BÔ Y TẾ  
CỘNG HOÀ XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

Số: 4308/QĐ-BYT  
Hà Nội, ngày 07 tháng 9 năm 2021

QUYẾT ĐỊNH
Phê duyệt đề án Tăng cường khả năng cung ứng, sử dụng Oxy y tế cho các cơ sở điều trị bệnh nhân COVID-19

BÔ TRƯỞNG BÔ Y TẾ
Căn cứ Nghị định số 75/2017/NĐ-CP ngày 20/6/2017 quy định chức năng, nhiệm vụ, quyền hạn và cơ cấu tổ chức của Bộ Y tế;
Căn cứ Luật khám bệnh, chữa bệnh ngày 23/11/2009;
Căn cứ Luật phòng, chống bệnh truyền nhiễm ngày 21/11/2007;
Căn cứ Nghị quyết 86/NQ-CP ngày 06/8/2021 của Chính phủ Về các giải pháp cấp bách phòng, chống dịch bệnh COVID-19 để thực hiện Nghị quyết số 30/2021/QH15 ngày 28 tháng 7 năm 2021 của Quốc hội khóa XV;
Căn cứ Quyết định số 3616/QĐ-BYT ngày 29/7/2021 của Bộ Y tế về việc phê duyệt Đề án “Tăng cường năng lực cấp cứu, hỗ trợ tích cực cho các bệnh viện điều trị người bệnh COVID-19 nặng”;
Căn cứ Quyết định số: 4111/QĐ-BYT ngày 26/8/2021 của Bộ trưởng Bộ Y tế về việc ban hành tài liệu Hướng dẫn thiết lập cơ sở thu dụng, điều trị COVID-19 theo mô hình thấp tầng;
Xét đề nghị của Vũ trưởng Vũ Trang thiết bị và Công trình y tế.

QUYẾT ĐỊNH:

Điều 1. Phê duyệt đề án Tăng cường khả năng cung ứng, sử dụng Oxy y tế cho các cơ sở điều trị bệnh nhân COVID-19.

Điều 2. Quyết định này có hiệu lực kể từ ngày ký ban hành.

Điều 3. Các Ông, Bà: Chánh Văn phòng Bộ; Chánh Thanh tra Bộ; Vũ trưởng, Cục trưởng các Vụ, Cục thuộc Bộ Y tế; Tổng Cục trưởng thuộc Bộ Y tế; Thủ trưởng các đơn vị trực thuộc Bộ Y tế; Giám đốc Sở Y tế các tỉnh thành phố trực thuộc trung ương; Thủ trưởng y tế ngành và thủ trưởng các đơn vị có liên quan chịu trách nhiệm thi hành Quyết định này./.

Noi nhận:
- Như điều 3;
- TG Phạm Minh Chính, Trưởng BCDQG phòng chống dịch COVID-19 (để báo cáo);
- Các thành viên BCDQG;
- Bộ trưởng (để báo cáo);
- Các đ/c Thủ trưởng Bộ y tế;
- Cổng TTĐT Bộ y tế;
- Lưu: VT; TB-CT.

KT. BÔ TRƯỞNG
THÚ TRƯỞNG

Trần Văn Thuần
SCHEME

INCREASE THE SUPPLY CAPACITY, USING MEDICAL OXYGEN FOR FACILITIES TREATMENT OF COVID-19 PATIENTS

(Issued together with Decision No.………../ QD-BYT dated May 2021 of the Minister of Health)
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PART I: PROJECT BUILDING BACKGROUND

1. The necessity to develop the project: 1.1. Epidemic situation: The situation of the COVID-19 epidemic in the world is very complicated. Worldwide, more than 220 million people have been infected with COVID-19, including over 4.5 million deaths. Since the end of March 2021, the world recorded a strong outbreak of epidemics in many countries and regions around the world, especially in Asian countries.

From April 27, 2021 to now, Vietnam is facing the "fourth wave" of the COVID-19 epidemic that attacks and causes serious consequences, the number of COVID-19 cases across the country has increased dramatically, rapidly with over 480 thousand new infections (accounting for 99% of cases since the outbreak in our country). The epidemic broke out on a large scale, with a large scale and complex nature, with many sources of infection, outbreaks, and variations, especially the appearance of the Delta variant, which spread very quickly and dangerously, increasing the risk of disease. severe cases compared to the previous 3 outbreaks. The number of critical illnesses and deaths has increased, so far there have been more than 13,000 deaths. The medical examination and treatment system is facing unprecedented challenges in history.

Through the time of implementing social distancing according to Directive No. 16/CT-TTg in the southern provinces and cities and some localities across the country, the epidemic situation has been gradually controlled in one area. local and regional numbers. However, the epidemic is still complicated, especially in Ho Chi Minh City. Ho Chi Minh City and some neighboring localities (Binh Duong, Long An, Dong Nai). In some localities in the central region (Da Nang, Khanh Hoa, Phu Yen) the epidemic has not been thoroughly controlled, there is still the possibility of outbreaks and the risk of large outbreaks, because the epidemic has spread widely. communities, in factories, enterprises and densely populated areas.

1.2. Treatment of COVID patients and oxygen systems at medical facilities: Faced with a very serious situation, the Government and Prime Minister have directed localities to strictly implement the motto "4 on the spot" (command on-site, on-site forces, on-site vehicles and supplies, on-site logistics), ensuring the availability of resources for epidemic situations.

The Government and the Ministry of Health have directed many localities to strengthen the capacity of active resuscitation, focus on treating severe cases, and minimizing deaths. However, the organization and implementation of the directions, administration and regulations on epidemic prevention and control in some localities are still not strict, confused and inconsistent; The work of ensuring logistics under the motto "4 on the spot" in most localities has not been prepared in advance, leading to a lack of necessary supplies, equipment, medical gas and oxygen for epidemic prevention and control.

The intensive care unit (HSTC) is generally dispersed by size, accounting for 8 to 10% of hospital beds in medical facilities. According to the results of a recent study
Here, it is estimated that in 2021, the whole country will have over 16,000 HSTC hospital beds. However, the number of hospital beds and the HSTC’s capacity are currently unable to meet the increasing demand for treatment of COVID-19 patients. Many localities are lacking in equipment to treat severe patients. Many hospitals have HSTC beds but do not have a central oxygen system or a compressed air system, so ventilators cannot be used.

Hospitals and medical facilities are not interested in investing in additional procurement of central liquid oxygen systems, especially tanks, liquid oxygen tanks and gas oxygen bottles and terminals for COVID-19 patients. Therefore, it greatly affects the treatment of COVID-19 patients, because these patients must use a large amount of medical oxygen.

1.3. Situation of supply and production of medical oxygen: On the side of oxygen supply and production, according to the report of the Vietnam Gas Association (AIGA Vietnam), the total production of oxygen in Vietnam of the units of the association. Under normal conditions today is 1,115 tons/day, increasing to full capacity is about 1,430 tons/day. Not counting the amount of Oxygen used in industrial production (larger than the current medical oxygen output) that can be converted into medical oxygen in an emergency situation.

However, currently, for the production and supply of medical oxygen, there are some difficulties: transportation (logistics) because of the implementation of social distancing in epidemic provinces; Vaccination has not been carried out for officials and workers to maintain production; supporting policies to help enterprises import tanks, containers, copper pipes and oxygen guns for storage.

The system of agents and oxygen filling stations in the localities managed by the Departments of Industry and Trade should be connected to medical facilities using Oxygen to ensure no breakage. Information of suppliers and filling stations is required for regulation during the supply process to medical facilities and the Ministry of Health (via an information technology platform).

Currently, the source of oxygen used in industry is very large, it is necessary to develop a production plan to convert to medical oxygen and the process of converting tanks and tanks of industrial gases to proactively ensure the source of oxygen in the water. emergency situation.

