Ministry of Power
The Republic of Ghana

Project on Electrical Engineers Training for African Countries in the Republic of Ghana

Project Completion Report

August 2016

JAPAN INTERNATIONAL COOPERATION AGENCY
NEW JEC Inc.

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Contents

I. Basic Information of the Project

1. Country

Republic of Ghana

2. Title of the Project

The Project on Electrical Engineers Training for African Countries

3. Duration of the Project (Planned and Actual)

(Planned) From April 2011 to March 2014

(Actual) From August 2013 to September 2016

4, Background (from Record of Discussions (R/D))

Ghana has achieved one of the highest electrification rates in Africa and electrification plans on the national level has already seen the electrification of all district capitals. The Government of Ghana is vigorously working to electrify communities by extending the grid through various Projects including Self-Help Electrification Project (SHEP).

The Electricity Company of Ghana (ECG) is a distribution company that purchases power from the VRA and others and sells it to the final customers. The company is mandated to distribute and supply electric power to eight ECG operational regions of Ghana. ECG has its own Training Centre with seven trainers engaged in electrical technical training. Since ECG is a distribution company, most of the training involves electrical distribution technology. Approximately forty newly hired technicians every year undergo a mandatory two year artisanal training. In addition, programs are organized for existing staff members who have been already assigned to field operations without receiving the initial training and those who have to update their skills in specialized areas of operation. Three main courses are offered for the trainees at the ECG Training Centre; in-house training for new staff members; open course training for external personnel; and a staff facilitation program for the existing personnel. Training services using external consultants are also offered.

The ECG Training Centre has had the experience of receiving technicians from both Liberia and Sierra Leone for training in the past. The Training Centre provided class room sections and on-the-job training to the participants. The system has been well organized and many former trainees from those countries have successfully applied the gained skills to their work in their respective countries.

In August 2009, the Government of Ghana requested for Japan's Technical Cooperation project for capacity development for Electric Engineers in West African

Countries. In August/September 2010, Detailed Planning Survey Team organized by JICA visited Ghana and had a series of discussions on the Project with authorities concerned of the Government of Ghana. As a result, the Team and Ghanaian Side clarified the framework and schedule for implementing the project and reached a common understanding.

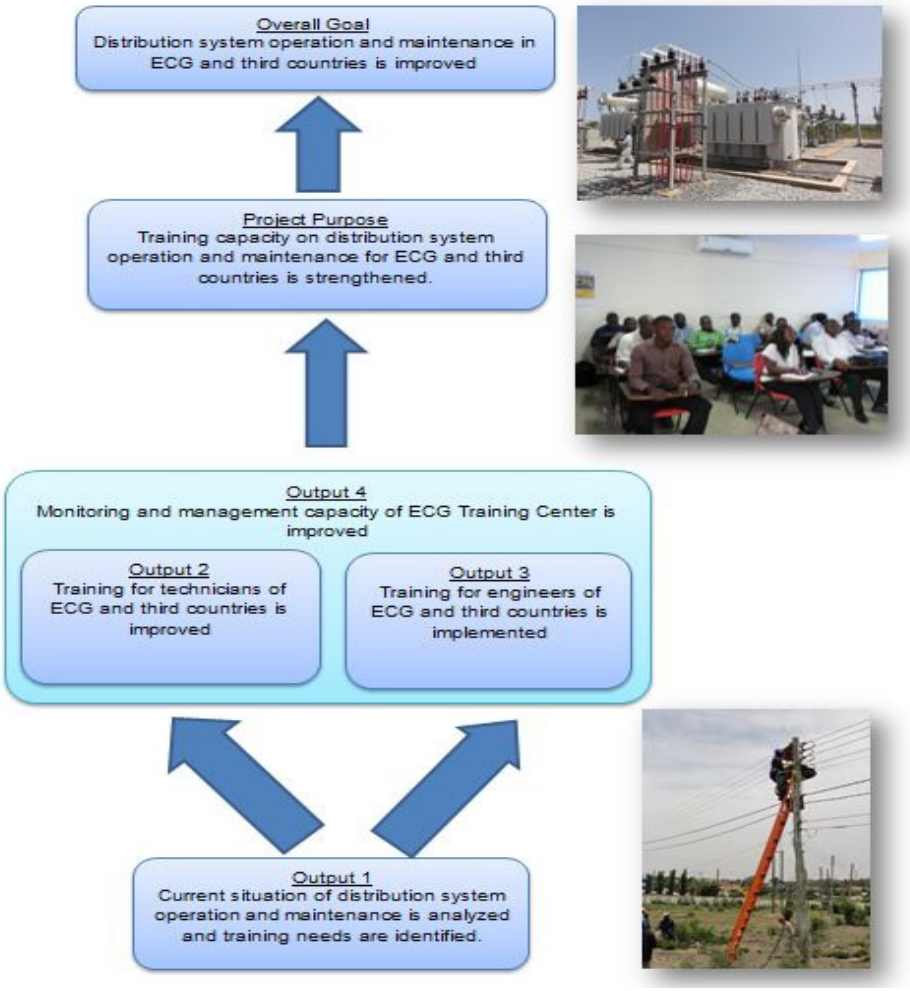
5. Overall Goal and Project Purpose (from Record of Discussions (R/D))

(Overall Goal)

Distribution system operation and maintenance in ECG and third countries is improved.

(Project Purpose)

Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened.



Source: JICA Expert Team

Fig. 1 : Overview of the Project

6. Implementing Agency

Electricity Company of Ghana (ECG)

II. Results of the Project

1. Results of the Project

1-1 Input by the Japanese side (Planned and Actual)

Inputs by the Japanese side were dispatched for covering the following 7 areas.

Table 1 Input by the Japanese side (Planned and Actual)

Planned	Actual
-Chief Advisor/Electrical Engineer for Distribution Planning (33kV/11kV)	-Chief Advisor/ Training Planning
-Electrical Engineer for Distribution System Operation (33kV/11kV)	-Power Distribution Planning/ Design
-Electrical Engineer for Substation Operation	-Power Distribution System Operation
-Electrical Engineer for Substation Maintenance	-Substation Maintenance
-Training Planning	-Training Monitoring/ Assistant for Power Distribution
-Equipment Specialist for Planning and Procurement	-Substation Equipment/ Procurement
-Coordinator	-Training Management/Coordinator

Detailed information is shown in ANNEX-1.

1-2 Input by the Ghanaian side (Planned and Actual)

Inputs by the Ghanaian side were assigned as planned as follows.

- Project Director
- Project Manager
- Project Coordinator
- Technical Manager
- Member of Technical Counterpart

Detailed information is shown in ANNEX-1.

1-3 Activities (Planned and Actual)

(1) As for the Output 1 “Current situation of distribution system operation and maintenance for ECG and Third Countries are analyzed and Training needs are

identified", current situation of ECG and third countries were grasped and analyzed by the Training Needs Survey for ECG and Third countries conducted from Sep.to Nov. 2013. Based on the result of this needs survey, Syllabus and curriculum were developed for the training courses of ECG and third countries. Therefore all the activities were implemented as planned.

(2) As for the Output 2 "Training for Technicians of ECG and third countries is improved", Consultant Team has developed the syllabuses, curriculums and training materials for these training courses.

