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# ENERGY BACKUP SYSTEMS MAINTENANCE TRAINING FOR HOSPITAL TECHNICIANS IN HAITI

Port-au-Prince, May 21-25, 2012

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## Summary

To ensure 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 training workshop for hospital technicians. The seminar focused on the operation, maintenance and monitoring procedures for batteries, inverters and diesel generators. IHFI worked with the Ministry of Health Project Management Unit (UGP) which sponsored and co-funded the training, including bringing 26 hospital technicians and other technical staff from facilities throughout Haiti to Port-au-Prince for five days of training. Training materials were developed in Creole, and IHFI staff and two local technical experts 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.

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

- 26 hospital technicians were trained on operation, maintenance 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 and organization and logistics.
- Overall, the participants were very satisfied with the instructors, the logistics and the topics covered, as evidence by 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 reused, expanded and built upon the Creole curriculum materials that had been developed for previous workshops.
- Participation of the Ministry of Health and a local vocational school were key contributors to the success of this workshop, and to the expected continuation of additional workshops.

## 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 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 development of a local in-country instructor capacity for future technician trainings, including a local vocational school, Haiti Tec, 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.

The seminar was part of a long-term training program which already includes the following workshops:

#	Dates	Subject covered		Participants
		Battery/Inverter	Generator	
1	May 2010	1 day	-	12 technicians
2	March 2011	3 days	1 day	21 participants
3	December 2011	3 days	2 days	16 participants
4	March 2012	-	3 days	18 participants
5	May 2012	2.5 days	2.5 days	24 participants

# Organization of the Training

## Logistics

The training took place on May 21-25, 2012 at the Haiti Tec facilities in Port-au-Prince, Haiti. Twenty-six 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, the bus transport between hotel and Haiti Tec, and the technicians' travel to Port-au-Prince, while IHFI covered a small per diem for the participants, and paid for instructors, materials and the participation of Haiti Tec and their facilities. On the last day of the training, the Tt team rented one generator of 40 kW for practical exercises.

As part of the class, each participant received a binder with course materials and logging sheets to be completed. Each participant also received a tool kit with general tools (e.g., kill-a-watt meter, voltage tester, outlet wiring tester, electrical tape, wire connectors, safety goggles, gloves), battery tools (e.g., metallic brush, pipette, hydrometer), and generator tools (e.g., multimeter, wrenches, screwdrivers). The full list of instruments can be found in Appendix C. Certificates of course completion were provided by UGP on the last day of the training.

## Participants

Twenty-six technicians from 17 different hospitals, the Ministry of Health (MSPP) and Haiti Tec attended the five-day training. The full list of participants can be found in Appendix A.



Group picture of the participants and the instructors

## Instructors

The battery/inverter section of the training was instructed by Jude Juste (Tt) and Loby Gratia (Tt), and the generator section was taught by Ronick Dieudonne (Tt), Franz Gilbert (Services Professionnels) and Armand Gerald (Haiti Tec). All sections were instructed in Creole.

**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.

**Loby Gratia** is an electrical technician on the IHFI project with nearly 20 years of experience with electrical installations and inverter repair.

**Ronick Dieudonne** is an electrical engineer on the IHFI project with several years of experience in diesel generator operations and maintenance.

**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.

**Armand Gerald** is an independent expert on diesel generators and generator systems who teaches this subject at Haiti Tec.



IHFI employees and technical experts instructing hospital technicians with Power Point presentation (left) and hands-on battery labs (right)

## Course Structure and Content

### Summary Agenda

The first four days of the seminar consisted of Power Point presentations on battery/inverters (2 days) and diesel generators (2 days) 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"> <li>• Basics of electricity</li> <li>• Loads</li> <li>• Batteries</li> </ul>	Jude Juste; Loby Gratia
Day 2	<ul style="list-style-type: none"> <li>• OutBack inverter MATE display</li> <li>• Wiring</li> </ul>	Jude Juste; Loby Gratia

Day 3	<ul style="list-style-type: none"> <li>• General description of generators</li> <li>• How to start and stop a generator</li> <li>• Control board</li> </ul>	Ronnick Dieudonné; Frantz Gilbert ; Armand Gerald
Day 4	<ul style="list-style-type: none"> <li>• Most frequent problems</li> <li>• Safety measures</li> <li>• Maintenance</li> <li>• Logging</li> </ul>	Ronnick Dieudonné; Frantz Gilbert ; Armand Gerald
Day 5	<ul style="list-style-type: none"> <li>• Generator practical exercises: <ul style="list-style-type: none"> <li>- Identify generator parts</li> <li>- Maintenance procedures</li> <li>- Logging</li> </ul> </li> <li>• Battery practical exercises <ul style="list-style-type: none"> <li>- MATE logging lab</li> <li>- Battery maintenance lab</li> <li>- Multi-meter lab</li> </ul> </li> </ul>	Ronnick Dieudonné; Loby Gratia; Frantz Gilbert and a technician from Services Professionnels  Jude Juste; Loby Gratia

### Day 1 – Introduction, Loads and Batteries

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 and electrical terminology, followed by the methodology for battery equalization. In the afternoon, the participants completed simple load calculation exercises with calculators, and studied the procedures for battery maintenance other than equalization.

