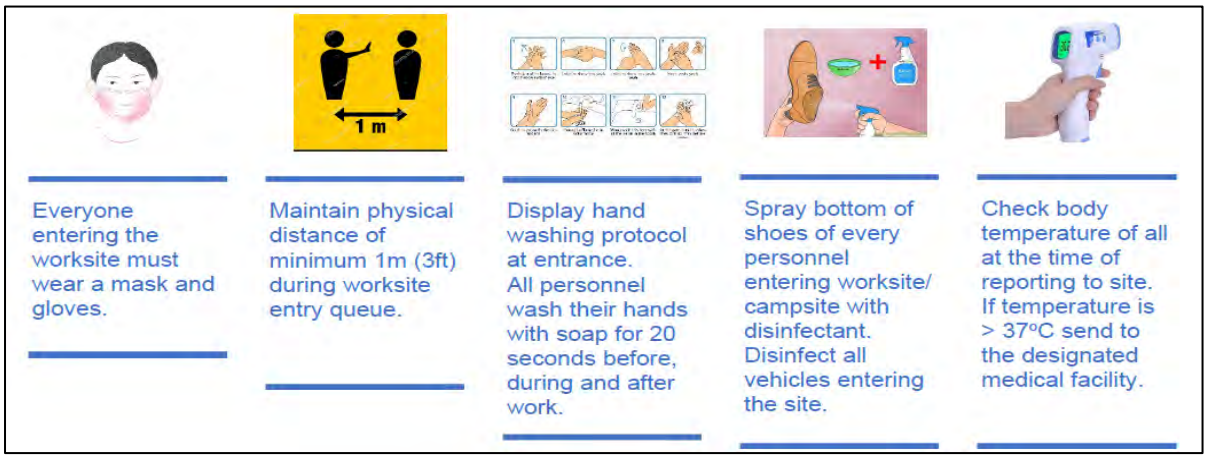
- Steam for a minimum of 30 seconds.
- Rinse for at least three (03) minutes with a hypochlorite solution containing 100 parts per million (ppm) available free chlorine (note: one tablespoon per two (02) gallons of water is approximately 100 ppm available free chlorine), or rinse for at least three (3) 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.
- Employee's 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

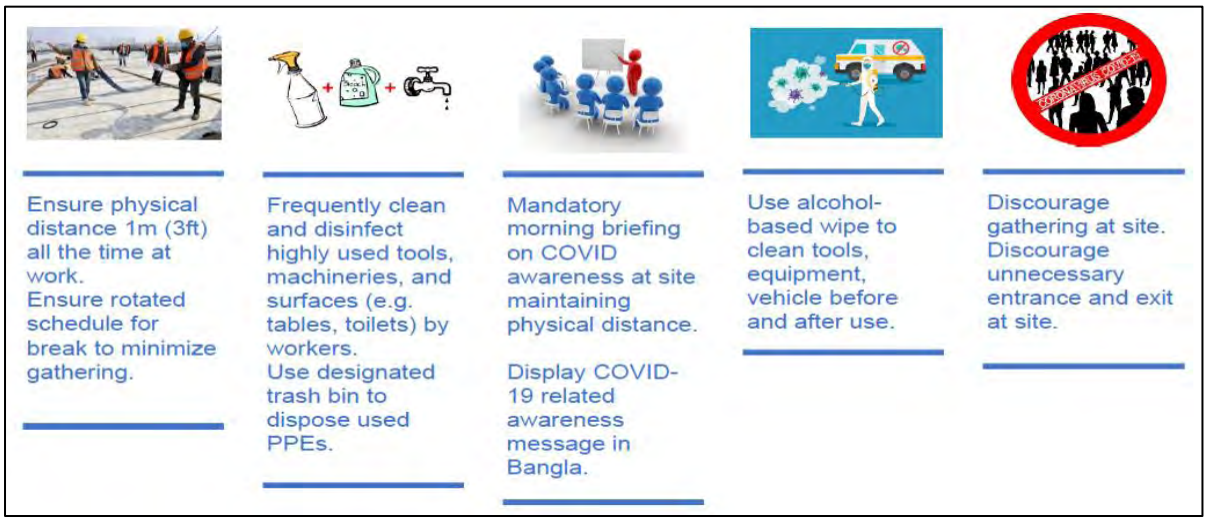
The contractors shall at all times be responsible to take all reasonable precautions to maintain the health and safety of personnel and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. ADB prepared a COVID-19 Health and Safety 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