Training Course for Technicians of ECG was implemented in June 2014, in June 2015 and July 2016 respectively. And Training for Technicians of Third Countries was implemented in July 2014 but 2nd and 3rd Training Courses were not implemented yet due to the outbreak of Ebola Virus Disease.

As for the item "2-2.Replace training equipment and facilities of ECG", all the measuring equipment for training was delivered in March 2015.

Therefore it can be said that almost of activities were implemented as planned except for "2-5 Deliver training programs for the third countries".

(3) As for the Output 3 "Training for engineers of ECG and third countries is implemented", the implementation of the training courses for ECG Engineers "System Protection and Control", "Distribution Planning" and "Distribution Design" have been achieved as planned.

But the Training Course for Engineers of Third Countries "System Protection and Control", has not implemented yet due to the outbreak of Ebola Virus Disease

JICA Ghana Office decided to postpone this third countries training course for the time being in Oct. 2014. There is no clear prospect to restart the third countries training so far now. Considering above mentioned situation, almost of activities were implemented as planned except for "3-5 Deliver training programs for the third countries".

(4) As for the Output 4 "Monitoring and management capacity of ECG Training Centre is improved", the Survey on the monitoring system of ECG Training Centre was conducted in Oct. 2014 and current situation of the Centre was grasped.

The Consultant Team drafted up the monitoring plan for the training courses in March 2014 and monitoring activities were carried out based on this monitoring plan. Monitoring Activities from the second training courses were conducted mainly by the Ghanaian Counterpart.

Judging from these situations, it can be said that Output 4 has been achieved.

Planned and Actual Project Activities are shown in Table 2.

Table 2 Activities (Planned and Actual)

Planned Project Activities	Actual Project Activities
(1) Output1. Current situation of distribution system operation and maintenance is analyzed	Finished trough the needs survey for ECG and third countries and submitted the Survey Report to JICA
1-1 Review the electricity policy and plan of Ghana and regional cooperation framework	Finished trough the needs survey for ECG
1-2 Review the current situation challenges of distribution system O&M in ECG and the third countries	Finished trough the needs survey for ECG and third countries
1-3 Review the current situation of human resources development of ECG engineers and technicians	Finished trough the needs survey for ECG
1-4 Identify the training needs of ECG engineers and technicians and the third countries	Finished trough the needs survey for ECG and third countries
(2) Output2. Training for technicians of ECG and the third countries is improved	
2-1 Review the existing training course of ECG for technicians	Finished trough the needs survey for ECG
2-2 Replace training equipment and facilities of ECG	All the equipment was delivered in March 2015.
2-3 Update necessary training materials	Prepared necessary training materials
2-4 Deliver training programs for ECG technicians	Implemented the training as planned (June 2014,June 2015, July 2016)
2-5 Deliver training programs for the third countries	Implemented the training once (July 2014)
2-6 Observe the training performance and feed-back to training courses	All the monitoring activities were implemented as planned
(3) Output3. Training for engineers of ECG and third countries is implemented	
3-1 Develop syllabuses, curriculum and material for three training programs	Developed for "System Protection & Control" and "Distribution Planning"
3-2 Install new equipment and facilities for training	Substation for training was completed in April 2016.
3-3 Strengthen skills and technology of ECG training	Implementing technology transfer in "System Protection & Control" and "Distribution Planning"
3-4 Deliver training programs for ECG engineers	Implemented the training course on "System Protection & Control""Distribution Planning" and "Distribution Design" as planned.
3-5 Deliver training programs for the third countries	Developed syllabuses, curriculum and material but training courses have not implemented yet.
3-6 Observe the training performance and feed-back to training courses	All the monitoring activities were implemented as planned
(4) Output4. Monitoring and management capacity of ECG and third countries is improved	
4-1 Observe and analyze the current capacity of ECG for monitoring and management of training	Implemented the survey on Monitoring system of ECG
4-2 Prepare plan for methodologies and procedures for improvement	Prepared "Monitoring Plan"
4-3 Improve ECG capacity for training monitoring and management	Counterpart people could implement the monitoring activities by themselves.

2. Achievements of the Project

2-1 Outputs and indicators

(Target values and actual values achieved at completion)

Table 3: Achievement of Output (As of Jul. 2016)

Outputs	Verifiable Indicators	Achievement
Output 1 Current situation of distribution system operation and maintenance is analyzed and training needs are identified		Output 1 is achieved
	Report compiled training needs	Visited EGG and the third countries (Liberia, Sierra Leone, and Gambia) during September and November of 2013 and identified the needs of C/P and stakeholders for technicians and for engineers, respectively. The report describing these needs has been issued. After the survey trip, the JICA team has continued to listen to these needs during the training and subsequent monitoring processes.
Output 2 Training for technicians of ECG and the third countries is improved		Output 2 is partially achieved. For ECG: Output 2 is achieved. All the training courses for ECG technicians were implemented as planned. For third countries: Output 2 is partially achieved. In an original schedule, there were three (3) training courses planned but only one training course was implemented due to Ebola Disease outbreak.
	・Number of trainees for technician courses will increase.	Compared with before 2013, the number of trainees for technicians has not been changed.(However, quality of the training has been improved)
	・Number of certified trainees (Ghana: more than 30, third countries: more than 36)	As of July, 2016 The number of ECG trainee technicians: 28/30（Implemented/Planned ） The number of trainee technicians from the third countries: 12/36 （Implemented/Planned ）
Output 3 Training for engineers of ECG and third countries is implemented		Output 3 is partially achieved. For ECG: Output 3 is achieved. All the training courses for ECG engineers were implemented as planned. For third countries: Output 3 is not achieved. In an original schedule, there were two (2) training courses planned but no training course was implemented due to Ebola Disease outbreak.
	・Number of training courses for engineers will increase	As of July, 2016, the number of courses increased to three (3) in duration of the Project. The times of course implemented for ECG engineers: 5/5（Implemented/Planned ） The times of course implemented for engineers from the third countries 0/2（Implemented/Planned）
	・Number of trainees (Ghana: more than 50, third countries: more than 12)	As of July, 2016, total 57 trainees were trained. The number of ECG trainee engineers: 57/50 （Implemented/Planned ） The number of trainee engineers from the third countries: 0/12 （Implemented/Planned ）

Outputs	Verifiable Indicators	Achievement
Output 4 Monitoring and management capacity of ECG is improved.		Output 4 is achieved. As of February 2016, three staff members had been assigned to monitoring. (One is the HRD manager and the other two are a technical manager, and a trainer respectively.) Technology transfer on course monitoring has been conducted for three (3) members of C/P. Judging from the presentation of the result of the monitoring by C/P at JCC (3) and (5), self-sustainability was recognized.
	・Quality of revised texts	Training staff at the ECG Training Centre have wide and deep knowledge in their fields, as well as hands-on experiences and skills. In close collaboration with Japanese experts, comprehensive and structured textbooks have been written. Textbooks have developed in accordance with the syllabus of training courses and technical standard of ECG with reference to the training materials of the Japanese Electric Power Companies. Figures, photos and statistic tables of the power distribution system have been inserted in the textbooks for helping understanding of trainees. Over the course of follow-up discussions and work, these textbooks have been revised. Major revisions of the textbooks are as follows; 1) Textbook for technicians: Two revisions were made. Version 1.0 was revised to 1.1 in June 2015. 2) Textbook for Engineer course 'System protection and Control' : Second training conducted in February 2016, version 1.0 was revised to 1.1 3) Textbook for Engineer course 'Distribution planning' and 'Distribution design': Version 1.0 was revised to Version 1.1 in July 2016 The quality of these textbooks has been enhanced by these above mentioned revises.