### Day 2 – Inverter and Wiring

The second day was dedicated 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) and 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 3 – Introduction and Operation of Generators

During the first two days of the generator section, the instructors used a Power Point presentation with diagrams and pictures. 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

In the afternoon, the instructors explained the proper procedures for starting and stopping a generator, and how to read and navigate control boards.

#### Chapter 2: How to start and stop a generator

- 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

#### Chapter 3: Control board

- Most common control boards
- How to read and navigate control boards

### Day 4 – Troubleshooting, Maintenance and Monitoring of Generators

The second day of the generator section was dedicated to troubleshooting, safety, maintenance and monitoring of generators. First, the instructors 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. Finally, the technicians were provided with a logging booklet including daily logging sheets and logging sheets for every 250 operating hours.

#### 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)

#### Chapter 6: Logging

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

### Day 5 – Practical Exercises

The last day of the training was dedicated to practical exercises on both battery/inverter and generator. It used the battery/inverter system installed at Haiti Tec for the first seminar in early 2011. It rented a

40 kW generator for the day from a local company, Technomoteur. The group of participants was divided in two, and then by groups of three participants rotating on the different exercises:

#### Battery/inverter practical exercises

- Multimeter
- Battery maintenance (hydrometer reading and equalization procedure)
- MATE reading and logging

#### Generator practical exercises

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



Generator maintenance session led by Service Professionnels on the rented generator

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

# 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, averages ranged from 4.5 to 4.8 out of 5. Similarly the topics covered were in line with the participants' satisfaction, average marks ranged from 4.3 to 4.5 out of 5 for the battery/inverter section and 4.3 to 4.8 for the generator section, except for the topic of the most common issues with generators (3.8). This section also received the lowest grade during the March 2012 training. The hands-on sessions received very good average grades ranging between 4.4 and 4.8.

In terms of logistics, the participants were very satisfied by the organization (4.6), documents (4.6) and tool kit (4.3). The participants were more satisfied with the new classroom (4.3 instead of 3.6) and with transport (4.0 instead of 3.5) compared to March 2012. However, they were still not very satisfied with the hotel (3.5) and the food (3.3).

Regarding the topics that should be covered again in future seminars, for the battery/inverter section, the technicians mentioned predominantly the MATE (listed by 11 technicians), wiring (9) and battery equalization (8), followed by loads (4) and battery maintenance (3). For the generator section, they listed first the most common issues with generators (16) and the control board (11), followed by logging (4), how to start/stop (3), general description and maintenance (2). Finally, for practical exercises, the MATE came up first again (14), followed by generator maintenance and logging (8), kill-a-watt meter (7) and battery (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: This fourth workshop confirmed that Haiti Tec looks to be a good partner for trainings. Their facility is in a good location near the airport in Port-au Prince, they have a supportive administrative team, and they already have a program that teaches similar classes. Two instructors from Haiti Tec attended the training and one jointly taught the generator session.
- 2) Training facility: Future training should be conducted in the classroom used during this seminar instead of the classroom with the inverter/battery system because it has air conditioning and more space. Special effort should be made in future training to increase the quantity and diversity of the food provided for lunch.
- 3) Training follow-up: It is recommended that the Haiti Tt team call each hospital technician and/or conduct follow-up site visits to review and assist them in battery and generator maintenance.

Repeat or more advanced trainings for the same technicians could be offered annually. The same training should also be offered to new technicians.

- 4) Training material: Tetra Tech will review and improve the training material on the most common issues with generators because the topic received the lowest grade and the highest demand to cover the subject again in future training.

## Appendix B: Training Agenda

Monday, May 21	Tuesday, May 22	Wednesday, May 23	Thursday, May 24	Friday, May 25	
<p><b>Welcome</b></p> <p><b>Test</b></p> <p><b>Basics of electricity</b> Terminology review</p> <p><b>Loads</b></p> <ol style="list-style-type: none"> <li>1. Load analysis</li> <li>2. Energy efficiency</li> <li>3. Phantom Loads</li> <li>4. Kill-a-watt meters</li> <li>5. LAB using meters</li> </ol>	<p><b>MATE Summary Screens</b></p> <ol style="list-style-type: none"> <li>1. Reading MATE summary screens</li> <li>2. Understanding charging and discharging</li> <li>3. Summary Screen Exercise</li> </ol>	<p><b>Introduction to Generators</b></p> <p><b>General description of generators</b></p>	<p><b>Most frequent problems with generators</b></p> <p><b>Safety measures</b></p> <p><b>Maintenance</b></p>	<p><b>Practical exercises on generators</b></p> <ol style="list-style-type: none"> <li>1. Identify generator parts</li> <li>2. Maintenance (change oil, oil filters, etc.)</li> <li>3. Logging practice</li> </ol>	<p><b>MATE LAB: Logging Review</b></p> <ol style="list-style-type: none"> <li>1. Error screens</li> <li>2. Monthly logging</li> </ol> <p><b>Battery LAB</b></p> <ol style="list-style-type: none"> <li>1. How to use a hydrometer</li> <li>2. How to start an EQ charge</li> </ol> <p><b>MATE LAB: Logging</b> Checking &amp; recording daily logs</p>
Lunch	Lunch	Lunch	Lunch	Late Lunch	
<p><b>Batteries</b></p> <ol style="list-style-type: none"> <li>1. Battery Review</li> <li>2. Checking if your battery is full</li> <li>3. Equalization</li> </ol> <p><b>Day 1 review</b></p>	<p><b>Wiring</b></p> <ol style="list-style-type: none"> <li>1. Wiring, breakers/fuses, grounding</li> <li>2. Good &amp; bad wiring practices</li> </ol> <p><b>Day 2 review</b></p>	<p><b>How to start and stop a generator</b></p> <p><b>Control Board</b></p> <p><b>Day 3 review</b></p>	<p><b>Logging</b></p> <p><b>Discussion</b></p> <p><b>Day 4 review</b></p>	<p><b>Test</b></p> <p><b>Final discussion and test</b></p> <p><b>Distribution of certificates</b></p>	