Therefore, the development of the Project “Strengthening the supply and use of medical oxygen for treatment facilities for COVID-19 patients” is a very necessary and urgent task, requiring the participation of many people. Not only the health sector, the Government, ministries and agencies, but also the responsibility of local authorities and the whole society.

2. Some concepts: Some terms in this scheme are understood as follows:
- Central oxygen system: Tank, evaporator, pressure reducing valve, gas supply line, zone valve,...; jack head quick connection to the hospital bed;
- Compressed oxygen: Oxygen contained in compressed air cylinders for medical use.
- Liquid oxygen: Oxygen contained in tanks is in liquid form.
- Conversion formula: 01 ton of liquid oxygen = 777 m^3 Oxygen gas at a temperature of 30oC;
- 1st floor, 2nd floor, 3rd floor: A 3-storey treatment tower model of COVID-19 collection and treatment facilities according to the instructions for setting up COVID-19 collection and treatment facilities according to the tower model 3 floors 1.

Model of 3-storey tower for COVID-19 treatment

- Popular portable liquid oxygen tank and gas bottle:

<table>
<thead>
<tr>
<th>No.</th>
<th>Categories</th>
<th>Liquid volume</th>
<th>Weight (kg)</th>
<th>Gas conversion capacity</th>
<th>Illustrating images</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Portable 1 liquid oxygen tank</td>
<td>1m3 /1000 liters</td>
<td>1,080</td>
<td>926 m3 /154 bottles Oxygen 40 liters of pressure</td>
<td>926 m3 /154 bottles Oxygen 40 liters of pressure 150bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150bar</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Portable liquid oxygen tank</td>
<td>0.5m3 /500 liters</td>
<td>525</td>
<td>450 m3 /75 bottles Oxygen 40 liters pressure</td>
<td>450 m3 /75 bottles Oxygen 40 liters pressure 150bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150bar</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Portable Oxygen 3 Liquid Bottle</td>
<td>0.175m3 /175 liters</td>
<td>175</td>
<td>150 m3 /25 Oxygen bottles 40 liters pressure</td>
<td>150 m3 /25 Oxygen bottles 40 liters pressure 150bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150bar</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4 Gas Oxygen Bottle</td>
<td>40 liters</td>
<td></td>
<td>6 m3 pressure gas</td>
<td>6 m3 pressure gas 150bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150bar</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Gas Oxygen Bottle</td>
<td>8-10 liters</td>
<td></td>
<td>1.2 m3 - 1.5 m3 gas pressure</td>
<td>1.2 m3 - 1.5 m3 gas pressure 150bar</td>
</tr>
</tbody>
</table>

1 Decision No. 4111/QD-BYT dated August 26, 2021 of the Minister of Health on the promulgation of documents guiding the establishment of COVID-19 collection and treatment facilities according to the 3-storey tower model.
3. Legal grounds:

- Pursuant to the November 23, 2009 Law on medical examination and treatment;
- Pursuant to the November 21, 2007 Law on Prevention and Control of Infectious Diseases;
- Pursuant to Decree No. 75/2017/ND-CP dated June 20, 2017 of the Government;
- Pursuant to Decree No. 155/ND-CP dated November 12, 2018 amending and supplementing a number of regulations related to business investment conditions under the state management of the Ministry of Health;
- Pursuant to Decree No. 4042/QD-BYT dated August 21, 2021 of the Minister of Health on the issuance of temporary guidance on mobile medical station model in the context of COVID-19 epidemic.
- Decision No. 447/QD-TTg dated April 1, 2020 on epidemic announcement COVID-19.
- Public telegram No: 1068/CD-TTg dated August 5, 2021 and Public telegram number: 1102/CD-TTg dated August 23, 2021 of the Prime Minister on strengthening measures to prevent and control the COVID-19 epidemic. 19.
- Dispatch No. 1168/CD-BYT dated August 7, 2021 of the Ministry of Health on strengthening the implementation of measures to prevent and control the COVID-19 epidemic.
- Decision 3616/QD-BYT dated July 29, 2021 approving the project "strengthening emergency and intensive care capacity for hospitals treating severe COVID-19 patients".
- Decision No. 4111/QD-BYT dated August 26, 2021 of the Minister of Health on promulgating documents guiding the establishment of COVID-19 collection and treatment facilities according to the 3-storey tower model.
PART II: OBJECTIVES AND SCOPE OF THE PROJECT

1. General objective:

Actively develop a plan and organize a close connection between supply and demand in order to exploit and use most effectively resources for producing medical oxygen in the country. Prepare medical oxygen infrastructure to treat COVID-19 patients according to scenarios and epidemic developments with the motto "4 on the spot".

2. Specific objectives:

To guide localities and facilities to treat COVID-19 patients; Calculating demand for use, investing in means of ensuring the plan is one level higher in terms of Medical oxygen for the treatment of COVID-19.

Synthesize the capacity of production, supply, transport and storage of medical oxygen in the country, prepare medical oxygen infrastructure according to scenarios and developments of the COVID-19 epidemic. Develop contingency plans for production, supply and storage systems.

Connecting the network of oxygen production and supply nationwide, developing a plan to coordinate and support policies for the network of production, supply, transport and storage of medical oxygen.

3. Scope of the project: The project is implemented nationwide.

4. Deployment time: Phase 1:

Localities where there is a complicated epidemic situation: City. Ho Chi Minh City, Binh Duong, Dong Nai, Long An... to plan and immediately implement urgent and focused activities within a maximum of one month and other localities to complete their local plan within two months. after the Project is signed and promulgated.

Phase 2: Continue to implement incomplete activities, expand scale, upgrade oxygen infrastructure, purchase oxygen-containing equipment..., increase production, and effectively coordinate production network Export and supply oxygen nationwide.
PART III: SOLUTIONS

1. Establishment of Medical Oxygen Coordination Units in the localities: - The provinces and centrally-run cities (provinces and cities) set up Medical Oxygen Coordination Units in their localities and assign a Deputy Comrade. Chairpersons of People's Committees of provinces and cities act as department heads, leaders of Departments of Health act as permanent deputy heads of sections, and members of relevant departments, branches and units to direct and administer oxygen preparation. The economy is proactive in epidemic prevention and control in the area with the following solutions:

+ Monitor and evaluate the use and demand of medical oxygen according to the situations of the number of COVID-19 cases in the area to promptly advise provincial and city leaders to direct the implementation of the Scheme.

+ Direct and coordinate with production and supply units to ensure medical oxygen supply capacity to meet demand. Support local manufacturers (if any) in ensuring stable production and supply.

+ Directing the organization of connection and information exchange between patient treatment facilities COVID-19 for manufacturers, suppliers of Oxygen and for system administration.

+ Propose and report to the People's Council, the People's Committee of the province and city to decide on the arrangement of investment funds for the construction of facilities, procurement of medical oxygen system equipment according to the approved case scenarios in the locality.

+ Strengthen the application of information technology to monitor and administer the use of medical oxygen at hospitals and medical facilities in the province and city. Connect and update information with the Oxygen Coordination Working Group - Ministry of Health.

2. Calculation of medical oxygen demand: Based on statistics and calculations of the Ministry of Health for the demand for medical oxygen use treatment of specific COVID-19 patients: Table of medical oxygen demand 4 according to regulations Tissue and treatment layer:

<table>
<thead>
<tr>
<th>Stt</th>
<th>Size (hospital bed)</th>
<th>1st floor</th>
<th>2nd floor</th>
<th>3rd floor</th>
<th>Liquid ton</th>
<th>Liters of gas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Liters of gas</td>
<td>Liters of gas</td>
<td>Liquid ton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.249.128</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td></td>
<td>1.6</td>
<td></td>
<td></td>
<td>3.122.820</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>0.02</td>
<td>18,000</td>
<td>1.2</td>
<td>967,680</td>
<td>6.245.640</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>0.04</td>
<td>36,000</td>
<td>2.5</td>
<td>1,935</td>
<td>12,491,280</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>0.07</td>
<td>54,000</td>
<td>3.7</td>
<td>2,903</td>
<td>18,736,920</td>
</tr>
</tbody>
</table>


3 The plan to calculate the oxygen demand for treatment of COVID-19 patients of the Department of Medical Examination and Treatment from statistics, calculation and classification of 2359 patients in Vietnam.

