



USAID
FROM THE AMERICAN PEOPLE

ENERGY BACKUP SYSTEMS MAINTENANCE TRAINING FOR HOSPITAL TECHNICIANS IN HAITI

Port-au-Prince, March 17-21, 2014

MARCH2014

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech Inc.

Table of Contents

- Summary 3
- Introduction..... 4
- Organization of the Training 5
 - Logistics 5
 - Participants 5
 - Instructors 6
- Course Structure and Content 7
 - Summary Agenda..... 7
 - Day 1 – Introduction, Loads/Batteries, Inverter and Wiring 7
 - Day 2 – Inverter and Wiring 8
 - Day 3 – NEC Presentation/ Introduction and Operation of Generators 8
 - Day 4 – Troubleshooting, Maintenance and Monitoring of Generators 9
 - Day 5 – Environmental section/ Practical Exercises 9
- Evaluation of the Training 11
 - Participants’ Evaluation and Comments 11
 - Summary and Recommendations..... 11
- Appendix A: List of Participants 12
- Appendix B: Training Agenda 13
- Appendix C: Invitation sent to Participants..... 14
- Appendix D: Training Materials Provided 15
- Appendix E: Evaluation of the Training by the Participants 16

Summary

To further ensure proper maintenance and improve chances for sustainability of the battery/inverter backup power systems and diesel generators installed in Haitian hospitals, USAID's Improving Health Facility Infrastructure (IHFI) project designed and implemented a five-day training workshop for hospital technicians. The seminar focused on the operation, maintenance and monitoring procedures for batteries, inverters and diesel generators, on how to dispose of the waste generated by battery/inverter installations and diesel generators, also, on how to follow the NEC to ensure proper operation and safety of electrical installations. IHFI worked with the Ministry of Health Project Management Unit (UGP) which sponsored and co-funded the training. Training materials were developed in French. IHFI staff and a local technical expert made up the teaching team.

Workshop materials and basic electrical tools were provided to each technician, and an interactive, one-day hands-on session was designed to meet the training objectives. In addition, participants were taught how to measure and log readings in logbooks and sheets designed for this purpose. Participants were also taught how to identify waste and protect better the environment.

Following are some of the key conclusions and achievements of this training workshop:

- 13 hospitals technicians were trained on operation, maintenance, environmental protection and data logging of batteries, inverters and diesel generator systems. Travel and expenses, including the hotel stay in Port-au-Prince for out-of-town technicians, were paid for all the participants by UGP; IHFI provided the cost of instructors, materials, organization and logistics.
- Overall, the participants were very satisfied with the instructors, the logistics and the topics covered, as seen in the completed evaluation questionnaires.
- Data collection and logging, in addition to providing valuable data on operations, challenges technicians to be responsible and know their equipment better; this is one of the underpinnings of the IHFI program in Haiti.
- The team used, expanded and built a French version of the curriculum materials instead of the Creole curriculum materials that had been developed for previous workshops.
- Participation of the Ministry of Health was a key contribution to the success of this workshop.

Introduction

As part of USAID's Improving Health Facility Infrastructure (IHFI) program in Haiti, Tetra Tech (Tt) worked with the Project Management Unit (UGP) of the Haitian Ministry of Health and Population (MSPP) to organize and deliver a basic-level training workshop for MSPP hospital technicians on environmental protection, maintenance and upkeep of batteries, inverters and diesel generators. The workshop, spanning five full days, had the following objectives:

- Expand knowledge of operation, maintenance and monitoring of batteries, inverters and diesel engine generators to ensure maintenance and improve chances for sustainability of the installed units in Haitian hospitals.
- Evaluate the technicians' knowledge of operation, maintenance and monitoring of batteries, inverters and diesel engine generators to better tailor future trainings to their needs.
- Continue to develop and test a basic training approach and curriculum that can eventually be repeated in country to reach all MSPP and other health facility technicians.
- Continue the development of a local in-country instructor capacity for future technician trainings, where much of this capacity could reside.
- Introduce the concepts and habits of measurement, logging and documentation of key operating parameters of diesel generators, as part of a process to develop databases of system performance throughout MSPP health facilities.
- Introduce the notion of environment protection to ensure that technicians' works have no negative impact on the health and the well-being of the population.

Organization of the Training

Logistics

The training took place on March 17- 21, 2014 at the UGP facilities in Port-au-Prince, Haiti. Thirteen technicians from all over Haiti were invited to participate. Organization and funding were shared between IHFI and UGP: UGP paid for the welcome ceremony, the lodging, and the technicians' travel to Port-au-Prince, while IHFI covered the per diem for the participants, catering, and paid for instructors and materials. On the last day of the training, Tetra Tech used UGP's generators for practical exercises, (the two generators of 12 kW).