	・Quality of revised tools	The Consultant team drafted a monitoring plan for the training courses in March 2014 and monitoring activities were carried out based on this monitoring plan. 'A survey on the monitoring system of the ECG Training Centre' was conducted in October 2014 and grasped the current situation of the Centre that there was not clear system for improving training courses. Monitoring tools (Pre and post questionnaires) were newly developed and used for checking the level of understanding of the courses and revised based on the improved curriculum and textbooks of the course. In addition, the questionnaires were revised for analyzing not only the level of understanding but also the tendency of the trainees' academic background, job experience and other factors so that deeper analysis is possible to figure out the relationship between the levels of understanding land participants' background.
	・Number of JCC meetings	JCC meetings were held as follows. ・The first Joint Coordinating Committee: 9th December, 2013 ・The second Joint Coordinating Committee: 16th July, 2014 ・The third Joint Coordinating Committee: 23rd July, 2015 ・The fourth Joint Coordinating Committee: 25th February 2016 ・The fifth Joint Coordinating Committee: 28th July 2016 Report on implementation, schedule adjustments for the next year, and revision of PDM were discussed. The outcome of monitoring was shared among all stakeholders and discussed for further improvement. At the third meeting of JCC, one of trainers attached to the Centre presented the monitoring process he was involved in.

2-2 Project Purpose and indicators

(Target values and actual values achieved at completion)

Achievement of the Project Purpose is as follows.

Table 4: Achievement of Project Purpose

Project Purpose	Verifiable indicators	Achievement
Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened	・Number of training courses for technicians and engineers will increase.	Compared with before 2013, the number of training courses for technicians has not changed. However, training courses for engineers have started with JICA Technical Cooperation while there was no training course for engineers before the Project. Through the Project, number of training courses for engineers increased from zero (0) to three (3) and implemented five (5) times.
	・Syllabus, curriculum and training materials will be revised or newly developed.	The syllabus and curriculum have been well prepared. In order to prepare them, Japanese experts had taken initiatives to create textbooks, considering regulations for construction and safety and the current situation of Ghana. The textbooks were also created based on constant and frequent communication between Japanese experts and lecturers in the Training Centre and the Project Office of ECG. The textbooks are highly regarded by the lecturers. However, there is no reference attached in the figures and tables of the textbooks, and it is difficult to distinguish between content written by the JICA experts and quotations from original sources. Corresponding to this instruction, the reference of quotation was attached to clarify the original by the experts. In sum, the indicators were achieved.

3. History of PDM Modification

(1) PDM (Ver.1) changed to PDM (Ver.2) in the second Joint Coordinating Committee on 16th July, 2014.

(2) PDM (Ver.2) changed to PDM (Ver.3) in the third Joint Coordinating Committee on 23rd July, 2015.

(3) PDM (Ver.3) changed to PDM (Ver.4) in the fourth Joint Coordinating Committee

on 25th February, 2016.

Detailed contents changed were shown in ANNEX-3.

4. Others

4-1 Results of Environmental and Social Considerations (if applicable)

There are no relevant matters.

4-2 Results of Considerations on Gender/ Peace Building/ Poverty Reduction (if applicable)

There are no relevant matters.

III. Results of Joint Review

1. Results of Review based on DAC Evaluation Criteria

1-1. Relevance

The relevance of the project is very high. It was maintained until project completion and thereafter.

(1) Consistency with the Development Plan of Ghana

According to Ghana Shared Growth Development Agenda (GSGDA) II (2014-2017), priority policy interventions focus on the following key areas: 1) electricity and thermal energy; 2) renewable energy (hydro, biomass, wind, and solar); 3) waste-to-energy; 4) Other energy sources including nuclear energy; 5) access to petroleum products; 6) energy efficiency and conservation; 7) transportation of energy products; 8) energy and the environment; 9) Gender and Energy; 10) the regulatory environment; 11) mobilization of investment for energy sector development; and 12) building human resource capacity and research and development. The Project is relevant to the above-mentioned key areas of 1), 6), and 12).

(2) Consistency with Development Needs

- Intervention into electricity distribution sub sector

Ghana achieved an electrification rate of 76% in 2013 as an outcome of the National Electrification Scheme and the Self Help Electrification Project. However, there are still serious problems such as frequent blackout and unstable power supply. One of the reasons is high electricity loss rate in transmission and distribution network. In fact, currently the distribution loss is about 25% in Ghana. In this context, it is imperative that Distribution System operation and maintenance in ECG is improved.

- Needs to strengthen the training capability of ECG Training Centre

  Though the ECG Training Centre provided various kinds of trainings, they didn't have published holistic textbooks or well-structured syllabus for several training courses. The quality of the trainings highly depends on lectures' ability. Moreover, the main target of the trainings was not engineers but technicians. So, there was no higher level training course for engineers. Therefore, there was a need to create the holistic textbooks along with the well-structured syllabus as well as to establish new training courses for engineers in order to strengthen training capability of ECG Training Centre. In this context, the Project activities were relevant to such a need.

- Appropriateness of targeting training participants

  Direct beneficiaries of the Project are 20 training staff (8 trainers attached to the Centre, 12 lecturers from ECG) at the ECG Training Centre and associated administrative staff and lecturers sent from the Project Office, while indirect beneficiaries are 6,200 ECG staff utilizing the Training Centre in general, especially 690 engineers and 270 technicians of ECG, and 120 trainees from the third countries in the field of distribution maintenance.

  To create the syllabus for the training courses, one of the important issues was how to target the training participants. Through the close consultation with ECG Training Centre, the Project decided the clear criteria to select trainees as follows;

  1) Trainees are selected one each from ten regional offices of ECG.
  2) Staff specialty is the same field as the provided courses.
  3) Trainees have at least three years' experience.

  Since there is a skill gap of ECG staff between urban and rural areas, the main target for the training was decided to be staff from regional Centre of ECG and training participants have been chosen upon discussion among the regional Centre of ECG and the Training Centre. Though the Project team has recommended ECG to select staff with less than ten years of work experience, ECG Training Centre intended to enhance the quality of the courses by accommodating participants from diverse backgrounds. Finally, staff from diverse backgrounds was chosen to participate in the training.

- Consistency of the training for the third countries

The ECG Training Centre is considered as one of the centres of excellence to train electrical technicians and engineers, especially for English-speaking countries in the Western Africa, in a framework of the West Africa Power Pool (WAPP) initiated by the Economic Community of West Africa States (ECOWAS). With the fund from WAPP, the ECG Training Centre provided the training for other West African Countries namely, Liberia, Sierra Leone, and Gambia in 2010, and there are future potential plans to conduct similar kinds of training again. The importance of the ECG Training Centre has been increase not only for Ghana but also for the West African countries.

In particular, the provision of the training for the third countries is also highly relevant in terms of the following aspects;

1) There is much in common between Ghana and the third countries in O&M of distribution equipment and HRD,
2) Compared to the third countries, the ECG Training Centre is much better equipped with training facilities, and
3) There are professional lecturers attached to the Training Centre and the engineers at the Project Office working at the forefront and they have more and better knowledge and experience than the third countries.