4 When designing medical oxygen systems at COVID-19 treatment facilities, additional backups should be included to ensure operation.

**General requirements:**

3.1.1. Medical gases for treatment floors: COVID-19
treatment facilities need the following medical gases: - Mobile medical station: Compressed air oxygen.
- Floor 1: Oxygen compressed air.
- Level 2: Pneumatic oxygen combined with liquid oxygen, medical compressed air 4 bar.
- 3rd floor: Liquid oxygen, 4 bar medical compressed air, vacuum gas.

3.1.2. Requirements for central oxygen system: - System model:
Central gas source - transmission - control system - terminal system.

- There is a backup source to ensure the system's continuous supply.
- Supplying adequate and continuous medical gases to the place of use with standard quality for medical use.
- Outputs: convenient for operation, safe.
- Convenient for checking and repairing the system. -
Ensure safety in terms of medical hygiene, fire safety, electrical safety.
- The system can be upgraded and expanded as needed.
- The quantity and type of gas are suitable for each hospital's treatment stratification for COVID-19 patients. - For facilities that collect and treat severe and critical levels, the number of air outlets is guaranteed to be 100% of the number of beds.

### 3.2. Medical gas solutions for treatment floors: 3.2.1. Mobile commune and ward health stations: Medical gas

Medical gas solution 5 has at least 02 5-liter bottles, oxygen bags and 02 oxygen pressure gauges; 02 oxygen masks and other necessary accessories to use oxygen for patients.

3.2.2. Floor 1: Asymptomatic and mild treatment facility: At this treatment floor, only using oxygen in the eyeglass frame, breathing through a breathing mask, does not require setting up a central system. Calculation of oxygen demand based on

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the size of the number of beds of each collection facility (see Table of Medical Oxygen Demand by Treatment Scales and Floors).

Recommended selection of bottles for this treatment stage: - 40L bottles.

- Bottle type 8L-10L.
3.2.3. Level 2: Moderate and severe treatment and collection facilities: a. Oxygen: At this treatment floor, oxygen glasses are used, mask breathing and HFNC breathing are used. It is recommended to upgrade and expand the central medical oxygen system for facilities that already have a central oxygen system, and for facilities that do not have a central medical gas system, which need to be built new. The number is calculated based on the bed size of each treatment facility (see Table of Medical Oxygen Demand by Treatment Sizes and Floors).

Recommended selection of tanks, bottles and bottles for the Oxygen system: - Liquid Oxygen tank type ŷ 6 m³ is recommended for provincial hospitals, district hospitals, and large-scale district hospitals. liquid6, recommended for level, small-scale district hospital without central oxygen system.
- Bottles of 8L - 40L for mixed use.

It is recommended to choose the capacity of the evaporator and the pressure reducing valve in accordance with the flow rate used at the same time at 100%, use 2 evaporators to work alternately to avoid the reduction of heat exchange efficiency when operating continuously. customary.

b. Pneumatic:

Based on the technical features of high current oxygen machine (HFNC) to calculate compressed air capacity of the treatment facility.

Recommended selection of central compressed air system (if any): -

Central compressed air system of air compressors: Quantity of 02 screw or helical air compressors.
- Central controller: Controls power, alarms, and alternate running settings for the compressor. Compressed air tank capacity ŷ total capacity within 1 minute.
3.2.4. 3rd floor: Hospital for treatment and treatment of severe and critical levels: a. Oxygen: This is the highest level of treatment in the system to treat COVID-19 patients, at these facilities, oxygen is used for non-invasive mechanical ventilation, invasive mechanical ventilation, and ECMO that requires a large flow of oxygen, starting with oxygen. forced to build a central oxygen supply system. The number of calculations is based on the bed size of each treatment facility to establish the appropriate system.

It is recommended to choose the type of liquid oxygen tank for the central oxygen system 10 m³.

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6 The smallest liquid oxygen tank available on the market
It is recommended to choose the capacity of the evaporator and the pressure reducing valve in accordance with the flow of use at the same time at 100%, use 2 evaporators to work alternately to avoid the reduction of heat exchange efficiency when operating continuously. customary.

b. Pneumatic:

Used for ventilators with calculated capacity based on the number of beds in each treatment facility.

Recommended selection of central compressed air system: -
Central compressed air system: Quantity used ŷ 02 air compressors running alternately.

- Central controller: Controls power, alarms, and alternate running settings for the compressor. Compressed air storage tank total capacity ŷ total capacity within 1 minute.

c. Suction gas:

Used for suction machines with capacity calculated based on the number of beds in each treatment facility.

Recommended selection of central suction air system: - Central medical suction system has 02 suction pumps running alternately.
- The controller runs alternately the suction machines. Bacterial filtration & separation system.

Suction gas storage tank.

4. Improve domestic production and supply capacity of medical oxygen: 4.1

Medical oxygen production and supply group: -

Production and supply units should contact the Department of Health for early vaccination for all employees. All employees carry out the production and supply of medical oxygen to ensure that it is not broken in an emergency.

- Making plans and production plans to ensure epidemic prevention and control measures under the support of authorities to operate continuously (including cases of F0, F1 cases).

- Solution for priority issuance, green channel for tankers, medical oxygen transport vehicles to go in/out of blocked areas and prohibited roads on the supply route to medical facilities. - Ensure a stable power supply, and have a preferential electricity price mechanism for medical oxygen production to ensure throughout the supply chain.

- There is a mechanism for preferential loan interest rates, shortening the loan procedures of banks and creating favorable conditions for early payment for enterprises producing and supplying medical oxygen.

- Prioritize customs clearance procedures for imported products: tanks/tanks/bottles, central oxygen system and related terminals and auxiliary equipment.
ten

- Medical oxygen supply units need to actively survey and prepare supply and reception plans (with backup plans) for treatment facilities.

4.2. Solution to convert using industrial oxygen: Standard industrial oxygen has similar properties to medical oxygen due to the same production technology and equipment, but some factories only directly produce transmitted oxygen. pipelines for direct use in billet smelting do not have a liquefaction system.

A relatively large quantity of industrial inert gas cylinders can also be conversion used in the current urgent conditions.

Solution: -

Through the Ministry of Industry and Trade, request steel and synthetic industrial gas production units to provide production data, provide maximum oxygen and when required, switch to supply for the medical field.

- Coordinate with the Ministry of Labor, War Invalids and Social Affairs to issue a process to guide the conversion of industrial inert gas bottles (Nito, Argon, Oxygen) to medical oxygen bottles to increase the number of medical oxygen cylinders in case of medical emergencies. necessary.

- Report to the Government leaders, the National Steering Committee for Disease Prevention and Control to decide to expropriate and confiscate industrial oxygen products in urgent situations.

5. Strengthening the application of information technology in operation management, coordination and supply: The Ministry of Health deployed the software for management, coordination and supply of medical oxygen nationwide with the participation of the Ministry of Health. Update oxygen usage data of treatment facilities, update oxygen production and supply status of production and supply units in the system.

- Facilities treating COVID-19 patients: The staff in charge of operating the oxygen supply system, daily updating the data on medical oxygen use to the general management software system. At treatment facilities that use liquid oxygen tanks with large volumes, automatic monitoring devices connected to information technology systems and specialized staff should be used to ensure continuous oxygen supply.

- Production and supply units: update production and supply data; reserves; The ability of existing vessels, tanks, and equipment to be provided and installed for treatment facilities on the system.