After the class, maintenance tools (wrenches, wire connectors, funnels, electrical tape, screwdrivers...) were given to UGP to distribute to each hospital. The full list of instruments can be found in Appendix C. Certificates of course completions were provided by IHFI on the last day of the training.

Participants

Thirteen technicians from 10 different hospitals and the Ministry of Health (MSPP) attended the five-day training. The full list of participants can be found in Appendix A.



Exhibit 1: Group picture of the participants at UGP

Instructors

The seminar was opened by Ndeye K. Fall (IHFI's Manager). The battery and inverter sections were taught by Jude Juste and Loby Gracia. The environmental section was presented by Jacnord Augustin and NEC sections were presented by Lesly Theard and Ronick Dieudonné respectively. Finally, the generator section was instructed jointly by Ronick Dieudonné and Frantz Gilbert. All sections were instructed in French and creole.

Battery/Inverter - Jude Juste is an electrical engineer on the IHFI project with 3 years of experience in the sizing, design, installation, commissioning and maintenance of battery/inverter systems, with specific experience in Outback inverter installations.

Environmental Management - Jacnord Augustin is an environmental engineer on the IHFI project with over 10 years of experience in environmental management.

Generator - Frantz Gilbert is the owner and principal technical expert of Services Professionels, a Haitian firm that specializes in repair and maintenance of diesel generators. With more than 20 years of experience, he supervises approximately 15 technicians that service equipment and provide emergency repairs throughout the country.

National Electric Code (NEC)/Generator- Ronick Dieudonne is an electrical engineer on the IHFI project with several years of experience in diesel generator operations and maintenance.



Exhibit 2: Delivery of the certificates by UGP and Tetra Tech Leaders (left); Welcome speech by Ndeye K. Fall, IHFI's Manager (right)

Course Structure and Content

Summary Agenda

The first four days of the seminar consisted of Power Point presentations on environmental protection, battery/inverters,diesel generators and the safety measures on the National electrical code, while the last day was dedicated to practical exercises. The following table provides a brief description of the course structure. The detailed agenda of the training can be found in Appendix B.

Day #	Title	Instructors
Day 1	<ul style="list-style-type: none"> • Basics of electricity • Loads • OutBack inverter MATE display • Wiring 	Jude Juste;
Day 2	<ul style="list-style-type: none"> • Battery calculation exercises • Battery practical exercises <ul style="list-style-type: none"> - MATE logging lab - Battery maintenance lab - Multi-meter lab 	Jude Juste ; Loby Gratia
Day 3	<ul style="list-style-type: none"> • Overview of the National Electrical Code (NEC) • proper installation and maintenance practices of inverter/battery systems • Lead and health • Waste Management • Installing, Placing and recycling of batteries • Negative effects of some battery's substance on the environment 	Lesly Theard,Ronick Dieudonné ; Jacnord Augustin
Day 4	<ul style="list-style-type: none"> • General description of generators • How to start and stop a generator • Batteries Control board • Most frequent problems • Safety measures • Maintenance/ Logging 	Ronick Dieudonné; Frantz Gilbert
Day 5	<ul style="list-style-type: none"> • Generator practical exercises: <ul style="list-style-type: none"> - Identify generator parts - Maintenance procedures - Logging 	Ronick Dieudonné; Frantz Gilbert

Day 1 – Introduction, Loads/Batteries, Inverter and Wiring

The first half of the day consisted of a basic introduction to the seminar. The participants first completed a registration form to provide data on their education, experience background, and the type of

inverters, batteries and generators they are in charge of at their hospital. The instructors then reviewed the basics of electricity, electrical terminology and the methodology for battery equalization, followed by an introduction to navigating the OutBack inverter MATE display (e.g., turning the inverter on and off, reading the LED lights on the MATE, finding errors and warning screens).

The instructor spent the afternoon on understanding proper wiring rules (e.g., color coding of wires, where to place disconnects, how to size overcurrent protection (breakers and fuses) to wire size, basics of equipment and system grounding, and the importance of not having exposed splices).

Day 2 – Inverter and Wiring

The Instructor started the second day of the seminar with an informal written quiz of the previous day, with a series of questions such as: “List 3 things that you need to monitor and log each day; each month” ; “How much water should there be in your batteries before equalizing?” ; “What does the green flashing light on the FNDC mean?” A mistake was discovered in a logbook EQ graphic which showed fully watering the batteries before EQ – instead of just assuring the water was over the plates.