- Superiority in technical know-how and experience from Japan

The scope of the Project activities is also appropriate to make the most use of Japanese experts' knowledge and experience. Distribution planning, maintenance, protection and control, and associated monitoring techniques of Newjec, Kansai Electric Power Co., Inc. and Shikoku Electric Power Co., Inc. have been utilized for the technology transferred with careful consideration of the context. Especially, the related local regulations and needs were considered to create the textbooks.

(3) Consistency with the Japanese ODA Policy

In 2012, Japan's Basic Policy of Assistance to Ghana sets up the ODA policy "Promoting Dynamic Economic Growth that Benefits the People Widely". The infrastructure sector is positioned as one of the strategic areas which contribute to achievement of this policy through utilizing Japanese technological capabilities to their maximum extent.

1-2. Effectiveness

Effectiveness of the project is Medium.

(1) Achievement of Project Purpose

The Project Purpose "Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened" is partially achieved. The rationale of this judgment is based on the observation of two indicators as follows.

Regarding the first indicator "Number of training courses for technicians and engineers will increase", the Project established new three training courses for engineers. So, the number of training courses for engineers was increased. However, the number of training courses for technicians was not increased because, regarding the training courses for technicians, the Project activity was set to improve the quality of training but not to increase the number of training as decided on PDM (Output 2) at the beginning of the Project.

Regarding the second indicator "Syllabus, curriculum and training materials will be revised or newly developed", the Project newly created the syllabus, curriculum, and training materials for four kinds of training courses totally (one training course for technicians and three training courses for engineers). Additionally, each training material (textbook) was revised based on the monitoring results. The quality of the textbooks is highly evaluated by ECG Training Centre and the Ministry of Power.

(2) As mentioned above, the observation of both indicators is very positive.

Therefore, it is true that training capacity on distribution system operation and maintenance for ECG is strengthened. However, the training capacity of the third countries was not strengthened. Because of Ebola outbreak in Liberia and Sierra Leone in 2014, four trainings for the third countries were canceled although five trainings were planned. Therefore, it is fair to judge that the Project Purpose is partially achieved. Causal relationship between Outputs and Project Purpose.

The Project set up four Outputs to achieve the Project Purpose. As mentioned in the section 2-1, Output 1 and Output 4 were achieved and Output 2 and Output 3 were partially achieved. The reason of "partially achieved" is cancelation of activities for the third countries. And as the result of four positive outputs, the Project Purpose is also partially achieved. Considering this fact, it is fair to say the relationship between Output and Project Purpose is appropriate.

1-3. Efficiency

Efficiency of the Project is medium.

(1) Comparison of planned and actual input

【Plan (it was estimated in 2010 based on the detail design study)】

- Total budget: 290 million Japanese Yen
- Duration: 3 Years

【Actual】

- Total budget: 508 million Japanese Yen
- Duration (Total): 5 Years and 10 Months (from November, 2010 to August, 2016)
- Duration (Main Activity): 3 years (from August, 2013 to August, 2016)

Inputs of the Project are shown in Table.5.

Table 5: Inputs for the Project (for Main Activity)

Japanese Side	Ghana Side
• Experts: experts in 7 areas (84.75MM) • Equipment: Foreign Currency: 853,870 USD Local Currency: 25,099 GHS • General Operation Cost for Ghana: Foreign Currency: 8,994 (000JPY) Local Currency: 413,489 (GHS) • General Operation Cost for Third Countries: Foreign Currency: 4,143 (000JPY) Local Currency: 65,255 (GHS) • Travelling costs for Training in Japan Foreign Currency: 3,879 (000JPY)	• Counterpart Personnel: 8 people were assigned. • Land and Facilities: (EX)Project office space and facilities in ECG Control room of ECG

Though the R/D of the Project was signed in November, 2010, it took several years to select the Japanese consultant team for the implementation of the Project. In fact, unsuccessful bidding occurred twice.

Until the commencement of the main activity in August, 2013, two experts were dispatched twice in 2012. One of the reasons for the difference between planned and actual total budget are the cost to dispatch these two experts. Based on the updated information from the study by these experts on the needs and the

situation of ECG, the Project activities were reconsidered because much time has passed after the detail design study conducted in 2010. And then, as a result, more activities were included. This is the other reason for the budget increase. In fact, there is almost no gap between the reconsidered planned budget in 2013 and the actual one.

(2) Appropriateness of input in terms of quality, quantity, timing and costs

It is appropriate for input from the Japanese side in terms of quality, quantity and timing except for the installation of the sub-station for training.

For training of engineers, the three courses 'System Protection and Control', 'Distribution Design' and 'Distribution Planning' have been selected among the requested seven training fields based on their needs, the past results of JICA cooperation, and the advanced distribution system in Japan.

Input is designed to be minimized to encourage existing resources of C/P with efficient support from Japanese side.

The dispatch period of Japanese experts is adjusted based on the progress of the Project.

The delay of eight months in installation of the sub-station for training decreased the efficiency of the Project.

(3) Appropriateness of input from quality, quantity, timing, and costs from the Ghanaian side

It is appropriate for input from the Ghanaian side in terms of quality, quantity and timing.

Since the ECG Training Centre has experience implementing training programs for WAPP members, the training for the third countries was efficiently implemented.

(4) External Factors

A disturbing factor for achieving outputs is the outbreak of the Ebola virus, which interfered with training for participants from the third countries.

1-4. Impact

(1) Impact of the Project is Medium.

Achievement of Overall Goal

It is possible to say that the Overall Goal will be achieved as a result of completion of the project in Ghana but not in the third counties.

The Overall Goal is to decrease Distribution loss and SAIFI (System Average Interruption Frequency Index) in Ghana and third countries by strengthening the training capacity on distribution system operation and maintenance for ECG and third countries.

Generally, Distribution loss and SAIFI are decreased by improvement of both hard and soft aspects.. Hard improvement means to improve the distribution network and to replace or to rehabilitate the old distribution facilities. Soft improvement means the human development to enhance the maintenance techniques of the technicians and engineers. Both factors are indispensable to achieve to decrease Distribution loss and SAIFI.

Through the Project, the training capability of ECG Training Centre has been strengthened and it leads to enhance the quality of distribution network maintenance and to decrease Distribution loss and SAIFI. It contributes to achieving the Overall Goal of the Project from the soft aspect.

On the other hand, when the Overall Goal is evaluated based on SAIFI, the shortage of power generation, which is currently frequently happens in Ghana, will negatively affect the evaluation result even if it is not a problem of electricity distribution. However, there is positive perspective in power generation sector in Ghana. GSGDA II mentions that Ghana is planning to increase the power generation capacity to 5,000 MW by the end of 2016. According to the public news, the government has many projects to construct power generation plans as well as to develop the oil and gas fields. The total amount of electricity which will be supplied by 2020 is more than 4,000 MW. Since the current power generation capacity is about 3,400MW, the power generation capacity will be dramatically increased in near future and the amount is more than enough to meet the demand which is increased 6.5 % annually. Therefore, the achievement of the Overall Goal is feasible.