## Appendix C: List of Training Materials Provided

The following documents were distributed to all the participants as handout material:

### 1) A binder in Creole with the following course material:

#### **Battery/Inverter section**

- a. Cover
- b. Agenda
- c. Initial quiz
- d. Exercises on load (table to fill in and slides)
- e. Questions of phantom loads
- f. Slides and tables on kill-a-watt meter
- g. Slides on battery maintenance
- h. Slide on battery reading from inverter
- i. Slides on MATE Summary Screens
- j. How to read DSF
- k. Example questions
- l. Slides on wiring
- m. Graphic summary of warnings and errors
- n. Graphic summary of battery maintenance
- o. Graphic summary of examples systems and alarms

#### **Generator section**

- p. Cover page
- q. Chapter 1: General description of generators
- r. Chapter 2: How to start/stop generators
- s. Chapter 3: Control board
- t. Chapter 4: Most common issues
- u. Chapter 5: Safety and maintenance measures
- v. Chapter 6: Logging
- w. References
- x. Test questions
- y. Daily logging sheets and logging sheets for every 250 operating hours for approximately one year

Examples of some of the slides can be found below.

### 2) A logging book with the following logs:

- a. Cover (1 page)
- b. Duties Summary (1 page)
- c. 12 x daily log (31 line, i.e., a month per page) (12 pages)
- d. 12 x monthly log (31 line, i.e., a month per page) (12 pages)

- e. Equalization procedure (4 pages)
- f. Hydrometer diagram (1 page)
- g. Battery diagram (1 page)
- h. 12 x Equalization log (2 x 12 = 24 pages)
- i. 12 x Generator log (31 line, i.e., a month per page) (12 pages)
- j. 3 x Generator log every 250 hr (4 tables per page) (3 pages)

**3) A tool kit including the following:**

**General tools**

- a. Calculator
- b. Kill-a-watt meter
- c. Voltage tester
- d. Outlet wiring tester
- e. Electrical tape

**Battery tools**

- f. Hydrometer
- g. Funnel
- h. Pipette
- i. Metallic brush
- j. Safety goggles

**Generator tools**

- k. Multimeter
- l. Oil filter wrench
- m. Adjustable wrenches
- n. Screwdrivers
- o. Electrical tape



Tool kits distributed to each participant

Some of the Power Point Presentation on battery/inverter O&M used during the seminar and distributed to the participants

### Enstalasyon batri e Antreyen

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### Elektrolit

- ~ 25% asid silfirik, 75% dlo
- Mete dlo distile sèlman
- Si asid silfirik la soti, reaksyon chimik la pap kapab fèt byen
- Kenbe yo lwen de tout sa ki ka kontamine yo

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### Netwayaj kouvèt batri yo

- Kenbe yo pwòp, lwen ak salte, pousyè ak tout sa ki ka kontamine yo
- Pa netwoye kouvèt batri yo ak bikabonat
- Gwo salte ka lakoz yo dechaje pou kont yo

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### Netwayaj Korozyon

- Netwoye tèminal yo ak bròs fil
- Pa netwoye kouvèt batri yo ak bikabonat.

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### Tchèk Dlo

- Chaje twòp ou dechaje twòp ka lakoz gaz la pa degaje
- Pa janm kite plak la ekspoze
- Pa mete twòp dlo anvan batri a chaje

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### Kontwòl Kapte tanperati

- Yon tanperati cho anpil kapab chaje batri a twòp
- Batri yo ta dwe omwen yon pous youn ak lòt
- Mete kapte a nan mitan ban batri a

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### Metòd Fil elektrik

Pou debranche yon inverter

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### Anvan w malyen oubyen Pase fil elektrik nan batri

© 2011 C/Inwa/UC & L/Inwa

### Aprè Enstalasyon

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### Ki jan batri a konplè?

Tcheke 3 paramèt sa yo:

- Eta chaj la
- Vòltaj batri a
- Jou depi li plen

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### Eta chaj la (% S.O.C.)

- Konstan, eke estab
- Li pa change byen vit e w mete chaj oubyen a li ap chaje
- Li lakize le w mete, ouyen retire ampè a nan batri a
- Li disponn sèlman le FNDC monte a eke li nan sistèm nan

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### Lekti SOC OutBack yo

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### Problèm nan Lekti SOC OutBack yo

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### Fèmen inverter a sou Mate la

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### Sistèm Operasyon

Ki li inverter a dwe fèmen sou Mate la?