The last part of the Day was devoted to calculation exercises with loads of simple calculators led by participants, they explained on a rotating basis the Mate process. For the hands-on activity, the students split up into two groups of about five people. Each group had two inverters and MATE in a separate room. They practiced navigating the MATE and finding the following points: 1) Starting and stopping an equalization; 2) Finding the daily log values of battery voltage and state of charge; 3) Finding the Error messages; 4) Finding the Warnings messages; 5) Finding battery temperature (a NEW setpoint for EQ logs).

Day 3 – NEC Presentation and Environmental Section

During the first half of the Day, the instructor talked about NEC compliance and safety. First, he covered the basics of electrical circuits including topics such as AC and DC, transformers, inductance, circuits, resistors, voltage drop, and generators. He then presented an overview of the National Electrical Code chapters and the importance of following the code for safety and good practice. He reviewed wire and breaker sizing, conduit use, and grounding.

In the afternoon, the instructor used a Power Point presentation with diagrams and pictures; He made a brief review of the effect of sulfuric acid on the environment and explained the following topics:

- Effect of lead on health
- Where to find lead
- Quantity of lead in batteries
- The recycle of lead-acid battery
- How to use battery in end of life

He listed environmental problems related to the batteries such as: the effect of sulfuric acid on health and the environment (e.g., in case of ingestion: may cause death; in contact with skin causes irritation; in soil: contaminates groundwater; in the air: can produce "acid rain", burns plants and animals). They explained the effects of the Generator and fluorescent lamps on the environment such as fuel leaks, waste oils, mercury, ballast, and the most common issues with generators, the main causes of these problems and the appropriate corrective measures. Then, they described all the safety measures required and stressed the importance of maintaining a clean environment around generators.

Day 4 – Operation of Generators and Troubleshooting/Maintenance of Generators

In the first half of the day, the instructors used a Power Point presentation with diagrams and pictures for the generator section. First, they gave a general introduction to generators covering the following topics:

Chapter 1: General description of generators

- Basic operation of generators
- Most popular brands of generators in Haiti
- How to read generator ID tags
- Main components of generators: motor, alternator, etc.
- Speed and frequency
- Main systems: air, fuel, oil and water for cooling

The Instructor explained the proper procedures for starting and stopping a generator, and how to read and navigate control boards.

Chapter 2 and 3: How to start, stop a generator and control board

- Parameters to check before starting a generator (oil, water, fuel, battery)
- Start procedure
- Parameters to check after starting a generator (alarm, voltage on each phase, frequency, temperature, oil pressure, battery voltage)
- Stop procedure
- Most common control boards
- How to read and navigate control boards

In the afternoon, the Instructor explained the most common issues with generators, the main causes of these problems and the appropriate corrective measures. Then, they described all the safety measures required and stressed the importance of maintaining a clean environment around generators. The course followed with detailed explanations accompanied by simple drawings on how to perform maintenance.

Chapter 4: Most common issues with generators

- Discharged battery
- Over-heating
- Unbalanced phases
- Old fuel

Chapter 5: Safety and maintenance

- Safety measures
- Importance of cleanliness
- Maintenance (change oil, fuel and air filters, and oil)

Day 5 – Monitoring Generators and Practical Exercises

During the first two hours of the day, the instructor provided a brief reminder of the previous day and continued with the logging chapter. The technicians were provided with a logging booklet including daily logging sheets and logging sheets for every 250 operating hours.

Chapter 6: Logging

- Importance of logging
- Daily logging
- Logging every 250 operating hours

The last part of the Day was dedicated to practical exercises on generator and evaluation test on battery / inverter and generator. IHFI used the battery / inverter system installed at UGP by the Tetra Tech team and the two 12 kW generators of UGP. For the generator practice, the group of participants was divided in four groups, groups of four participants rotating on the different exercises:

Generator practical exercises and evaluation test

- Identification of the main components of generators
- Maintenance procedures (change oil, change oil filter)
- Logging
- Discussion and questions



Exhibit 4: Generator maintenance session led by Professional service on the generator (left) and Battery/Inverter session (right)

The full list of training materials provided to the participants, as well as some examples, can be found in Appendix D.

