

Building Sustainable Capacity for Medical Oxygen Generation in Haiti

SUCCESS STORY | JUNE 2024

To increase the availability and use of oxygen in Haiti, EpiC partnered with the Ministry of Health (MOH) to improve medical oxygen production at 14 health care facilities across the country. After conducting assessments at each facility, EpiC trained 50 technicians and personnel, including MOH biomedical technicians, in the operation and maintenance of oxygen generating plants.

Reliable, consistent oxygen therapy is the cornerstone of quality health care. Without access to oxygen therapy, countries are vulnerable to increased morbidity and mortality during times of crisis such as the COVID-19 pandemic. In Haiti, prior to the COVID-19 outbreak, only two hospitals outside the Port au Prince area had oxygen generation plants—both of which were pressure swing adsorption (PSA) plants—operating on a regular basis. Access to medical oxygen was limited to several distributors in areas with larger populations. In response, several agencies donated oxygen generation systems to Haiti. However, these donations were often made without a proper installation plan, consideration of electrical requirements, maintenance plan and equipment, or training for facility-level technicians.

Technical support to optimize use of existing and newly installed oxygen generation plants was essential to increase the availability and use of oxygen in Haiti. Haiti's Ministry of Health (MOH), in partnership with the USAID-funded Meeting Targets and Maintaining Epidemic Control (EpiC) project worked to improve medical oxygen production at 14 facilities across the country and ensure oxygen could be effectively administered to patients. Based on average utilization and consumption needs from an assessment at Bienfaisance de Pignon Hospital, if each oxygen plant produced up to 10 oxygen cylinders (220 cubic feet) per day on an ongoing basis, the goal would be met.

Assessment

EpiC worked with project subpartner, the Dalton Foundation, to complete assessments of 15 oxygen generators at 14 facilities to better understand their capacity for oxygen production and identify operational bottlenecks hindering optimal production, areas for capacity improvement, and safety issues (see Table 1). Assessments began in July 2022 and were completed in February 2023 after delays caused by deteriorating security in the country. The project created an assessment tool to evaluate each facility's oxygen generator, production capacity, electrical system, internal and external oxygen distribution policies, procedures, safety, and staff training. These assessments were completed by trained biomedical technicians and engineers using an online application created specifically for this project, in partnership with members of MOH and under the guidance of hospital administrators.

The assessments revealed that many locations had little experience operating an oxygen generator, and all had safety violations. Results showed the need for training on safety, operation, and maintenance; maintenance kits including spare parts and accessories; additional equipment for each generator; and proper documentation (i.e., logbook to record number of hours run per day to inform when next maintenance would be needed, number of cylinders produced per day, purity level, etc.). It was also suggested that the community of practice—which EpiC had already established to provide a platform for sharing information and best practices related to operating oxygen generators—would be more useful if it also built skills on safety, operations, and oxygen transportation, as well as providing a forum to ask questions and find solutions.



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Table 1. Oxygen generating facilities assessed by the EpiC project

FACILITY NAME	VILLAGE	DEPARTMENT	FACILITY TYPE	ASSESSMENT LEADER	OXYGEN GENERATOR BRAND AND MODEL	TYPE OF PLANT*
Hopital La Providence de Gonaives	Gonaives	ARTIBONITE	Public	DALTON	Hanbell - Model AA6-22A	PSA
Hopital Sainte-Thérèse de Hinche	Hinche	CENTRE	Public	DALTON/AYIMED	Hanbell - Model AA6-22A	PSA
Direction Departemental Grand'Anse/Château (Ministry of Public Health and Population [MSPP] Office)	Jeremie	GRAND ANSE	Public	AYIMED	Hanbell - Model AA6-22A	PSA
Centre de Sante de Paillant	Paillant	NIPPES	Public	AYIMED	Hanbell - Model AA6-22A	PSA
Hopital Sacre Coeur De Milot	Milot	NORD	Private	DALTON	Atlas Copco	VSA
Hopital Bienfaisance de Pignon	Pignon	NORD	Private	DALTON	(PCI) - Model DOCS 200-55	VSA
Hopital Justinien du Cap	Cap Haitian	NORD	Public	DALTON/AYIMED	Hanbell - Model AA6-22A	PSA
Direction Sanitaire Nord Est (MSPP Office) Dr Jean Denise	Fort Liberte	NORD EST	Public	DALTON	Hanbell - Model AA6-22A	PSA
Centre Medical Beraca/ LaPointe	Port-de-Paix	NORD OUEST	Private	DALTON	Hanbell - Model AA6-22A	PSA
Hopital Notre Dame de la Paix de Jean Rabel	Jean Rabel	NORD OUEST	Public	DALTON	(PCI) - Model DOCS 200-55	VSA
Hopital Universitaire d'Etat de Haiti (HUEH)	Port au Prince	OUEST	Public	DALTON	Ultra Controllo Model ULTRA-CREW 22	PSA
Direction Sanitaire Sud	Les Cayes	SUD	Public	AYIMED	Hanbell - Model AA6-22A	PSA
St. Boniface Hospital	Fond Des Blancs	SUD	Public	AYIMED	Atlas Copco - Model GA5FF	PSA
Direction Departementale Sud-Est	Jacmel	SUD EST	Public	AYIMED	Hanbell - Model AA6-22A	PSA
Hopital Saint-Michel (Government Hospital)	Jacmel	SUD EST	Public	AYIMED	Desran Air - Model: DSR-10A	PSA