However, regarding the third countries, the Project didn't achieve the Project Purpose because of the cancelation of the planned trainings due to the Ebola outbreak. Therefore it may be difficult to achieve the Overall Goal in the third countries. In consideration of the situation both in Ghana and the third countries, it is fair to conclude that Impact of the Project is Medium.

1-5. Sustainability

The sustainability of the Project is medium.

(1) Policy and institutional aspects

As mentioned on the section 1-1. Relevance (1), according to GSGDA II (2014-2017), in the energy sector, "energy efficiency and conservation' and "building human resource capacity and research and development" are recognized as important and focused areas. Currently, the improvement of ECG in both management and technical aspects is one of the agendas. In this context, the government has the plan to privatize ECG and it is under process to select private company for the concession contract. However, according to the interview with some stakeholders including the Director of Distribution in the Ministry of Power (from a meeting on 12 February, 2016), there might be no drastic change in a role and activities of ECG Training Centre, though the privatization (concession) may have a significant impact on electricity policy in Ghana.

(2) Organizational aspects

Regarding the provision of training, the ECG Training Centre is the only one governmental organization which has provided training in the area of distribution for utility companies inside and outside of Ghana. In addition, ECG plays an important role as one of the organizations which can provide training to the WAPP countries. Therefore, self-sustainable service provision is expected to continue.

Regarding the monitoring activity to improve quality of training, at the ECG Training Centre, three staff members are assigned to monitoring. They consist of an officer in charge of human resource development, a technical manager, and a lecturer and they communicate each other to reflect results of monitoring into the contents of training. Therefore, there is appropriate internal coordination in the ECG Training Centre. Considering the proper assignment of personnel as well as the fact that monitoring has been institutionalized in ECG even before the Project, there is no significant problem for the sustainability to continue monitoring.

(3) Technical aspects

The textbooks are tailored to the current context of ECG (construction standard, regulation, and local needs). During the work for creating the textbooks,

Japanese experts and C/Ps and lecturers from the Project Office closely communicated on the contents of the textbooks and this process significantly contributed to technology transfer from the Japanese experts to C/Ps and the lecturers from the Project Office.

Then, during the training implementation, initially, training courses were carried out under the full responsibility of the Japanese experts and then successive training courses were carried out mainly by the C/P and lecturers from the Project Office. Judging from the fact that course management has been smoothly progressing, sufficient knowledge and technology can be said to have been acquired.

In consideration of the above-mentioned fact, technical sustainability is high. It is expected that improvement of the training course, such as its syllabus, curriculum, and training materials, can be made through repetition of monitoring and feedback which will be done by C/P and engineers from the Project Office and these materials will be used at the ECG even after the Project.

It should be noted that important assumption for the sustainability is "Trained trainers continue to work for ECG" as it is mentioned on PDM. However, the trainers (C/Ps) attached to the ECG Training Centre are highly motivated to teach. Moreover, there is a low turnover rate at the ECG Training Centre and the cycle of transfer of assignments is rather long. Therefore, the risk associated with HRD seems low.

(4) Financial aspects

The ECG Training Centre is positioned under the ECG HQ, so the ECG Training Centre lacks its own accounting system. However, a necessary budget has been allocated in the past.

Since ECG is highly conscious about the training for staff, the budget will be allocated as planned in the future. However, there are a few issues about honorarium for the lecturers from the Project Office.

2. Key Factors Affecting Implementation and Outcomes

1) Positive Factor

Mr. George Yaw Marfo, ECG Training Centre principal, is highly esteemed within ECG and his cooperation was crucial for the all implementation process of the Project. Since the implementation process is related to various levels of stakeholders as shown below, it was necessary to coordinate both administrative

and technical departments as well as central and regional offices of ECG. So, his engagement is considered as a positive factor of the Project.

The development procedure to establish training courses;

- Needs Survey for the training course (in Ghana and third countries)
- Development of the training course (syllabus, curriculum and training-materials)
- Technology transfer to the lecturers
- Implementation of the training course
- Monitoring
- Improvement of the training course (syllabus, curriculum and training materials)
- Re-introduction to the lecturers

2) Negative Factor

- Cancelation of the training for the third countries

  The Project implemented the first training for the third countries in June 2014. After that, though the training course for technicians "Underground Cable and Substation Maintenance" and the training course for engineers "System Protection and Control" were planned to be conducted for the third countries in 2015 and 2016, these training courses were canceled due to the Ebola outbreak in August 2014. On January 14, 2016, the epidemic of the Ebola virus in West Africa was announced to be over. However, soon after this announcement, a new case of the disease was reported. In this context, although the Project has been prepared to conduct these trainings every year, the training for the third countries was not carried out in 2015 or 2016. It negatively affected the achievement of the Project Purpose because it contains to strengthen the training capacity of the third countries, too.

- Delay of the 33kv sub-station construction

  There was a very old and unusable sub-station in ECG Training Centre before the Project. So, as one of the Project components, the provision of the sub-station which can be used for training purposes in the ECG Training Centre was included. Though it was planned to be constructed in July 2015, the construction was completed in April 2016 because of low capacity of the contractor. It negatively affected the achievement of the Project Purpose because the actual utilization of

the sub-station for practical training was so limited though the way to use the sub-station in the related training coursed was proposed by the Project.

3. Evaluation on the results of the Project Risk Management

Risk Management was conducted as shown in Table 6 and controlled very well all through the duration of the Project.

Table 6 Risk Factors and Risk Management for mitigation

Risk Factor	Risk Management for Mitigation
Assignment of C/P	Through the discussion with Ghana side about the preparation of training courses, we confirmed the allocation of C/P in the Minutes of Understanding.
Assignment of Japanese Expert	Based on the MOU above, we try to coordinate the allocation of Japanese Experts.
Management of Scheduling and Implementation	We exchanged views with Ghana side mainly about the implementation schedule of training courses periodically and tried to confirm the important items by the MOU for the smooth implementation of the Project.
Share of Information	In addition to the progress of the preparation work of the training courses, we had the meeting with the C/P frequently for sharing the information and confirmed the important items by the MOU to avoid misunderstanding of each other. General Progress of the Project was reported in JCC and shared among related people. But Project Director (Chief Director, Ministry of Energy) and Project Manager (Managing Director ECG) were too busy to attend JCC. We visited the Project Manager directly and report the progress of the Project.
Office Space and Working Environment	When we started the Project, we requested working space based on the R/D. The office space with adequate equipment was prepared by Ghana side.
Budgetary Allocation by Ghana side	We showed the 3 years plan of project implementation, and requested Ghana side to prepare the expense for the training course and management in advance. In implementation of the training courses, JICA side prepared the budget for printing textbooks. And the honorarium for the outside lecturers, daily allowance and accommodation for the third countries trainees were prepared by JICA.

4. Lessons Learnt

4-1. Recommendations to ECG

(1) Sourced trainers and lecturers from more diversified staff pools

ECG has been getting accreditation from the NABPTEX, and will be able to issue some kinds of certificates for trainees in near future. Similarly, in order to mobilize trainers and lecturers with updated hands-on experience, the provision of certificates for them according to the acquired skills will be effective in incentivizing potential entrants to the trainers and lectures positions at the Centre.

(2) Needs for follow-up training for the trainees from the third countries

In regions including the third countries, ECG is the only institution equipped with training facilities. As soon as the Ebola virus is eradicated, training which has hitherto been suspended should be restarted and follow-up training commenced.