- Pou reyajiste yon paramèt
- Lè w ap travay nan fil elektrik AC yo oubyen nan chaj yo
- Lè batri yo ba anpil (pou anpeche yo dechaje plis)

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### Sistèm Operasyon

Ki li brekè inverter a Dwe fèmen?

- Lè w ap dekonekte fil elektrik yo nan batri a
- Lè w ap retire yon inverter pou repare
- Lè w ap travay nan fil elektrik sou sistèm DC a

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### Vòltaj Batri

Batri ap chaje (14.0V)

Batri ap repoze (13.5V)

Batri ap dechaje (13.0V)

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### Jou depi li plen

FNDC Paramèt "Chaj"	Konsiy tipik
DC BAT 18.0V 100%	2% nan kapasite batri e
BAT 2.8A 0.16000	1/3 anvan vòltaj asidè a
BAT 0.00000	Pou plis pase 2 èdtan
BAT 0.00000	

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### Jou depi li plen

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MATE Summary Screens



Source: A-M-Ping ©2017 Civeau & Livens

Day 1, 11:05AM



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1

Day 1, 3:53PM



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3

Day 2, 7:45AM



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4

Day 2, 9:10 AM



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5

Day 2, 3:37PM



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6

Day 2, 4:02PM



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7

### Pase fil Kouran

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1

### Bwat Brekè

- Lòd
- Kòd koulè
- Kanal
- Kite fil siplemantè

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2

### Koneksyon Fil kouran

- Fè rakò nan yon bwat
- Sekirize tout koneksyon yo
- Pa kite tèminal yo ekspoze

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3

### Dekoneksyon

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4

### Dekoneksyon & Brekè yon OutBack

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5

### Brekè pwoteksyon kont gwo kouran

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6

### Proteksyon kont gwo kouran

Gwoò Fil kouran	Amps (at 75°F)	Brekè estanda/ gwoò filab
14	20	15
12	25	20
10	35	30
8	50	50
6	65	60
4	85	80
2	115	110
1/0	150	150
2/0	175	175
4/0	230	225, 250

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### Prekasyon

1,800 W Load:  $1,800W = 15A \times 12V$   
 $15A \times 1.25 = 20A$

1,440 W Load:  $1,440W = 12A \times 12V$   
 $12A \times 1.25 = 15A$

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### Lè vòltaj bese

Delko — 100' — Chaj

Delko — 200' — Chaj

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9

### Move grawon

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10

### Kout zèklè

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11

### Ekipman nan yon sistèm grawon

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12

### Ekipman nan yon sistèm grawon

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13

### "sistèm grawon"

Connect negative to ground at only one point on DC side

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14

### "sistèm grawon"

Connect white wire to ground at only one point on AC side

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15

### Fil kouran AC yo

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16

### Jan envètè a transfere

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17

### kominikasyon ant envètè yo

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Power Point Presentation on generator maintenance used during the seminar and distributed to the participants

**Séminaire de formation des techniciens sur l'opération, l'entretien et le suivi des génératrices**

Organisé dans le cadre du projet d'Assistance des Infrastructures de Santé en Haïti (AIS-H), financé par USAID et dirigé par l'Inetech.

Boile Math Tac, l'Inetech-TRINIDAD, Haïti  
22 Février - 2 Mars 2012

**Séminaire de formation des techniciens sur l'opération, l'entretien et le suivi des génératrices**

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Ce séminaire a été rendu possible grâce à la participation d'Inetech et le patronage de l'Unité de Gestion de Projets (UGP) du Ministère de la Santé Publique et de la Population (MSP).

**Fèy enskripsyon**

- Non, Prenon
- Lopital ou responsabla
- Dire etid ou
- Konbyen tan eksperyans ou genyen
- Konbyen tan ou genyen nan Lopital la
- Nimewo telefòn ou
- Kourye ou si ou genyen

**Dèlko lopital la**

- Konbyen dèlko ki genyen?
- Pou chak Dèlko:
  - Mak
  - Modèl
  - Pwisans
  - Laj
  - Konbyen è de mach li genyen?
  - Ki pwoblèm li genyen?
  - Konbyen tan dèlko a fè ap mache chak jou?

**Egzanp fèy enskripsyon ranpli**

NUMERIKAL	DESKripsyon de l'è
1	1-SDMO
2	2-FGWilson
3	3-Kohler
4	4-Olympian
5	5-Himoinsa
6	6-Broadcrown
7	7-Cummins Onan

**Ajennda Seminè**

1. Deskripsyon jeneral yon Dèlko
2. Demare / Kanpe yon Dèlko
3. Tablo kòmand
4. Problèm ki pi frekan yo
5. Mezi sekirite yo / Antrèy an
6. Fomilè
7. Diskisyon
8. Tès

**Chapit 1: DESKRIPSYON JENERAL YON DELKO**

1. Ki sa yon Dèlko fè?
2. Ki pati esansyèl yon Dèlko
3. Diferan sikwi alimentasyon yo
4. Dèlko dizèl ki pi popilè yo

**Ki sa yon Dèlko fè?**

- Wòl yon dèlko se prodwi kouran ou byen nou ka pi byen di, transfòme enèji kalòrifik (chalè) an enèji mekanik epi enèji mekanik an enèji elektrik.