*PSA: Pressure swing adsorption (PSA) oxygen plant; VSA: Vacuum swing adsorption (VSA) oxygen plant

Upon completion of the assessments, the project wrote graded reports indicating if the site was capable of meeting oxygen production goals. Each facility also received individualized recommendations, including a list of needed repairs, items to purchase to safely transport filled tanks, and safety equipment and training topics to be covered. Many of these recommendations have been followed; others are still in progress.

FINDINGS FROM THE ASSESSMENT

Two locations had serious safety concerns. The oxygen plant at one hospital was not grounded and could have caused a major explosion. At another hospital, a high voltage wire was laying across the driveway with a partially open connection on the ground. This could have caused deadly electrocution to anyone passing by. Both locations have since resolved these issues.



An electrical hazard found during the assessment at one hospital. It has since been corrected. Photo credit: Dalton Foundation

Box 1: Oxygen Generation Training Curriculum

- Module 1: General Overview and Pre-Installation Considerations
- Module 2: Overview of Oxygen Plant Operations
- Module 3: General Safety and Security
- Module 4: Oxygen Distribution
- Module 5: Policies and Procedures: Creation and Utilization of Documentation
- Module 6: Basic User Maintenance

Building Capacity for Oxygen Generation

Assessment results also informed the development of a training curriculum. The project trained 50 technicians and personnel from 14 facilities, including MOH biomedical technicians, in the operation and maintenance of oxygen generating equipment (including VSA and PSA plants) to strengthen health care system capacity to sustainably ensure optimal equipment use. The original plan was to hold four in-person workshops at different locations throughout Haiti. Due to the complex security situation in Port au Prince, only two in-person trainings were held in Cap Haitien and Les Cayes. For the other trainings, the project created the six-module [online course](#) Oxygen Generation for Haiti: Operations and Distribution, which included a baseline test and final exam (Box 1). The course was posted to an open-source online learning platform.

In-person trainings were conducted by EpiC project biomedical engineers in March 2023. Each technician was provided a workbook to follow along as they watched the training videos together as a group. The sessions were followed up with on-site maintenance visits by EpiC. Participants were encouraged to also complete the online course to deepen their understanding and to do so annually to refresh their skills.

Participants were eager to learn and highly engaged throughout the three-day training. The average final exam score increased from 69% at baseline to 85% after completing the training.



Participants at biomedical training in Les Cayes, March 15–18, 2023. Photo credit: EpiC/Dalton Foundation



Participants at biomedical training in Cap Haitian, March 6–10, 2023. Photo credit: EpiC/Dalton Foundation

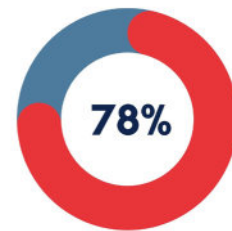
Online participation has been marginally successful. To date, 51 individuals have enrolled in the online course, 19 completed it. Five individuals are in progress and 27 have not yet started. Technicians who participated in the in-person training may have felt they learned enough there and did not see the benefit of completing the online course.

Due to the drastic increase of political instability and widespread gang violence throughout the country, EpiC has had to carefully plan each visit to ensure the safety and security of staff. The violence has caused significant delays to some aspects of the project, but at the same time required new and innovative ways to continue the technical training when travel has not been possible. Some of the changes the project was forced to make will benefit the oxygen ecosystem in the long term as online trainings will always be available to technicians and new hires.