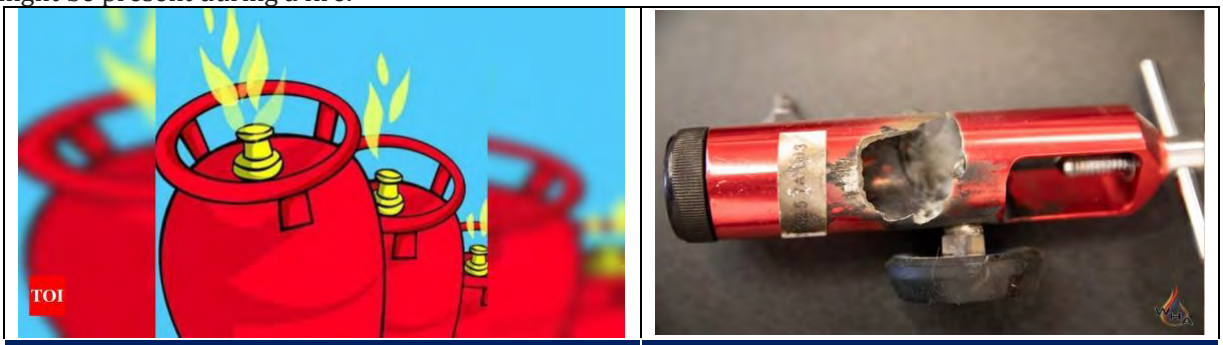
Introduction: Various kinds of Gases are used in medical facilities for treatment purpose. Their contribution helps saving life in hospitals, clinics and other medical facilities. But these gases can also be dangerous if not handled properly. Compressed gas cylinders are dangerous, heavy, sometimes awkward 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.

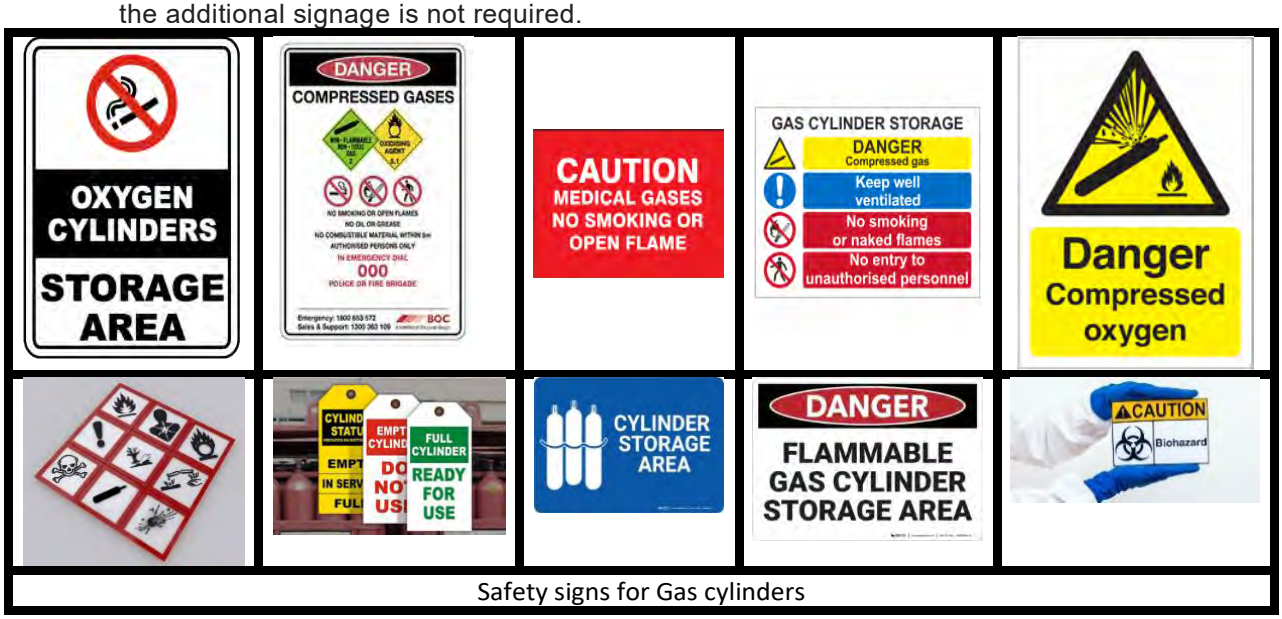
- Cylinders that are in use must be attached to a cylinder stand or to medical equipment designed to receive and hold cylinders.
- Small-size cylinders that are available for immediate use are not considered to be in storage.
- Cylinders cannot be chained to portable or moveable apparatus.
- Storage 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 cods 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.