**Dèlko dizèl ki pi popilè yo**

- 1-SDMO
- 2-FGWilson
- 3-Kohler
- 4-Olympian
- 5-Himoinsa
- 6-Broadcrown
- 7-Cummins Onan

**Foto Dèlko dizèl ki popilè yo**

- 1-SDMO
- 2-FGWilson
- 3-Kohler

**Foto Dèlko dizèl ki popilè yo**

- 4-Olympian
- 5-Himoinsa

**Foto Dèlko dizèl ki popilè yo**

- 6-Broadcrown
- 7-Cummins Onan

**Plak idantifikasyon yon dèlko**

**Ki pati esansyèl yon Dèlko**

- Yon Dèlko genyen yon motè a gaz ki atache ak yon altènate (dinamo)

**Figure 1. Dèlko ak konpzan'l yo**

- 1- Pwè sental
- 2- Pwè ankrayon
- 3- Q tèt
- 4- Tubo chofe
- 5- Gouyèn
- 6- Sèkè
- 7- Bati
- 8- Alimantè DC
- 9- Radyatè
- 10- Dinamo
- 11- Zòn lami
- 12- Chofe asabè
- 13- Bot
- 14- Sèkè
- 15- Releve gaz

**Figure 2. Dinamo oubyen Altènate**

**Diferan pyès ki konpoze dinamo a**

**Vitès et frekans ke yo utilize**

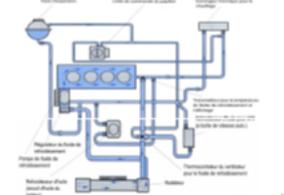
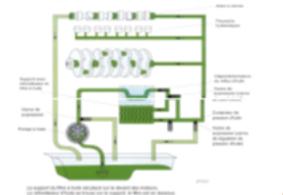
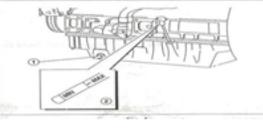
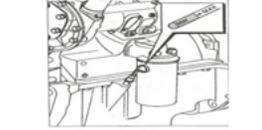
- Vitès
  - Dèlko ak vitès ba: 600 rpm
  - Mwayèn vitès: 900-1,200 rpm
  - Vitès wo: 1,500-3,600 rpm
  - 1800 rpm: vitès ki pi renkontre an Ayiti e an Amerik
  - 1200 rpm: vitès ki pi renkontre an Afrik e an Ewop
- Frekans
  - 60 Hz: Ayiti e tout Amerik dinò
  - 50 Hz: Ewop, Afrik e Amerik disid

**Diferan tip alimentasyon yo**

- Alimentasyon lè
- Alimentasyon gaz
- Alimentasyon lwil
- Alimentasyon dlo pou refwadisman

**Figure 3. Alimentasyon gaz**

- 1- Rezèwa
- 2- Filtrè gaz
- 3- Pompe inyeksyon
- 4- Injektè
- 5- Alimentasyon gaz
- 6- Canalisasyon HP
- 7- Gaz
- 8- Alimentasyon
- 9- Pomp ak men (Priming Pump)