(3) Implementation of Hands-on training using the sub-station

In regions including the third countries, ECG is the only institution equipped with sub-stations. The use of these sub-stations for hands-on training is recommended.

(4) For the more detailed monitoring

The Project introduced the practical monitoring method (using questionnaire and interview) in consideration of the Project duration as well as time and cost. However, results of monitoring by this method may be subjective. So, if ECG Training Centre needs more detailed monitoring method, it may be useful to utilize objective indicators such as test scores for checking the absolute level of understanding to have both subjective and objective indicators.

4-2. Lessons

(1) Need for verification of PDM during the project period

1) Indicator for measuring outputs

Output 4 'Monitoring and management capacity of ECG is improved' is difficult to be measured by such indicators as revised text books and tools and the number of JCC meeting that were held. Indicators, such as publication of monitoring reports in collaborations with HRD, increase the ratio of retrieved questionnaires to the trainees' supervisors.

After the launch of the project, JICA, Japanese experts, and Ghana C/P have identified these drawbacks and inconsistencies, and no revisions have been made before the time of terminal evaluation.

Regarding JCC, these problems should be pointed out and corrected.

(2) Implementation of tests for checking understanding of the trainees.

At the ECG Training Centre, there have been no tests issued to the trainees for checking course comprehension. Implementing such tests will be proposed. The level of understanding of the trainees is diversified. In order to grasp the absolute level of understanding of the trainees, and to implement the courses in a more effective way, imposing tests can be one of the effective methods.

Tests should be implemented before and after the workshops. Pre-tests are intended to check the initial level of understanding of the participants.

Post-tests are intended to check the amount of knowledge accrued over the course of the lectures. Since interviewed training staff is all in favor of the introduction of these tests, and since the tests have already been implemented for artisans, implementation by the ECG will be straightforward.

With the full scale introduction of the tests, the positioning of the tests in the overall PDCA system of the training, and the interpretation in the career development system of ECG, the costs associated with its introduction should be analyzed and considered.

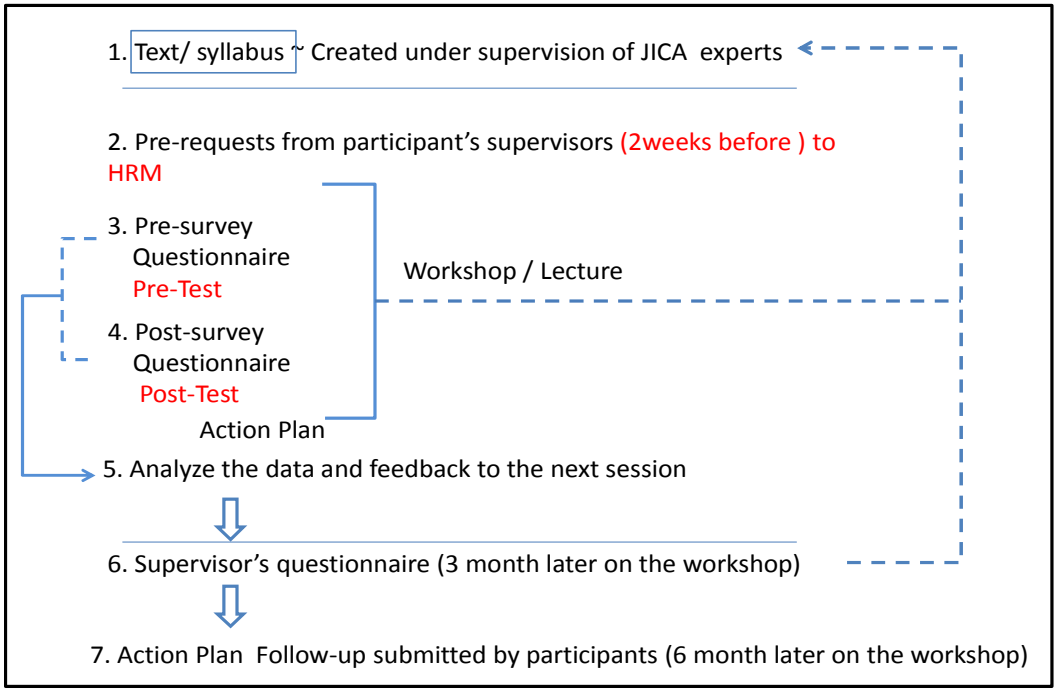


Fig. 2: Proposed Procedure for Monitoring Training Centre

Note: Before the JICA project, STEP 2, 4, 6 were already done by ECG Training Centre

Source: Created by Terminal Evaluation Team

(3) Clarification of sources and quoted sentences in the textbook.

Although the textbook is highly regarded by the C/P and trainers, the textbook's sources have not been clarified. Sentences should be quoted in original Japanese and their translated forms. JICA and its consultants should have rigorously abided by this requirement.

This commission has the potential risk of leading to copyright issues in the future.

IV. For the Achievement of Overall Goals after the Project Completion

1. Prospects to achieve Overall Goal

1) The continuous effort of ECG for implementing training courses for engineers and technicians will surely make the ECG`s Capability of Distribution System Operation and Maintenance strengthen and thus lead to achieve the Overall Goal.

2) In order to achieve the Overall Goal, it is indispensable to strengthen the capability of distribution system operation and maintenance in third countries. Therefore when the Ebola disease is eradicated, third countries training courses suspended in the Project should be restarted as soon as possible.

2. Plan of Operation and Implementation Structure of the Ghanaian side to achieve Overall Goal

1) ECG Training Centre should continue the training courses for engineers and technicians as conducted in the Project cooperating with Engineering Department in ECG Headquarters.

2) Training course for Technicians is especially important for achieving the Overall Goal of the Project. ECG Training Centre should consider the times and number of candidates of the training courses flexibly in order to produce more number of qualified technicians.

3. Recommendations for the Ghanaian side

1) Textbooks developed in the Project cover a wide area of each training theme. Therefore these textbooks can be used for various needs of engineers and technicians of ECG. For example the refresh course for the senior technicians can be established by using a part of our textbook. Please utilize our textbooks effectively in accordance with the needs of engineers and technicians.

2) ECG Training Centre should prepare the personnel expenses to invite the lecturers from outside of ECG Training Centre such as Engineering Department in ECG Headquarters. And ECG Training Centre should make effort to assign ECG's staff as

the lecturer of the training course instead of other resources outside ECG.

3) ECG should consider requesting JICA to support the follow-up technical cooperation for the third countries training program suspended due to the Ebola Virus outbreak.

4. Monitoring Plan from the end of the Project to Ex-post Evaluation

ECG should report the following activities to JICA Ghana Office at the end of the year.

1) Annual Performance of training activities in ECG Training Centre

2) Duration, number of the trainees and the result of the monitoring of the training courses below.

- Maintenance Techniques for Power Equipment and Implementation Procedure"
- "System Protection and Control"
- "Distribution Planning"
- "Distribution Design"

3) The performance and result if the third country training courses can be restarted

ANNEX

ANNEX　1 : Results of the Project
(List of Dispatched Experts,　List of Counterparts, List of Trainings, etc.)
ANNEX 2: List of Products, (Reports, Manuals, Handbooks, etc.)
ANNEX 3: PDM (all versions of PDM)
ANNEX 4: R/D, M/M, Minutes of JCC (*)
ANNEX 5: Monitoring Sheet (copy) (*)
(Remarks: ANNEX 4 and 5 are internal reference only.)