- Departments of Health in localities, Health of Ministries and sectors: monitor, manage and coordinate the supply of oxygen for treatment facilities in the area.

- Ministry of Health: Synthesize reports, monitor the production, supply and use of medical oxygen nationwide.
6. **Safety of production and use:**

Safety of fire prevention, fire and explosion in transportation, extraction/loading and storage of medical oxygen, testing of medical oxygen standards, pressure testing according to current regulations.

7. **Reserve and backup:**

Localities take the initiative in purchasing and estimating medical oxygen and necessary supplies and equipment to meet and exceed one level of medical oxygen for the scenarios, developments of the COVID-19 pandemic.

The Ministry of Health plans to purchase a part of equipment for the Oxygen system to proactively deal with the situation of 300,000 COVID-19 cases.
PART IV: FINANCE IMPLEMENTATION OF THE PROJECT

1. Estimated funding for the implementation of the project: - Funding for construction and completion of the medical oxygen supply system for treatment COVID-19

    - Funding to support interest on imported bank loans, equipment reserves, oxygen tanks medical.

    - Funding for the implementation of the project at the central level, provinces, hospitals and implementation of activities in accordance with the objectives of the Scheme.

2. Funding sources: -

    State budget, ODA, donor contributions and other lawful capital sources.

    - The central budget ensures funding for the intensive care centers under the management of the Ministry of Health.

    - Local budgets follow the principle of "4 on the spot" to ensure funding for treatment facilities and intensive care centers under local management. The Ministry of Health will provide support according to its capacity to regional Intensive Care Centers managed by localities to implement epidemic prevention and control measures.

    - Hospitals can mobilize funding from organizations, individuals, and institutes grants and other lawful funding sources.
PART V: ORGANIZATION OF IMPLEMENTATION

1. Departments and Departments under
   the Ministry of Health: 1.1. Department of Medical
   Equipment and Construction: - Acting as a permanent focal point to assist the Minister of Health in
directing the
   implementation of the Scheme; - Responsible for directing and guiding centrally-affiliated hospitals to
develop projects (or plans); - Monitoring
   statistics, coordinating the oxygen supply system for treatment
COVID-19 patient.
   - Proposing to the National Steering Committee for COVID-19 Prevention and Control, requesting
ministries and branches7 to implement contents related to supporting the production, supply and backup of
medical oxygen.
   1.2. Department of Medical Examination and
   Treatment: - Guidelines for calculating the need for oxygen for patient treatment
COVID-19.

1.3. Department of Planning and
   Finance: - To assume the prime responsibility for summarizing, allocating funds, and guiding financial
activities of the Project in accordance
   with law. - The focal point to organize the procurement and import of liquid oxygen tanks and gas
oxygen bottles for the treatment of COVID-19 patients.
   - The focal point for formulating preferential policies in the production, supply and import of medical
oxygen.

1.4. The Office of the
   Ministry: - To closely coordinate with the Department of Medical Equipment and Works to direct and
organize the
   implementation of the Scheme; - Summarize funding sources to serve the Project.

1.5. Department of Information
   Technology: - Coordinating in deploying information technology applications for monitoring and administration
the use of medical oxygen at hospitals and medical facilities nationwide;
   - Synchronous connection of information data sources related to the COVID-19 epidemic.

1.6. Department of Communication and Emulation and Reward:
   - Coordinate with Department of Medical Equipment and Construction, Central Center for Health
   Education and Communication, Health & Life Newspaper and related units to implement the implementation.
   communication and emulation and commendation contents of the Project.

7 The Ministry of Defense supports transportation; The Ministry of Industry and Trade supports imports, gives priority to ensuring production power sources,
offers incentives on electricity prices and mobilizes industrial oxygen; The Ministry of Labour, Invalids and Social Affairs supports standards for converting
bottles and containers; The Ministry of Transport supports the granting of green channels; The Ministry of Finance supports loan interest rates.
2. National and regional intensive care centers:

- Based on the contents of the scheme of the Ministry of Health, hospitals are responsible for urgently assessing the current state of the medical oxygen system, developing a project (or detailed implementation plan) and costing the construction investment. Building, upgrading and expanding; review the number of existing bottles, breathing lines, oxygen terminals and additional purchases to ensure efficient operation of the equipment; report to competent authorities for consideration and approval; organize the implementation after the Project is approved.

- Report information, data, activities... fully and promptly to the Provincial Oxygen Coordination Working Group, the Ministry of Health upon request and perform other assigned tasks within the scope of the Scheme. 3. The People’s Committees of the provinces/cities directly under the central government:

- Establishment of the Medical Oxygen Coordination Unit of the province and city to implement the project.

- Direct and urge the Department of Health, departments and hospitals to actively and expeditiously implement the Scheme, and at the same time allocate local budgets and other lawful funding sources to implement the plan/project in the province. local.

4. Departments of Health, Department of Military Medicine, Health of Ministries and Sectors:

- Formulate the scheme of the province, city or branch and submit it to the competent authorities for approval.

- Departments of Health act as a permanent member of the local oxygen coordination department to manage the use and supply of medical oxygen to treat COVID-19 at hospitals and medical facilities in the area.
PART VI: SOCIAL - ECONOMIC EFFICIENCY

The project "Strengthening the supply and use of medical oxygen for COVID-19 treatment facilities" nationwide is in line with the new strategic orientation of the World Health Organization and other countries. advanced, focusing on improving the capacity of treating COVID-19 cases, rescuing, reducing the number of critically ill patients, and treating severe and critical cases, minimizing mortality.

The project will strengthen the capacity to treat many patients, reduce the mortality rate, and limit referrals. Therefore, this project has a profound humanitarian meaning, contributing to the successful implementation of the "dual goal" of the Government and the health sector.

In particular, the project's investment is sustainable, long-term, economical, and not wasteful. The investment project helps to strengthen the active resuscitation capacity of the medical examination and treatment system and hospitals nationwide, not only treating COVID-19 patients but also contributing to the treatment of severe patients of the hospitals. other specialties in the future.
APPENDIX 1: LIST OF MEDICAL OXYGEN PRODUCERS AND SUPPLY UNITS NATIONWIDE

(List as of August 16, 2021 and plan to add additional updates)

1. NORTHERN

<table>
<thead>
<tr>
<th>No.</th>
<th>Company name</th>
<th>Office address</th>
<th>Factory address</th>
<th>Scope of ability to supply</th>
<th>Full name / Mobile phone number (Leader of the company)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Air Liquide Vietnam Co., Ltd. Air Liquide Bac Ninh factory</td>
<td>Que Vo Industrial Park, Ward Van Duong, city Ninh, Bac Ninh city, province Bac Ninh</td>
<td>Que Vo Industrial Park, Ward Van Duong, city Bac Ninh</td>
<td>Bac Ninh, Bac Giang, Hanoi, Ha Nam, Hai Duong, Hung Bac Yen, Nam Dinh, Thai Binh, Hai Phong, Quang Ninh, Vinh Phuc, Thu Tho, Thai Nguyen, Ninh Binh, Lang Son</td>
<td>Pham Minh Tuan 0914389082</td>
</tr>
<tr>
<td>5.</td>
<td>Air Liquide Vietnam Co., Ltd.</td>
<td>Que Vo Industrial Park, Ward Van Duong, city</td>
<td>Yen Phong Industrial Park, Yen Phong District, Bac Ninh Province</td>
<td>Bac Ninh, Bac Giang, Hanoi, Ha Nam, Hai Duong, Hung Yen, Nam Dinh, Thai Binh,</td>
<td>Trinh Van Thang 0917294811</td>
</tr>
<tr>
<td>No.</td>
<td>Company name</td>
<td>Office address</td>
<td>Factory address</td>
<td>Scope of ability to supply</td>
<td>Full name / Mobile phone number (Leader of the company)</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Air Liquide Factory Yen Phong</td>
<td>Bac Ninh street, province Bac Ninh</td>
<td>Hai Phong, Quang Ninh, Vinh Phuc, Phu Tho, Thai Nguyen, Ninh Binh, Lang Son</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Industrial Gas Trading Company Limited</td>
<td>264 Ton Duc Thang, Hang Powder, Dong Da, Hanoi</td>
<td>Dak So CN Point, Hoai Duc, Hanoi</td>
<td>Hanoi</td>
<td>Nguyen Minh Khoa 0913232323</td>
</tr>
<tr>
<td>7.</td>
<td>Vietnam Industrial Gas Joint Stock Company (Thanhgas)</td>
<td>609 Truong Dinh, Giap Bat ward, Hoang Mai district, city Hanoi</td>
<td>Long-term contract with partners (Company Messer Hai Industrial Gas Limited Department- Hai Branch Positive)</td>
<td></td>
<td>Duong Duc Hoan 0978992228</td>
</tr>
</tbody>
</table>