<p><b>Diferan tip gaz pou Dèlko</b></p> <ul style="list-style-type: none"> <li>• Dizèl</li> <li>• Mazout</li> <li>• Gazolin</li> <li>• Propa'n</li> </ul>	<p><b>Diferan tip enjeksyon yo</b></p> <ul style="list-style-type: none"> <li>• Enjeksyon dirèk</li> <li>• Enjeksyon alimantasyon DC</li> <li>• Enjeksyon elektronik</li> </ul>	<p><b>Sensors</b></p> <ul style="list-style-type: none"> <li>• Sensor lwil</li> <li>• Sensor gaz</li> <li>• Sensor tanperati</li> <li>• Sensor nivo dlo nan radiatè</li> </ul>	<p><b>Figure 4. Alimantasyon dlo pou Refwadisman</b></p> 	<p><b>Figure 5. Alimantasyon Lwil</b></p> 
21	22	23	24	25
<p><b>Chapit 2: SISTEM DEMARAJ E KANPEYON DELKO</b></p> <ol style="list-style-type: none"> <li>1. Sa ou dwe verifiye anvan w demare yon Dèlko</li> <li>2. Pwosedè demaraj</li> <li>3. Paramèt ou dwe verifiye apre ou fin demare yon Dèlko</li> <li>4. Pwosedè pou'w kanpe yon Dèlko</li> </ol>	<p><b>Sa ou dwe verifiye anvan w demare yon Dèlko</b></p> <ul style="list-style-type: none"> <li>• Nivo lwil</li> <li>• Nivo dlo nan radyatè a</li> <li>• Nivo gaz la</li> <li>• Eta batri</li> </ul>	<p><b>Kòman w verifiye nivo lwil?</b></p> <ul style="list-style-type: none"> <li>• Rale get lwil la epi gade nan ki nivo lwil li ye</li> </ul> 	<ul style="list-style-type: none"> <li>• Ajoute lwil si se nesesè epi reajiste get la nan plas li</li> </ul> 	<p><b>Pwosedè demaraj</b></p> <ul style="list-style-type: none"> <li>• Demaraj analog (avèk kle)</li> <li>• Demaraj dijitalize (avèk Tablo kòmand)</li> <li>• Kite l mache 3 ak 5 minit anvan ou mete chaj sou li.</li> </ul>
26	27	28	29	30
<p><b>Paramèt ou dwe verifiye apre ou fin demare yon Dèlko</b></p> <ul style="list-style-type: none"> <li>• Verifiye si pagen alam ki aktive</li> <li>• Verifiye vòltaj chak faz yo (L1, L2) pou dèlko yon sèl faz yo epi (L1, L2, L3) dèlko ki gen twa faz yo.</li> </ul> 	<ul style="list-style-type: none"> <li>• Verifiye Vòltaj liy yo tankou (L1-L2) pou dèlko 1φ epi (L1-L2, L2-L3, L1-L3) pou dèlko 3φ</li> </ul> 	<p><b>Paramèt ou dwe verifiye apre ou fin demare yon Dèlko</b></p> <ul style="list-style-type: none"> <li>• Verifiye frekans la (59-61Hz)</li> <li>• Verifiye tanperati a (80-85°C)</li> <li>• Verifiye presyon lwil</li> <li>• Verifiye vòltaj batri a (13-14VDC)</li> </ul>	<p><b>Foto verifikasyon frekans, vòltaj batri e vitès</b></p> 	<p><b>Foto verifikasyon presyon lwil ak tanperati</b></p> 
31	32	33	34	35
<p><b>Paramèt ou dwe verifiye aprè ou fin mete chaj sou yon Dèlko</b></p> <ul style="list-style-type: none"> <li>• Kouran L1 epi L2 pou dèlko monofaze</li> </ul> 	<ul style="list-style-type: none"> <li>• Kouran L1, L2 epi L3 pou dèlko trifaze</li> </ul> 	<p><b>Pwosedè pou'w kanpe yon Dèlko</b></p> <ul style="list-style-type: none"> <li>• Retire chaj sou dèlko a</li> <li>• Kite l mache 3 ak 5 minit epi etèn li</li> <li>• Analog (ak Kle)</li> <li>• Dijitalize (ak tablo kòmand)</li> </ul>	<p><b>Chapit 3: TABLO KOMAND</b></p> <ol style="list-style-type: none"> <li>1. Tip tablo</li> <li>2. Lektè tablo</li> </ol>	<p><b>Tip tablo lekti paramèt yo</b></p> <ul style="list-style-type: none"> <li>• Power Wizard</li> <li>• Mics Nexys</li> <li>• Board 2001</li> <li>• Kohler PC board</li> <li>• Deepsea</li> <li>• Mics Telys</li> </ul>
36	37	38	39	40



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**Chapit 4: PROBLEM KI PI FREKAN YO**

1. Batri dechaje
2. Dèlko a sichofe
3. Faz yo pa balanse
4. Pwoblèm vye gaz

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**1 - Batri dechaje**

**Ki sa ki ka lakoz batri a dechaje?**

- a) Altènate anpann
- b) Batri a ka pa bon
- c) Regilatè DCA ka pa bon (konsekans)
- d) Bòd sòti Kouran eksitatis 12V

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**2 - Dèlko a sichofe**

**Ki sa ka koz yon dèlko sichofe?**

- a) Radyatè a ka sal
- b) Radyatè a koule
- c) Tiyo sikwi dlo a ka koule
- d) Kouwa a ka kase
- e) Pwop dlo a ka pa bon
- f) Tèmòst ka pa bon

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**3 - Faz yo pa balanse**

**Ki sa ka koz faz yo pa balanse?**

- Move konsepsyon sikwi yo
- Mete chaj sou sikwi yo san kontwòl

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**4 - Pwoblèm vye gaz**

- Gaz la kapab manke rafine
- Gaz la kapab te ramase kras kote yo te stoke l la
- Gaz la kapab pran kras nan materyèl menm ki konpoze sikwi a, si delko a alimante pa yon tank ekstèn.

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**Chapit 5: MEZI SEKIRITE YO E ANTRETYEN AN**

1. Mezi sekirite yo
2. Enpotans antretyen an
3. Pwosedi pou'w antretyen

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**Mezi sekirite yo**

- Toujou li ti livrè dèlko a anvan menm ou komanse itilize l
- Pa mete pyès ki pa fèt pou dèlko a ladan l
- Pa fimen lè n'ap mete gaz nan dèlko a
- Toujou byen seche gaz ki tonbe yo ak yon eponj ou byen yon twal absòban epi sere li yon kote ki si.