Those who completed the online course provided positive feedback, including:



Said they would recommend the oxygen generation course to other technicians, biomedical engineers, or hospital personnel.



Said they would be interested in taking additional video training courses either online or in person

Ensuring Ongoing Management of the Oxygen Ecosystem

To effectively manage the oxygen network and ensure the oxygen generators are performing at optimum capacity, EpiC and partners have prioritized a three-pronged approach:

1. Making regular technical visits to perform preventive maintenance, troubleshoot mechanical failures, and perform on-site repairs
2. Conducting remote monitoring of the oxygen generators through video calls and collecting weekly production data
3. Operating a community of practice to provide technical training and best practices weekly, with project biomedical technicians available to answer questions

Technical visits to sites

Since March 2023, EpiC has visited all the sites to perform maintenance and repairs. As of June 2024, each site has received at least two visits. Six sites in the southern region received repairs in March 2023 and were revisited in October and November 2023. The eight sites in the northern region have received at least two maintenance and repair visits from July 2023 through January 2024, with some locations receiving additional visits as necessary.

In addition to routine maintenance, EpiC made special visits to Gonaives and Beraca as these sites had serious or unexpected mechanical issues. The technical team travelled twice to Gonaives in January 2024 to assist with installation of a new transformer to replace a damaged one. After this successful installation, EpiC organized a second visit to Gonaives in March 2024 to perform maintenance and repair work, which finally brought this site back up and running at full capacity. Thanks to this successful intervention in Gonaives, the health department of Artibonite can now produce oxygen to respond to the oxygen needs of the entire Artibonite department and the Hopital Immaculee Conception of Port de Paix in Nord-Ouest, a neighboring department.

Remote monitoring and support

Weekly remote monitoring of oxygen sites and video calls to alleviate mechanical issues has become critical in the face of the security crisis in Haiti. It is the sole technical support available for the southern region during times of increased instability. In early April 2024, Paillant site reported a motor compressor issue, causing a breakdown. EpiC spoke with the site operators to diagnose the problem and provide recommendations on how to fix the issue. Due to the skills of the operators in Paillant and remote support from EpiC, the oxygen generator was successfully repaired remotely. Now Paillant is the main provider of oxygen for the whole southern region, including Nippes, the Southeast, and Grand-Anse.

Community of practice


The community of practice is maintained through a WhatsApp group. MOH biomedical technicians, operators, and technicians of all the oxygen generator sites along with the EpiC technical team discuss technical issues impacting the proper functioning of the oxygen generators. Participation levels have increased significantly over the last three months with more than 50 individuals now active. Virtual trainings are provided weekly along with posting of training videos, links, and other oxygen-related content.

EpiC and partners will continue to provide maintenance and repair support to generators for the next several months and work to transition all aspects of their support to the MOH so the oxygen network in Haiti can thrive beyond the life of the project.

Reflections and Lessons Learned

- To expedite the procurement process and ensure correct parts and consumables were purchased, photographs of each piece of equipment, including both modality number and data plate were vitally important. To successfully maintain equipment the team determined that a large procurement would be necessary. Having photographs of the equipment ensured the project could check which parts were needed to save time and give the procurement team confidence in purchasing the correct parts for maintenance.
- To address the safety concerns identified in the assessment and minimize risk to staff and equipment, fire extinguishers and proper oxygen tank transportation carts were delivered to health facilities.

- To address the need for improved documentation, a logbook was developed and distributed to facilities. The logbook contains a daily preventive maintenance checklist, a daily safety and security checklist, a daily production log, and a maintenance and repair log for documentation over 12 months. A training video was developed to orient staff on proper use of each of the forms included as well as a detailed explanation of the importance and future use of the data being collected. Each site's technician completed an in-person logbook training when logbooks were delivered.
- Training programs should be tailored to each site. Understanding each location's production, processes, safety protocols, and training and maintenance plans helped inform the outline of the training curriculum. The project tailored the material specifically to the needs of the technicians involved. Further, in-person training provides excellent opportunities to ask questions, meet peers, and create camaraderie and lasting support among participants. In-person trainings were preferred by participants with higher attendance, completion rates, and knowledge gain compared to the online trainings.
- Technicians and operators are highly motivated to do their job despite facing challenging working conditions.
- Leadership is key to the success of each oxygen generator. Locations with engaged and supportive leadership are much more successful, and oxygen generators have much less down time. Stakeholder engagement and leadership at each site is also key in ensuring that safety violations are corrected, and safety remains a top priority.

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