2. CENTRAL CENTRAL

<table>
<thead>
<tr>
<th>No.</th>
<th>Company name</th>
<th>Office address</th>
<th>Factory address</th>
<th>Scope of ability to supply</th>
<th>Full name / Mobile phone number (Leader of the company)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Vietnam Industrial Gas Joint Stock Company (Thanhgas)</td>
<td>Ngo Gia Tu Duc Giang Street, Long Bien, Hanoi</td>
<td>No. 5A Hoa Cam Industrial - Cam Le - Da City Nang</td>
<td>Park Da Nang, Quang Nam, Quang Ngai</td>
<td>Mai Dinh Hop 0904010099</td>
</tr>
<tr>
<td></td>
<td>Nghe An Industrial Gas Joint Stock Company</td>
<td>No. 77 Phan Boi Chau, City. Vinh, Nghe An</td>
<td>No. 16, Street No. 1 VSSIP Nghe An Industrial Park</td>
<td>Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Hue</td>
<td>Nguyen Hubei 0974947555</td>
</tr>
<tr>
<td>No.</td>
<td>Company name</td>
<td>Office address</td>
<td>Factory address</td>
<td>Scope of ability to supply</td>
<td>Full name / Mobile phone number (Leader of the company)</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------</td>
<td>-----------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Long Phat Oxygen Gas Trading And Service Co., Ltd</td>
<td>No. 61 Dinh Tien Hoang Street, Tu An Ward, City. Buon Ma Thuot, Dak Lak Province, Road No. 2,</td>
<td>19/5 Street, Eatam Ward, Buon Ma Thuot City, Dak Lak Province</td>
<td>Buon Ma Thuot, Dak Nong</td>
<td>(Company leader) Mr. Bui Van Hung 0903583337</td>
</tr>
<tr>
<td>5.</td>
<td>Da Nang Oxygen Joint Stock Company</td>
<td>Industrial Park, Road No. 2, Hoa Khanh North, Lien Khanh Chieu, Danang city Service Joint Stock Company 01 A</td>
<td>Industrial Park Central region Hoa Khanh North, Lien Nguyen Chieu, Da Nang City 6.</td>
<td>(Ha Tinh - to Binh Dinh and North West of Hoa Khanh, Hoa Khanh, (19/5) Street, Eatam Ward, Buon Ma Thuot City, Dak Lak Province</td>
<td>Nguyen Anh Tuan - 0903515115</td>
</tr>
</tbody>
</table>

**SOUTH**
<table>
<thead>
<tr>
<th>No.</th>
<th>Company name</th>
<th>Office address</th>
<th>Factory address</th>
<th>Scope of ability to supply</th>
<th>Full name / Mobile phone number (Leader of the company)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Nippon Sanso Vietnam Joint Stock Company Phu My Branch 1</td>
<td>Road 2A, Phu Industrial Park My 1, Phu My Ward, Phu My Town, BRVT</td>
<td>Road 2A, Phu My Industrial Park 1, Phu My Ward, TX Phu My, BRVT</td>
<td>All provinces from Da Nang to the South</td>
<td>Le Phu Minh 0974900757</td>
</tr>
<tr>
<td>5.</td>
<td>Linde Gas Vietnam Co., Ltd</td>
<td>1B, Phu My 1 Industrial Park, Tx Phu My, Ba Ria Province Vung Tau</td>
<td>D3, Phu My Industrial Park, Phu My, Ba Ria Vung Tau Dong Province Ba Ria Vung Tau</td>
<td>Ho Chi Minh, Long An, Road Nai, Binh Duong, 2, Tx. Phuoc, Tay Ninh, Tien Giang Dong Nai, Ho Chi</td>
<td>Nguyen Van Viet 0903366319</td>
</tr>
<tr>
<td>6.</td>
<td>Dong Nai Oxygen Co., Ltd</td>
<td>No. 2, Road 1A, Bien Hoa 2 Industrial Park, Long Binh Tan Ward, Bien Hoa City, Dong Nai Province</td>
<td>No.2, Road 1A, Bien Hoa 2 Industrial Park, Long Binh Tan Ward, Bien Hoa City, Dong Nai Province,</td>
<td>Minh City, Binh Duong, Long An</td>
<td>Nguyen Thanh Tam 0983744699</td>
</tr>
<tr>
<td>7.</td>
<td>Welding Rod Technology Joint Stock Company (Sovigaz)</td>
<td>1-3 Nguyen Truong To, Ward 13, District 4, HCMC</td>
<td>Block 4, Lot A, Road No.1, Dong An Industrial Park, Thi xa Thuan An, Binh Duong Province</td>
<td>From Khanh Hoa province to the eastern and southwestern provinces and HCMC Area</td>
<td>Mr. Trinh Anh Phong 0908109016</td>
</tr>
<tr>
<td>No.</td>
<td>Company name</td>
<td>Office address</td>
<td>Factory address</td>
<td>Scope of ability to supply</td>
<td>Full name / Mobile phone number (Leader of the company)</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>9.</td>
<td>Oxygen Tuan Anh Gia Lai Co., Ltd</td>
<td>248C Phan Dinh Phung, Pleiku City, Gia Lai</td>
<td>Village 9, Nghia Hung commune, Chu Pah , Gia Lai</td>
<td>Ngai, Kon Tum, Nha Trang, Quy Nhon Binh Duong, Dong Nai, Vung Tau,</td>
<td>Pham Anh Khoa 0977227799</td>
</tr>
</tbody>
</table>
APPENDIX 2: MEDICAL OXYGEN AND INDUSTRIAL OXYGEN PRODUCTION CAPACITY

1. Medical Oxygen Gas Production Capacity:

1.1 Production capacity:

Currently, through reviewing and requesting medical oxygen production and supply units to report. There are currently 26. nationwide factory (Appendix attached), in which:

- **North: 07 factories**
  + Average total production capacity of liquid oxygen: 530.6 tons/day (Equivalent to 412,276.2 m$^3$ oxygen).
  + Maximum production capacity of liquid oxygen: 592.08 tons/day (equivalent to 460,046 m$^3$ oxygen).
  + Total quantity) Liquid oxygen storage facilities: 3690.8 Tons (Equivalent to 2,867,715.6 m$^3$ oxygen).
  + Filling/extraction (40L type): 3,800 bottles/day.
  + Total capacity to convert/extract Bottles (type XL45): 280 bottles/day.
  + Total number of liquid oxygen tank trucks: 21 vehicles.
  + Total number of vehicles transporting Bottles / Bottles: 19 vehicles.