Evaluation of the Training

Participants' Evaluation and Comments

All the participants filled out an evaluation form; results are provided in Appendix D. Instructors got excellent marks, ranging from 4.38 to 4.8. Similarly the topics covered were in line with the participants' satisfaction, marks ranged from 4.0 to 4.4 out of 5, except for the sessions on the most common issues of generators. In terms of logistics, the participants were satisfied by the organization (4.0), food (3.8), tool kit (1.4), documents (3.9) and classroom (4.3).

Summary and Recommendations

Overall, the training was a success. The technicians were satisfied with the topics covered, and they had time to ask specific questions and actually practice maintenance procedures under guidance during the hands-on exercises. They were also thrilled to receive the tools that they were given at the training. An important contribution of this training is an improved contact and communication with technicians in the field, leading to better monitoring of backup system performance, and telephone troubleshooting in case of problems.

A number of areas were identified as lessons or items to follow-up to improve future trainings:

- 1) Training partner: The classroom was held at UGP's training facility and the main classroom was very good to accommodate 13 students plus desks, IHFI's Team, lab equipment, projection screen and dry erase board.
- 2) Training follow-up: It is recommended that the IHFI team call each hospital technician and/or conduct follow-up site visits to review and assist them in generator maintenance also when they want an EQ charge to happen on the hospital's batteries. IHFI needs to keep a log of the date in which each hospital site performs an EQ and how long the EQ has lasted. Repeat or more advanced trainings for the same technicians could be offered annually.
- 3) Training material: It would be useful for the instructors to meet one day in advance and conduct a mock training in order to go over the different teaching styles and review some basic teaching methodologies. This would also help to improve coordination between the different instructors' interventions.

Appendix A: List of Participants

#	Nom	Prenom	Hospital	Department	Telephone
1	Alcius	Jean Roland	Hopital Communautaire Grande Rivière du Nord	North	3841- 2921
2	Lormil	Westin	CSPL/ MSPP	West	3877- 2788
3	Jovin	Garry	CSL- Marigot (Jacmel)	SouthEast	3609- 1996
4	Fanfan	Gusnel	Centre de Santé St Michel	West	3609- 0264
5	Victor	Jean Ilfrade	Bureau Communautaire Ennery	West	3781-1271
6	Louis	Laurore Charlemagne	UGP	Southwest	3756- 6066
7	Dauphin	Patrick	DSSE	Southwest	3743-8289
8	Jn Baptiste	Jacson	CAL, Pestel Jeremie	Grand Anse	3780-0496
9	Leon	Dieubeni	BCS/ Croix des Bouquets	West	3748-8473
10	Severe	Mario	BCS/ Croix des Bouquets	West	3483-8370
11	Blanfort	Djames	CHAPI	West	3743-5855
12	Dorleus	Frantzcy	MCDB	West	3637-9088
13	Gervé	Widly Vickens	UGP	West	

Appendix C: Invitation sent to Participants



UNITE DE GESTION DU PROJET MSPP/PEPFAR



Port-au-Prince, le 28 Février 2014

Objet: Invitation

Madame, Monsieur,

Par la présente, on vous informe que L'Unité de Gestion du Projet MSPP/PEPFAR en partenariat avec le Programme d'Amélioration des Infrastructures des Centres de Santé (IHFI) d'USAID organise le séminaire de formation niveau 2, «**Techniques de maintenance et de monitoring des systèmes électriques**». Cette séance de formation vise les techniciens en charge de la maintenance et du support électrique des sites du programme MSPP/PEPFAR bénéficiaires de l'installation d'un système électrique dans le cadre du programme de renforcement des infrastructures de santé.

Le séminaire se tiendra, du **17 au 21 Mars 2014** de 8 heures AM à 4 heures PM, au local centre de formation de l'UGP, sis à Delmas 81 #10.

Veillez s'il vous plait soumettre les noms des techniciens de votre équipe de maintenance, qui ont déjà reçu la formation niveau 1 afin qu'ils puissent participer au niveau 2, par email à assistance@ugp.ht ou par téléphone au [\(509\)2813-2973/2813-2974](tel:(509)2813-2973/2813-2974) avant le 10 Mars 2014.

Veillez recevoir, Madame, Monsieur, nos salutations distinguées.