ANNEX 1: Result of the Project

(1) List of Dispatched Experts

-Chief Advisor/ Training Planning	Mr. Hiroshi Kurakata	Newjec Inc.
-Power Distribution Planning/ Design	Mr. Takamu Genji	ditto
-Power Distribution System Operation	Mr. Tatsuhiro Tamura	ditto
-Substation Maintenance	Mr. Tsuguhiro Yamada	Shikoku Electric Power Co., Inc
	Mr. Shinya Nishimatsu	ditto
	Mr. Tomohisa Fujita	ditto
	Mr. Toshio Aki	ditto
-Training Monitoring/ Assistant for Power Distribution		
	Mr. Seiji Ito	Newjec inc.
	Dr. Yukihiro Mikumo	ditto
-Substation Equipment/ Procurement	Dr. Shinichi Tohjoh	Tohjoh Intelligent Network Co., Inc
-Training Management/Coordinator	Ms. Ritsuko Kawabe	

(2)List of Counterpart

-Project Director

Mr. Solomon A. Asoalla Acting Chief Director, Ministry of Power

-Project Manager

Mr. Robert Dwamena Managing Director, ECG

-Project Coordinator

Mr. George MARFO Principal, ECG Training Centre

-Technical Manager

Mr.Clemence Akpeloo Technical Manager, ECG Training Centre

-Member of the Counterpart

Ms Ama Otu-Ansah Ag. Sectional Manager ECG Training Centre

Mr. Isaac K. Nukpezah Instructor, ECG Training Center

Mr.Kingsford Amoako ditto

Mr. Maxwell Essel ditto

Mr. Samuel Andoh ditto

Mr.Peter King Asare ditto

Mr. Agbi Bless Worlanyo ditto

Mr. George Hommey Divisional Manager Protection and Control

Mr. Rodnell Bilson Protection and Control

Mr.Frank Osei Owusu	Protection and Control
Mr. George Eduful	Manager, Research
Mr. Issah B. Majeed	Research
Mr.Osei Adogo	Sectional Manager, Distribution Design
Mr.David Asiedu	Distribution Design

(3) List of the Training in Japan

Following seven (7) counterpart personnel were accepted to the training program in Japan in the first years of the Project (From 25th May 2014 to 7th June 2014).

1) Mr. George Marfo	Principal of the ECG Training Centre
2) Mr. Isaac K. Nukpezah	Instructor for substation maintenance and network operation and safety
3) Mr. Kingsford Amoako	Instructor for substation maintenance and network operation and safety
4) Mr. Maxwell Essel	Instructor metering and protection
5) Mr. Samuel Andoh	Instructor for overheads lines
6) Mr. Peter King Asare	Instructor for underground cables
7) Mr. Agbi Bless Worlanyo	Instructor for overhead lines and underground cables

(4) List of the Performance of Training Courses for ECG and Third Countries

1) Training Courses for ECG Technicians "Maintenance Techniques for Power Equipment and Implementation Procedure"
   ① 23~27 June 2014
   ② 22~26 June 2015
   ③ 11~15 July 2016
2) Training Courses for ECG Engineers "System Protection and Control"
   ① 23~27 Feb. 2015
   ② 2~12 Feb. 2016
3) Training Courses for ECG Engineers "Distribution Planning"
   ① 13~17 July 2015
   ② 18~22 July 2016
4) Training Courses for ECG Engineers "Distribution Design"
   ① 15~17 Feb. 2016
5) Training course for Third Countries Technicians "Maintenance Techniques for Power Equipment"
   ① 30 June ~ 11 July 2014

ANNEX 2　List of Products

(1) Textbooks

1)Textbook for Training Courses for ECG and Third Countries Technicians "Maintenance Techniques for Power Equipment and Implementation Procedure" -

- Part-1 Distribution line Maintenance
- Part-2 Substation Equipment Maintenance

2) Textbook for the Training Courses for ECG and Third Countries Engineers "System Protection and Control"

3) Textbook for the Training Courses for ECG Engineers "Distribution Planning"

4) Textbook for the Training Courses for ECG Engineers "Distribution Design"

(2) Monitoring Report

1) Monitoring Plan for Training Courses (Mar.2014)

2)Monitoring Report on Training Course for Technicians of ECG "Maintenance Techniques for Power Equipment and Implementation Procedure" (July 2014)

3)Monitoring Report on Training Course for Technicians of Third Countries "Maintenance Techniques for Power Equipment" (July 2014)

4)Amendment of Teaching Materials on "Maintenance Techniques for Power Equipment" (July 2014)

5) Monitoring Report on the Training Course for ECG Engineers "System Protection and Control " (March, 2015)

6) Amendment of Curriculum and Textbook for Engineers of ECG "System Protection and Control" Course (March, 2015)

7) Result of the Questionnaire for Trainees` Supervisors (Feb. 2015) Training Course for Technicians of ECG "Maintenance Techniques for Power Equipment and Implementation Procedure" (1)

8) Monitoring (Action Plan Follow-up) (Feb. 2015) Training Course for Technicians of ECG "Maintenance Techniques for Power Equipment and Implementation Procedure" (1)

9) Result of the Questionnaire for Trainees` Supervisors (July. 2015) Training Course for Technicians of Third Countries "Maintenance Techniques for Power Equipment" (Overhead Line)

10) Monitoring (Action Plan Follow-up) (July. 2015)
Training Course for Technicians of Third Countries “Maintenance Techniques for Power Equipment” (Overhead Line)
11) Monitoring Report on the Training Course for ECG Engineers
“Distribution Planning “ (August, 2015)
12) Amendment of Curriculum and Textbook for Engineers of ECG
“Distribution Planning “ (November, 2015)
13) Result of the Questionnaire for Trainees` Supervisors
“System Protection and Control “ (November, 2015)
14) Monitoring (Action Plan Follow-up)
“System Protection and Control “ (November, 2015)
15) Result of the Questionnaire for Trainees` Supervisors
“Distribution Planning “ (December, 2015)
16) Monitoring (Action Plan Follow-up)
“Distribution Planning “ (March, 2016)
17) Monitoring Report on the Training Course for ECG Engineers
“Distribution Design “ (February, 2016)
18) Amendment of Curriculum and Textbook for Engineers of ECG
“Distribution Design “(July, 2016)
19) Result of the Questionnaire for Trainees` Supervisors
“Distribution Design “ (July, 2016)

(3) Other Related Report
1) Inception Report (Oct.2013)
2) Training Needs Survey Report (for ECG) (Nov.2013)
3) Training Needs Survey Report for ECG Third Countries (Nov.2013)
4) Syllabus and Curriculum for Technicians of ECG and Third Countries (Mar.2014)
5) Syllabus and Curriculum for Engineers of ECG and Third Countries （Aug.2015）
－System Protection and Control Course
－Distribution Planning Course
6) Syllabus and Curriculum for Engineers of ECG (Feb.2016)
－Distribution Design Course

ANNEX 3: PDM (all versions of PDM)