- **Central region: 08 factories**
  + Average total production capacity of Liquid Oxygen: 100 Tons/day (Equivalent to 77,700 m$^2$ + Maximum$^3$ oxygen).
  + Total production capacity of Liquid Oxygen: 152.4 Tons/day (Equivalent to 118,414.8 m$2$ + Total amount$^3$ oxygen).
  + Total amount of liquid oxygen stored by facilities: 3,588 Tons (Equivalent to 2,787,876 m$2$ + Total capacity of bottle$^3$ oxygen).
  + Filling/extraction (40L type): 15,100 bottles/day.
  + Total capacity to convert/extract Bottles (type XL45): 340 bottles/day.
  + Total number of liquid oxygen tank trucks: 22 vehicles.
2. Industrial Oxygen Production Capacity:

Currently, according to the Vietnam Steel Association’s report, there are 13 large steel production units in Vietnam such as Hoa Phat Steel, Formusa Steel, etc., which use oxygen in natural form. Producing Oxygen or buying directly from industrial gas production units such as MESSER, Air Liquide, etc. To smelting steel billets, the annual use needs of Oxy gas refineries, the Steel billet need about 744 million m³ oxygen. The Vietnam Steel Association is ready to participate in the call. Calling steel production units to switch to support production and supply oxygen for epidemic prevention and control.

1.2. Commitment of manufacturers and suppliers:

Units committed to the Ministry of Health are ready to increase by 50% - 100% of capacity in case the National Steering Committee for Prevention and Control of COVID-19 epidemic issues an order during an emergency.

- South: 11 factories
  + Average total production capacity of Liquid Oxygen: 553.6 Tons/day (Equivalent to 430,147.2 m³ oxygen).
  + Amount of liquid oxygen stored by the facilities: 7,025,315 Tons (Equivalent to 2,787,876 m³ oxygen).
  + Total capacity of bottle filling/extracting (40L type): 11,500 bottles/day.
  + Total number of vehicles transporting Bottles / Bottles: 52 vehicles.
  + Total capacity to transfer/extract Bottles (type XL45): 247 bottles/day.
  + Total number of liquid oxygen tank trucks: 48 vehicles.
  + Total number of vehicles transporting Bottles / Bottles: 78 vehicles.

- Total number of vehicles transporting Bottles / Bottles: 52 vehicles.

+ Total capacity to transfer/extract Bottles (type XL45): 247 bottles/day.
+ Total number of liquid oxygen tank trucks: 48 vehicles.
+ Total number of vehicles transporting Bottles / Bottles: 78 vehicles.
## APPENDIX 3: INSTRUCTIONS FOR CALCULATING OXY8 DEMAND

1. Estimated number of people with COVID-19 in each treatment tier according to cases number of cases

<table>
<thead>
<tr>
<th>TT</th>
<th>Content</th>
<th>Percentage of total cases</th>
<th>Percentage in each floor</th>
<th>Number of people with COVID-19 in each floor by cases ((=\text{total number of patients} \times \text{percentage of patients by clinical level}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Level 1: Mild, asymptomatic patient:</td>
<td>83.6%</td>
<td>100%</td>
<td>836</td>
<td>4,180</td>
</tr>
<tr>
<td>1.1 Patient is mild and does not require oxygen</td>
<td>79.4%</td>
<td>95%</td>
<td>794</td>
<td>3,971</td>
</tr>
<tr>
<td>1.2 Patients breathing oxygen with glasses</td>
<td>2.1%</td>
<td>2.5%</td>
<td>21</td>
<td>105</td>
</tr>
<tr>
<td>1.3 Breathe through the mass</td>
<td>2.1%</td>
<td>2.5%</td>
<td>21</td>
<td>105</td>
</tr>
<tr>
<td>2. Level 2: NB moderate, heavy</td>
<td>11.20%</td>
<td>100%</td>
<td>112</td>
<td>560</td>
</tr>
<tr>
<td>2.1 NB moderate</td>
<td>7.00%</td>
<td>62.5%</td>
<td>70</td>
<td>350</td>
</tr>
<tr>
<td>2.3 Patient with respiratory failure, Oxygen for glasses</td>
<td>0.60%</td>
<td>5.4%</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>2.2 Patients with respiratory failure, oxygen through mass</td>
<td>3.20%</td>
<td>28.6%</td>
<td>32</td>
<td>160</td>
</tr>
<tr>
<td>2.4 High Flow Oxygen HFNC</td>
<td>0.40%</td>
<td>3.6%</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>3. 3rd floor: Severe, critical patient</td>
<td>5.20%</td>
<td>100%</td>
<td>52</td>
<td>260</td>
</tr>
<tr>
<td>3.1 Non-invasive mechanical ventilation</td>
<td>1.45%</td>
<td>27.9%</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>3.2 Very Severe: Invasive mechanical ventilation</td>
<td>3.70%</td>
<td>71.2%</td>
<td>37</td>
<td>185</td>
</tr>
<tr>
<td>3.3 ECMO</td>
<td>0.05%</td>
<td>1.0%</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

---

\* Sources from the Department of Health Care Administration
### 2. How to estimate the oxygen demand at each treatment floor by the total number of cases and by the number of cases at a time

<table>
<thead>
<tr>
<th>TT</th>
<th>Content</th>
<th>Explain how to calculate oxygen demand by total number of cases (liters of gas)</th>
<th>Explain how to calculate Oxygen demand according to the number of cases at a time (liter of gas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td><strong>Level 1: Mild, asymptomatic patient: 1.1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>patient, no need for oxygen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Patients breathing oxygen with glasses</td>
<td>If the frame oxygen level is 5 (litres/minute) x 60 (minutes) x number of hours/day x average number of treatment days x number of patients</td>
<td>If the frame oxygen level is 5 (litres/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
<tr>
<td>1.3</td>
<td>Breathe through the mass</td>
<td>If the oxygen mass is 15 (litres/minute) x 60 (minutes) x number of hours/day x average number of days of treatment x number of patients</td>
<td>If the oxygen level of the bag is 15 (litres/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
<tr>
<td>2.</td>
<td><strong>Level 2: NB moderate, heavy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>NB moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Patient with respiratory failure, Oxygen for glasses</td>
<td>If the frame oxygen level is 5 (litres/minute) x 60 (minutes) x number of hours/day x average number of treatment days x number of patients</td>
<td>If the frame oxygen level is 5 (litres/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
<tr>
<td>2.2</td>
<td>Patients with respiratory failure, oxygen through mass</td>
<td>If the oxygen mass is 15 (litres/minute) x 60 (minutes) x number of hours/day x average number of days of treatment x number of patients</td>
<td>If the oxygen level of the bag is 15 (litres/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
<tr>
<td>2.4</td>
<td>High Flow Oxygen HFNC</td>
<td>FiO2 100%, F 60/min: 60 (liters/minute) x 60 (minutes) x number of hours/day x average number of days of treatment x number of patients</td>
<td>FiO2 100%, F 60/min: 60 (liters/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
<tr>
<td>3.</td>
<td><strong>3rd floor: Severe, critical patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Non-invasive mechanical ventilation</td>
<td>If the Oxygen level is 100%: (F35, Vt 500, PEEP 10 FiO2 100, Bias flow 10): 27.5 (liters/minute) x 60 (minutes) x number of hours/day x average number of days of treatment x number of patients</td>
<td>If 100% Oxygen level: (F35, Vt 500, PEEP 10 FiO2 100, Bias flow 10): 27.5 (liters/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
<tr>
<td>3.2</td>
<td>Very Severe: Invasive mechanical ventilation</td>
<td>If the Oxygen level is 100%: (F35, Vt 500, PEEP 10 FiO2 100, Bias flow 10): 50 (liters/minute) x 60 (minutes) x number of hours/day x average number of days of treatment x number of patients</td>
<td>If 100% Oxygen level: (F35, Vt 500, PEEP 10 FiO2 100, Bias flow 10): 50 (liters/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
<tr>
<td>3.3</td>
<td>ECMO</td>
<td>If Oxygen level 10 (litres/minute) x 60 (minutes) x number of hours/day x average number of days of treatment x number of patients</td>
<td>If Oxygen level 10 (litres/minute) x 60 (minutes) x number of hours/day x number of patients</td>
</tr>
</tbody>
</table>
### 3. Estimation of oxygen demand at each treatment tier by total number of cases and by number of cases at a time