Luc Moïse Wedner **PIERRE**, MD/MPH
Directeur Exécutif

Appendix D: Training Materials Provided

The following documents were distributed to all the participants

- Notebook including the battery/inverter and generator presentations
- Logbook with daily and monthly logs for the battery/inverter system and generator
- Environmental management presentation
- National Electric Code (NEC) presentation

The following tools were given to UGP for distribution to the hospital administrator (one bag per hospital):

- Multimeter
- Oil filter wrench
- Adjustable wrenches
- Screwdrivers
- Funnel
- Metallic brush
- Electrical Tape
- Klein Tools
- Bag
- Hex Key
- Tools vice
- Digital Clamp Meter



Tools distributed to UGP for distribution to the hospital administrator (one bag per hospital)

Appendix E: Evaluation of the Training by the Participants

Legend	
1	Very bad
2	Not good
3	Average
4	Good
5	Excellent

#	Name	First Name	Instructors					
			Lesly	Jude	Ronick	Frantz	Jacnord	Loby
1	Alcius	Jean Roland	5	5	5	5	5	5
2	Lormil	Westin	5	5	5	5	5	5
3	Jovin	Garry	4	5	5	5	4	4
4	Fanfan	Gusnel	5	5	5	5	5	5
5	Victor	Jean Ilfrade	5	5	5	5	5	5
6	Louis	Laurore Charlemagne	5	5	5	5	4	5
7	Dauphin	Patrick	4	4	4	4	4	4
8	Jn Baptiste	Jacson	4	4	4	5	4	3
9	Leon	Dieubeni	5	5	5	5	5	5
10	Severe	Mario	5	5	5	5	5	5
11	Blanfort	Djames	4	4	4	5	3	4
12	Dorleus	Frantzcy	4	4	4	4	3	
13	Gervé	WidlyVickens	5	5	5	5	5	5
Average			4.6	4.7	4.7	4.8	4.38	4.6

LOGISTICS

#	Food	Classroom	Documents	Tools	Organization
1	4	5	5	5	4
2	4	5	5	4	4
3	4	4	4	4	4
4	4	4	4	4	4
5	4	4	5	5	5
6	4	4	4	4	5
7	4	4			
8	4	4	5	5	5
9	3	5	4	4	4
10	3	4	5	5	5
11	4	4	5	5	5
12	4	4	4	4	4
13	4	5	5	5	5
Avg	3.8	4.3	3.9	1.4	4.0

TOPICS – BATTERY/INVERTER

#	Loads	Battery maintenance	Battery equalization	MATE	Wiring
1	5	4	4	4	4
2	5	5	4	4	5
3	5	5	5	5	4
4	4	4	4	4	4
5	4	4	4	4	4
6	5	5	5	5	4
7	4	4	4	4	4
8	5	5	4	5	5
9	5	5	5	5	4
10	4	4	3	4	4
11	2	2	1	2	3
12	4	4	4	4	4
13	5	5	5	5	5
Avg	4.4	4.3	4.0	4.2	4.2

TOPICS - GENERATOR

#	General description	Start/Stop	Control board	Issues	Maintenance	Logging
1	4	4	4	4	4	4
2	4	4	4	4	4	4
3	5	4	4	4	4	5
4	4	4	4	3	4	4
5	4	4	4	3	4	4
6	4	5	4	4	4	4
7	4	4	4	4	4	4
8	5	4	4	4	5	5
9	4	4	4	5	5	4
10	3	3	3	4	3	3
11	4	4	4	4	4	4
12	4	4	4	4	4	4
13	5	5	5	5	5	5
Avg	4.2	4.1	4.0	4.0	4.2	4.2

TOPICS - ENVIRONMENTAL

#	General description	Acid Sulfuric effect on the Environment	Batteries Issues on the Environment	Fire and Explosion risk	Generator Issues on the Environment
1	4	5	5	5	5
2	5	5	5	5	5
3	4	4	4	4	4
4	4	4	4	4	5
5	4	4	4	4	4
6	4	4	4	4	4
7	4	4	4	4	4
8	4	4	4	4	4
9	4	3	4	3	4
10	4	4	4	4	3
11	4	4	4	3	5
12	4	4	4	4	4
13	5	4	4	4	4
Avg	4.2	4.1	4.2	4.0	4.2

PRACTICAL EXERCISES

#	Kill-a-watt meter	Battery	MATE	Generator - general	Generator - maintenance
1	4	4	4	5	5
2	4	5	4	5	4
3	5	5	5	5	5
4	4	4	4	4	4
5	4	4	4	4	4
6	5	5	4	4	4
7	4	4	4	4	4
8	4	5	5	5	5
9	4	5	5	5	5
10	4	3	4	2	2
11	4	4	4	3	3
12	3	4	3	3	2
13	5	5	5	5	5
Avg	4.2	4.4	4.2	4.2	4.0

U.S. Agency for International Development
1300 Pennsylvania Avenue, NW
Washington, DC 20523
Tel: (202) 712-0000
Fax: (202) 216-3524
www.usaid.gov