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**Mezi sekirite yo - 2**

- Pa mete gaz nan dèlko a pandan l'ap mache
- Toujou verifye si tout sinyalizasyon yo aktive nan tablo komand la (Si tout sensor yo bon)
- Evite tout kontak avek pouw asid batri a oubyen a gwo presyon ki soti nan enjektè yo

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**Mezi sekirite yo - 3**

- Evite netwaye, mete lwil ou lòt aranjman nan dèlko pandan l'ap mache
- Toujou evite rete pre tout pati k'ap vire yo
- Evite mete gwo rad epi kite cheve w lage lè w pre yon dèlko k'ap mache
- Pa devise bouchon radyatè a pandan dèlko a cho

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**Mezi sekirite yo - 4**

- Evite touche kò motè dèlko a lè l'ap mache
- Evite mete dlo lamè ou tout lòt pwodwi ki ka lakoz korozyon nan sikwi refwadisman an
- Dekonekte bòn batri a anvan nenpòt entèvansyon nan sikwi elektrik dèlko a

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**Enpotans antretyen an**

- Antretyen an pèmèt ou kenbe dèlko a pwòp epi asire bon mach li.

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**Enpotans propreté**

- Gade tout otou kote dèlko a ye a pwòp pèmèt ou evite gwo dife pran.
- Gade kò dèlko a pwòp ap pèmèt ou deyekte tout ti fwit ki genyen nan dèlko a.

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## Appendix D: Evaluation of the Training by the Participants

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

INSTRUCTORS					
#	Jude	Loby	Ronick	Frantz	Armand
1	5	5	5	5	5
2	5	5	5	5	5
3					
4	5	5	5	5	5
5	5	4	5	5	
6	5	5	5	5	5
7					
8	5	5	4	4	5
9					
10					
11	5	4	4	5	5
12	5	5	5	5	5
13	5	5	5	5	5
14	5	4	4	5	4
15	3	4	3	4	3
16	5	5	5	5	5
17	5	4	5	5	5
18	5	4	4	5	5
19	5	5	5	4	4
20	5	5	4	5	4
21	5	5	5	5	4
22	5	5	5	5	5
23	4	4	4	4	4
24	4	4	4	4	4
25	4	4	4	4	4
26	5	5	5	5	5
<b>Avg</b>	<b>4.8</b>	<b>4.6</b>	<b>4.5</b>	<b>4.7</b>	<b>4.6</b>

LOGISTICS							
#	Transport	Hotel	Food	Classroom	Documents	Tools	Organization
1	4	1	4	5	4	4	5
2	3	/	3	4	5	4	5
3							
4	3	3	3	3	4	3	3
5	/	/	2	4	5	5	4
6	/	/	3	3	4	3	5
7							
8	3	4	4	/	4	4	5
9							
10							
11	5	4	4	5	5	5	5
12	5	5	3	5	5	5	5
13	4	4	4	5	5	5	5
14	5	3	3	4	5	4	4
15	4	3	3	4	5	5	4
16	5	3	3	4	4	4	4
17	5	3	2	5	5	5	4
18	4	4	3	4	4	4	5
19	4	5	3	3	4	3	4
20	4	4	4	4	5	5	5
21	2	/	3	4	4	4	5
22	/	/	4	5	5	4	
23	/	/	/	/	4	4	5
24	/	/	3	4	/	5	4
25	/	/	5	5	5	4	5
26	/	/	4	5	5	5	5
<b>Avg</b>	<b>4.0</b>	<b>3.5</b>	<b>3.3</b>	<b>4.3</b>	<b>4.6</b>	<b>4.3</b>	<b>4.6</b>

TOPICS – BATTERY/INVERTER					
#	Loads	Battery maintenance	Battery equalization	MATE	Wiring
1	5	5	5	5	5
2	5	5	5	4	4
3					
4	3	3	3	3	3
5	4	4	5	4	4
6	4	4	4	4	4
7					
8	4	3	5	3	5
9					
10					
11	5	5	4	5	5
12	4	5	5	5	5
13	5	5	5	5	/
14	4	4	5	5	/
15	5	5	4	4	5
16	4	5	5	5	4
17	5	5	4	5	5
18	4	4	4	4	4
19	4	5	4	5	4
20	/	5	4	5	4
21	3	4	4	4	3
22	5	5	5	5	4
23	4	4	4	3	3
24	4	4	4	5	4
25	5	5	5	5	5
26	4	4	5	5	5
Avg	<b>4.3</b>	<b>4.5</b>	<b>4.5</b>	<b>4.5</b>	<b>4.3</b>

TOPICS - GENERATOR						
#	General description	Start/Stop	Control board	Issues	Maintenance	Logging
1	4	5	5	3	5	4
2	5	5	5	4	4	4
3						
4	3	4	4	4	4	3
5	4	4	4	4	4	5
6	5	5	5	3	4	4
7						
8	4	5	4	4	5	4
9						
10						
11	5	5	5	4	5	5
12	5	5	5	4	5	4
13	5	5	5	5	5	4
14	4	5	4	0	4	4
15	5	5	4	3	4	4
16	4	4	4	4	4	5
17	5	5	4	4	5	4
18	5	5	5	5	5	5
19	3	5	5	5	5	5
20	4	5	4	3	5	4
21	4	5	5	3	4	4
22	5	5	5	5	5	5
23	3	4	3	/	4	4
24	4	5	4	3	4	4
25	5	5	5	5	5	5
26	5	5	5	4	5	5
<b>Avg</b>	<b>4.4</b>	<b>4.8</b>	<b>4.5</b>	<b>3.8</b>	<b>4.5</b>	<b>4.3</b>