Table 1. Estimated oxygen demand in the scenario of 1000 cases and 5,000 cases

<table>
<thead>
<tr>
<th>TT</th>
<th>Content</th>
<th>Percentage of total cases</th>
<th>Number of patients at each floor when there is 1000 shift get</th>
<th>Oxygen demand in the situation of 1000 cases of COVID-19</th>
<th>Number of patients on floors when there are 5000 cases</th>
<th>Oxygen demand in a 5000 case scenario COVID-19</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>At each layer of Oxygen number of cases at a time (liters of gas)</td>
<td>Liquid oxygen (tons)</td>
<td>Demand in a day when the number of cases at a time (liter of gas)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>At each stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Floor 1: Mild patient, no symptoms: 1.1 Patient mild, no need to breathe</td>
<td>83.6%</td>
<td>836</td>
<td>151,200</td>
<td>0.2</td>
<td>151,200</td>
</tr>
<tr>
<td></td>
<td>Patient</td>
<td>breathing Oxygen 79.4% 1.2 Patient breathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>glasses 2.1% 1.3 Breathing through mass 2.1% 2.</td>
<td>794</td>
<td>1</td>
<td>1,728,000 won</td>
<td>345,600</td>
</tr>
<tr>
<td>2.</td>
<td>Floor 2: Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patient moderate, severe 11.20% 2.1 patients moderate 7.00%</td>
<td>21</td>
<td>21</td>
<td>37,800</td>
<td>37,800</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>2.3 patients with respiratory failure, oxygen frames 0.60% 2.2</td>
<td>112</td>
<td>112</td>
<td>1,080,000 won</td>
<td>113,400</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>patients with respiratory failure, oxygen through 3.20%</td>
<td>70</td>
<td>70</td>
<td>3,931,200</td>
<td>1,080,000 won</td>
<td>113,400</td>
</tr>
<tr>
<td></td>
<td>mass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.4 High-flow HFNC 3. Level 3: Severe, critical patient</td>
<td>0.40%</td>
<td>4</td>
<td>2,073,600</td>
<td>2,073,600</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>patient 3.1 Non-invasive ventilation 3.2</td>
<td>5.20%</td>
<td>52</td>
<td>22,717,800</td>
<td>22,717,800</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Very severe: Invasive mechanical ventilation</td>
<td>1.45%</td>
<td>15</td>
<td>4,019,400</td>
<td>574,200</td>
<td>185</td>
</tr>
<tr>
<td></td>
<td>3.3 ECMO</td>
<td>3.70%</td>
<td>37</td>
<td>18,648,000 won</td>
<td>2,664,000 won</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0.05%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total (liters)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Convert to Oxygen gas (m liter/1000)</td>
<td>3.477</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Convert to Liquid Oxygen (tons):</td>
<td>34.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table Notes:**
- The table calculates oxygen demand at each treatment tier by total number of cases and by number of cases at a time.
- The scenarios include mild, moderate, severe, critical, and very severe patients, with different methods of oxygen delivery.
- The table outlines the oxygen demand at each stage, total liters of oxygen, and the conversion to liquid oxygen (tons) for different scenarios.

**Conversion:**
- 1 liter = 3.477 m³
- 1 m³ = 0.345 tons
4. Estimated Oxygen demand of COVID-19 treatment and collection facilities by hospital bed size according to 3 treatment floors

<table>
<thead>
<tr>
<th>TT</th>
<th>Content</th>
<th>Ratio % in each floor</th>
<th>Estimated oxygen demand of COVID-19 treatment and collection facilities by hospital bed size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Size of hospital beds on each floor</td>
</tr>
<tr>
<td>1.</td>
<td>Floor 1: Mild, asymptomatic patient: 1.1 Mild patient, no need for oxygen</td>
<td>100%</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Patient oxygen</td>
<td>95%</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>with glasses frame 1.3 Breathe through mass</td>
<td>2.5%</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>2. Floor 2: Moderate patient, severe 2.1 Patient with moderate severity</td>
<td>100%</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Patient with impaired Respiration, Eyeglass oxygen</td>
<td>5.4%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2.2 NB in respiratory failure, oxygen through mass</td>
<td>28.6%</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>2.4 High flow oxygen HFNC</td>
<td>3.6%</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Floor 3: Severe, critical patient 3.1 Non-invasive ventilation 3.2 Very severe</td>
<td>100%</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3.3 ECMO</td>
<td>1.0%</td>
<td>0.2</td>
</tr>
</tbody>
</table>
### Estimated Oxygen demand of COVID-19 collection and treatment facilities by hospital

<table>
<thead>
<tr>
<th>TT</th>
<th>Content</th>
<th>Percentage in each floor</th>
<th>Size of hospital beds on each floor</th>
<th>Oxygen demand in 1 day</th>
<th>bed size converting into liquid bed oxygen at (tons) per floor</th>
<th>Demand Oxygen for 1 day</th>
<th>Convert to Liquid Oxygen (tons) 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Level 1: Mild patient, asymptomatic: 1.1</td>
<td>Mild patient, no need for oxygen</td>
<td>100%</td>
<td>5.000 won</td>
<td>900,000 won</td>
<td><strong>10,000</strong></td>
<td>1,800,000 won</td>
<td>Oxygen (tons) 2</td>
</tr>
<tr>
<td>1.2</td>
<td>Patient oxygen with glasses</td>
<td>95%</td>
<td>125</td>
<td>225,000 won</td>
<td>250</td>
<td>450,000 won</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Breathe through mass</td>
<td>2.5%</td>
<td>125</td>
<td>675,000 won</td>
<td>250</td>
<td>1,350,000 won</td>
<td></td>
</tr>
<tr>
<td>mass 2. Level 2: NB moderate, heavy</td>
<td>100%</td>
<td>5.4%</td>
<td>1,000 yen</td>
<td>9,676,800</td>
<td>12.5</td>
<td><strong>2,000</strong></td>
<td>19,353,600 won</td>
</tr>
<tr>
<td>2.1</td>
<td>Patients with moderate severity 2.3 Patients with respiratory failure,</td>
<td>62.5%</td>
<td>54</td>
<td>388,800</td>
<td>108</td>
<td>777,600</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Oxygen frames with glasses 2.2 Patients with respiratory failure, breathing Oxygen</td>
<td>5.4%</td>
<td>286</td>
<td>6.177,600</td>
<td>572</td>
<td>12,355,200</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>High-flow oxygen HFNC 3. through mass</td>
<td>3.6%</td>
<td>36</td>
<td>3.110,400</td>
<td>72</td>
<td>6,220,800</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Level 3: Severe, critical patient 3.1 Non-invasive ventilation 3.2 Very severe: Intrusive mechanical ventilation</td>
<td>27.9%</td>
<td>56</td>
<td>2,209,680</td>
<td>140</td>
<td>5,524,200</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>ECMO</td>
<td>1.0%</td>
<td>2.0</td>
<td>28,800</td>
<td>5.0</td>
<td>72,000 won</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 4: GUIDELINES FOR DESIGNING CENTRAL HEALTH GAS SYSTEMS

1. Design standards:

- Refer to NF S 90-155, HTM 2022 -
  Documentation for design, installation and operation of medical gas systems: ISO 7396-1 (Medical gas pipeline systems – Part 1: Pipeline systems for compressed medical gases and vacuum ) and ISO 7396-2 (Medical gas pipeline systems – Part 2: Anaesthetic gas scavenging disposal systems).
- Air Liquide Medical Systems design manual (Medical Gas Design Guide)

  a. Formula for calculating air source capacity: Outlet air outlets for COVID-19 patient treatment facilities operate at 100% capacity (maximum air supply).
  possibility), so when calculating the power source based on the empirical formula HTM 2022:
  Explain the symbols in the calculation formula for all gases: = number of beds
  b. Formula for oxygen source:

<table>
<thead>
<tr>
<th>Area</th>
<th>TK flow per outlet (litre/min)</th>
<th>Split flow rate Q (liter/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive treatment bed</td>
<td>ten</td>
<td>Ql = 10 + (nB-1)6</td>
</tr>
<tr>
<td>Surgery room</td>
<td>100</td>
<td>QT = 100 + 20(T-1)</td>
</tr>
</tbody>
</table>
c. Formula for 4 bar compressed air source:

<table>
<thead>
<tr>
<th>Area</th>
<th>TK flow per outlet (litre/min)</th>
<th>Split flow rate Q (liter/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive treatment bed</td>
<td>80</td>
<td>[Q^l nB^1 2 \frac{80}{4}]</td>
</tr>
<tr>
<td>Surgery room</td>
<td>40</td>
<td>[Q^T 40 (T^1)^4 \frac{40}{4}]</td>
</tr>
</tbody>
</table>

d. Calculation formula for VAC suction air source:

<table>
<thead>
<tr>
<th>Area</th>
<th>TK flow per outlet (litre/min)</th>
<th>Split flow rate Q (liter/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery room</td>
<td>40</td>
<td>QT=80</td>
</tr>
<tr>
<td>Intensive treatment bed</td>
<td>40</td>
<td>[Q^l 40^1 (nB^1)^4 \frac{40}{4}]</td>
</tr>
</tbody>
</table>
3. Calculation of medical gas pipeline size:

The method of choosing the size of the medical gas pipeline is to ensure low pressure loss on the pipeline than the allowable threshold (not more than 5% of the working pressure of the pipeline). Basically, the selection method can be summarized as follows:
1. Determine the pipe size by experience
2. Calculate the pipeline flow
3. Calculate the pressure loss according to the formula:

$$\Delta p = \frac{\text{Measured length of pipe}}{\text{Nearest length of pipe from Table A1}} \times \left[ \frac{\text{Design flow}}{\text{Nearest flow from Table A1}} \right]^2 \times \text{Pressure drop from Table A1}$$

In which:
- **Measured length of pipe**: The length of the pipe to calculate the pressure loss.
- **Nearest length of pipe from Table A1**: The nearest length according to table A1, Appendix G – HTM document 02-01 book A.

- **Design flow**: Design flow (that the pipe must carry).
- **Nearest flow from Table A1**: The nearest flow according to Appendix table A1.
- **G – document HTM 02-01 volume A**.
- **Pressure drop from Table A1**: Pressure according to table A1, Appendix G – document HTM 02-01 and A.

4. Solution for the system:
The medical gas system is designed according to the central gas supply model. The gas sources are concentrated in an area outside the COVID-19 hospital bed area (yellow area), which is convenient for monitoring supply status, safety, and noise avoidance. After that, the gas is led into the treatment bed area by a pipeline system. Outputs are boxes or combinations of automatic valve boxes, ensuring fast connection times.

The gas source includes a main source and a backup source. Ensure the continuous supply of medical gas to the COVID-19 hospital bed facility.
4.1. **Medical gas supply**: Location outside buildings. The pipeline leading to the treatment buildings is the shortest. Convenient for loading and replace the power supply, ensure a safe distance, prevent fire and explosion. Medical gas sources include:

- **Seamless gas bottles**: including 2 bottles, with stop valve, exhaust valve, separate pressure gauge for checking and replacing new cylinders.

4.2. **Medical compressed air supply**: Ensure system synchronization and meet TC HTM 2022 or NEPA 99 Equipment:
- The medical air compressor system is designed with at least 02 machines in parallel so that the system can still supply air when the main machine fails or is maintained. The system includes modules that can be flexibly installed in accordance with the machine room area.
- System control cabinet: has automatic and manual operation control functions (when maintaining).

- Accumulator to store compressed air ready for use, reducing the number of compressor starts. Pressure accumulator max. 10 bar, with safety (pressure) relief valve and pressure gauge.
- There is a dual oil filter system to calculate the oil in the compressed air. Each side ensures that the filter capacity is equal to the system capacity, ensuring that there is always enough air while 01 filter is being maintained. Dual drying system to separate water vapor in compressed air. Two filters are installed in parallel so that the system always supplies compressed air while one can be serviced.
- Dual filter system to filter bacteria in compressed air. Two filters are installed in parallel so that the system always supplies compressed air while one can be serviced.
- Pressure reducer 7bar - 4 bar. To reduce the pressure from the accumulator to 4 bar.

4.3. VAC suction air source:

Ensure system synchronization and meet TC HTM 2022, or NEPA 99 Equipment: - The medical

center suction system is designed with two parallel machines, running alternately, and at the same time ensuring for repair and maintenance. The system includes modules that can be flexibly installed in accordance with the machine room area.
- System control cabinet: has automatic and manual control functions of air compressors.
- Accumulator to store suction gas ready for use, reducing the number of machine starts, increasing compressor durability. Jar pressure capacity max. 10 bar, with safety (pressure) relief valve and pressure gauge.
- There is a double-determined trap on the pipeline to separate the fluid from flowing through the pipe to the outside environment.
- Dual bacterial filter to filter bacteria before releasing air to the outside environment to avoid environmental pollution.
- Quality requirements of the suction air filter
  o Pressure drop through the filter: ñ 25 mmHg o
  Bacterial filtration capacity: ñ 99.995% o Dust filtration capacity: 0.02 µm 4.4 . The transmission system:
- The transmission system is made of specialized medical-grade copper material, which is removed from toxic and heavy metals element, cleaning and degreasing to ensure arsenic-free.

  - High pressure resistance: 10mm diameter pipes withstand 110 bar, - 54mm diameter pipes withstand 17 bar pressure. - The vertical pipeline is run in the technical box. Pipes on each floor run along the corridor above technical ceiling. Piping from the hallway enters the outlet locations (air drive or headboard box, ...).

  - The medical gas pipeline system does not come into contact with electrical conductors, at least 50mm apart.
  - Pipes must be grounded (ground) separately.
  - The medical gas pipeline support system must be solid.

4.5. **Output device**

Features a quick connection. When plugging in the end of the pipe of the equipment used, automatically open the one-way valve to supply air to the equipment used, remove the end of the pipe, and automatically lock the air.

*The image shows the air outlet:*

Is the outlet air outlet with automatic valve installed. Accumulated Suitable for bedside meeting Installed at places of use (hospital bed, operating room, ultrasound, ... ).
4.6. Peripherals:

Basic means of supporting medical treatment. These devices use medical gas through connection to the terminal by quick disassembly. After being installed in the medical system, automatically supply gas to the device. After removing the terminal automatically cuts off the medical gas.

Peripheral devices can move from one location to another. Peripheral devices include: Flowmeter 15 l/p with humidifier: Helps the hospital bed breathe oxygen-rich air. The output air flow can be adjusted from 0 ~ 15 L/p. Pressure control system back pressure, ensuring stable output flow when the pipeline pressure changes.

With Oxygen Humidifiers

Illustration of wall mounted suction flasks:

Liquid tank: Unbreakable, spill-proof material
Vacuum adjustment range: 0 ~ 200 mmHg
The knob to adjust the amount of suction
Suction/suction stop button

Illustration of mobile suction suction:
Illustration of pulmonary aspiration (low pressure):

Connector types:

Quickly connect medical gas devices to the gas outlet. When plugged in, open the valve automatically to let the gas enter the device bag. When removing the automatic valve (in the air outlet) automatically closes to keep the gas in the pipeline.