PRACTICAL EXERCISES						
#	Kill-a-watt meter	Battery	MATE	Generator - general	Generator - maintenance	Generator - logging
1	4	5	5	5	5	5
2	5	5	4	5	5	4
3						
4	4	4	3	3	3	4
5	5	5	5	5	5	5
6	5	5	4	4	4	5
7						
8	5	5	4	5	4	4
9						
10						
11	4	4	5	5	5	5
12	5	5	4	5	5	4
13	5	5	5	4	5	5
14	5	4	5	5	4	4
15	5	5	4	5	4	4
16	5	5	5	4	4	4
17	5	5	4	4	5	4
18	4	4	4	4	4	4
19	3	5	5	4	5	5
20	5	5	5	4	4	4
21	5	4	4	4	4	4
22	5	5	5	5	5	4
23	3	/	3	/	4	5
24	5	5	5	4	4	4
25	5	5	5	5	5	5
26	5	5	5	5	5	5
Avg	<b>4.6</b>	<b>4.8</b>	<b>4.5</b>	<b>4.5</b>	<b>4.5</b>	<b>4.4</b>

Subjects to cover again in future seminars – BATTERY/INVERTER					
#	Loads	Battery maintenance	Battery equalization	MATE	Wiring
1			X	X	X
2				X	X
3					
4				X	
5	X			X	
6				X	X
7					
8		X			X
9					
10					
11			X		
12			X	X	
13					
14	X	X	X	X	X
15			X	X	
16	X				
17			X	X	
18					
19					X
20			X		X
21				X	
22					X
23			X	X	
24					
25					X
26	X	X			
<b>Total</b>	<b>4</b>	<b>3</b>	<b>8</b>	<b>11</b>	<b>9</b>

**Subjects to cover again in future seminars - GENERATOR**

#	General description	Start/Stop	Control board	Issues	Maintenance	Logging
1			x	x		x
2	x	x	x	x	x	x
3						
4			x			
5				x		
6				x		
7						
8		x	x	x		
9						
10						
11				x		
12			x	x		
13			x			
14	x	x	x	x	x	x
15			x	x		
16			x			
17			x			x
18				x		
19						
20				x		
21				x		
22				x		
23			x	x		
24				x		
25						
26				x		
<b>Total</b>	<b>2</b>	<b>3</b>	<b>11</b>	<b>16</b>	<b>2</b>	<b>4</b>

Subjects to cover again in future seminars - PRACTICAL EXERCISES						
#	Kill-a-watt meter	Battery	MATE	Generator - general	Generator - maintenance	Generator - logging
1			x			x
2	x	x	x	x	x	x
3						
4	x		x			
5						
6	x		x			
7						
8	x		x	x	x	x
9						
10						
11			x			
12			x			x
13	x	x	x	x	x	x
14	x	x	x	x	x	x
15			x		x	
16			x			
17			x			x
18				x		
19				x		
20						
21	x		x			
22					x	
23			x		x	
24						
25						x
26					x	
<b>Total</b>	<b>7</b>	<b>3</b>	<b>14</b>	<b>6</b>	<b>8</b>	<b>8</b>

## Appendix E: Technicians' Backgrounds

#	Bat, Inv	Gen	# of years of study	Specialty	School name	# of years of experience	# of years in the hospital
1	x	x	2 years	Mechanics	INASMO	2	2
2	x		2 years	Electricity in buildings	C.U.B	3	7
3	x	x	2 years	Electricity / Plumber	CFTTP	10	1
4	x	x	4 years	Electricity / Plumber	Ecole Professionnelle Methodiste des Freres	12	6
5	x	x	3 years	Electricity	Ecole Professionnelle J.B Darier	7	7
6	x	x	3 years	Electricity	Ecole Professionnelle St Trinite	7	6
7			6 years	Mechanics	St Gerald	5	5
8			3 Years	Electricity	Salezain	10	15
9	x	x	3 years	Refrigeration and A/C	Centre technique salesien	17	10
10			4 Years	Electricity (domestic and industrial)	Ecole Professionnelle J.B Damye	22	7
11	x	x	4 years	Electricity (domestic and industrial)	St. Trinite	14	8
12		x		Mechanics		34	36
13	x	x		Electro-mechanics	St. Gerard	16	10
14	x	x	9e AF	Electricity	Haiti Tec	2	5
15	x	x	3 years	Electricity	St. Trinite	22	12
16	x	x	4 years	Electricity	J.B Damier	5	14
17	x	x	3 years	Electricity, A/C	St. Trinite	15	10
18	x	x	Philo	Mechanics	St. Trinite	4	1
19	x	x	Philo	Civil Engineering	UNASMOH	2	2
20		x	BAC 1	Plumber	IRD/MEBSH/CAYES, Sud	3	1
21	x	x	3 years	Electrician	Salesien	10	5
22							5
23			8 months	Alternative Energy	Haiti Tec	9 months	
24	x	x	2 years	Telecommunications	Haiti Tec	2	
25	IT technician		5 years	IT	Canado	3	3
26	Receptionist		7 years	Travel agent, communication, service, IT	Business institute West Indies, Ecole commerciale de Julien Craan	3	1

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