PDM (Project Design Matrix) Ver.1.0
1. Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
2. Terms of Cooperation: From Sep. 2013 to Sep.2016
3. Target Group: Trainers of ECG

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MUANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Overall Goal Distribution System operation and maintenance in ECG and third countries is improved	・Technical loss of distribution systems(Ghana ○%, third countries ○%) ・Outrage statistics(Ghana ○%, third countries ○%)	・Annual report of ECG and third countries	・ There is no drastic change in Energy Policy in Ghana. ・ Necessary budget shall be allocated for the training.
Project Purpose Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened	・Number of certificated trainers of ECG(more than ○) ・Satisfactory rate for training(more than ○%)	・Annual report of ECG and third countries ・Quarterly Report of ECG and third countries	・ Trained trainers continue to work for ECG. ・Stakeholders fulfill their responsibilities in maintaining cooperation framework.
Outputs 1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified	・Report compiled training needs	・Quarterly Report of ECG and third countries ・Project Progress Report	・Trainees from third countries continue to participate in the training courses in ECG. ・ Equipment will be properly maintained for the training courses.
2. Training for technicians of ECG and the third countries is improved	・Number of certificated trainees (Ghana: a more than ○, third countries: more than ○) ・Number of equipment and facilities for replacement, repair and new installation.	・Quarterly Report of ECG and third countries ・Project Progress Report ・Inventory list	
3. Training for engineers of ECG and third countries is implemented	・Number of implemented training programs ・Number of trained trainers ・Number of equipment and facilities identified for replacement, repair and new installation ・Number of certificated trainees (Ghana: a more than ○, third countries: more than ○)	・Quarterly Report of ECG and third countries ・Project Progress Report	

4. Monitoring and management capacity of ECG and third countries is improved	・Quality of revised texts ・Quality of revised tools ・Number of JCC meetings	・Quarterly Report of ECG and third countries ・Project Progress Report	

Activities	Inputs (Means and Cost)	Important Assumptions
1. Crrent situation of distribution system operation and maitenance is analyzed and training needs are identified 1-1Review the electricity policy and plan of Ghana and regional cooperation framework 1-2 Review the currenr situation callenges of distribution system O&M in ECG and the third countriesECG 1-3 Review the currenr situation of human resources development of ECG engineers and technicians 1-4 Identify the training needs of ECG engineers and technicians and the third countries 2. Training for technicians of ECG and the third countries is improved 2-1 Review the exisiting training course of ECG for technicians 2-2 Replace training equipments and facilities of ECG 2-3 Update necessary training materials 2-4 Deliver tarining programs for ECG technicians 2-5 Deliver tarining programs for the third countries 2-6 Observe the training performance and feed-back to training courses 3. Training for engineers of ECG and third countries is implemented 3-1 Develop syllabuses, culliculum and material for three training programs 3-2 Install new equipments and facilities for training 3-3 Strengthen skills and technology of ECG training 3-4 Deliver tarining programs for ECG engineers 3-5 Deliver tarining programs for the third countries 3-6 Observe the training performance and feed-back to training courses 4. Monitoring and management capacity of ECG and third countries **is improved** 4-1 Observe and analize the current capacity of ECG for monitoring and management of training 4-2 Prepare plan for methodologies and procedures for inprovement 4-3 Inprove ECG capacity for training monitoring and management	**(Japanese Side)** A. The personnel will be provided, as enumerated below; Assignment of -Chief Advisor/Electrical Engineer for Distribution Planning (33kV/11kV) -Electrical Engineer for Distribution System Oeration (33kV/11kV) -Electrical Engineer for Substation Operation -Electrical Engineer for Substation Maintenance -Equipment Specialist for Planning and Procurement -Equipment Specialist for Pperational Instruction -Training Planning -Coodinator B.Training in Japan About ten (10) counterpart personnel are planning to be accepted to the training program in Japan in the three vears of the Proiect. C. Provision of Equipment Equipment will be provided based on the R/D. D. Allocation of the necessary budget of trainings for third countries. - Allowance for third countries` trainees are provided by JICA. - Transportation fee of trainees is arranged by own (Ghanaian Side) A. Assignment of Counterpart personnel - Project Director - Project Manager - Project Coordinator - Technical Manager - Technical Counterpart B. Joint Coordinaing Committee C. Office Space and others ECG will provide necessary office facilities including electricity, air-conditioning, water and internet during the duration of the Project. D. Allocation of the necessary budget for the activities described in PDM. E. Training for trainees of third countries ECG assigns necessary lecturers in order to implement trainings for third countries.	**(Pre-conditions)** ・Counterparts are assigned. ・Necessatry budget, office space and facilities for the Project are allocated.

ANNEX II

Plan of Operation

Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
Implementing Agency: Electricity Company of Ghana (ECG)
Target Group: Trainers of ECG
Project period: 3 years (2010- 2013)

Activities	JFY 2010		JFY 2011				JFY 2012				JFY 2013					In Charge	
	2010		2011				2012				2013				2014		
	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	GH	JPN
Project period: 3 years (2010- 2013)			→															
1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified																		
1-1 Review the electricity policy and plan of Ghana and regional cooperation framework			■															
1-2 Review the current situation and challenges of distribution system O&M in ECG and the third countries			■															
1-3 Review the current situation of human resources development of ECG engineers and technicians			■															
1-4 Identify the training needs of ECG technicians and engineers and the third countries			■															
2. Training for technicians of ECG and third countries is improved																		
2-1 Review the existing training courses of ECG for technicians			■															
2-2 Replace training equipments and facilities of ECG																		
(a) Select equipments and facilities to be replaced			■															
(b) Procure equipments and facilities				■	■	■												
(c) Install and setup procured equipments and facilities						■												
(d) Maintain properly the replaced equipments and facilities							■	■	■	■	■	■	■	■	■	■		
2-3 Update necessary training materials						■												
2-4 Deliver of training programs for ECG technicians				■	■	■	■	■	■	■	■	■	■	■	■	■		
2-5 Deliver of training programs for the third countries				■	■			■	■				■	■				
2-6 Observe the training performance and feed-back to training courses				■	■	■	■	■	■	■	■	■	■	■	■	■		
3. Training for engineers of ECG and third countries is implemented																		
3-1 Develop syllabuses, curriculum and material for three training programs																		
(a) Review the existing syllabuses, curriculum and material for training			■															
(b) Prepare plan for methodologies and procedures for implementation				■														
(c) Upgrade syllabuses, curriculum and material for training					■	■	■	■	■	■								
3-2 Install new equipments and facilities for training																		
(a) Select equipment and facilities to be replaced			■	■														
(b) Procure equipment and facilities					■	■	■	■	■	■								
(c) Install and setup procured equipment and facilities									■	■								
(d) Maintain properly the renewed equipment and facilities											■	■	■	■	■	■		
3-3 Strengthen skills and technology of ECG trainers																		
(a) Select trainers and define the target skills and technology for strengthening			■															
(b) Prepare plan for methodologies and procedures for training of trainers				■	■													
(c) Implement training for trainers						■	■	■	■	■	■							
(d) Conduct trainer assessment test for certification								■	■									
3-4 Deliver training programs for ECG engineers																		
(a) Formulate course schedule						■	■											
(b) Select lecturers							■	■										
(c) Arrange logistics								■	■									
(d) Deliver the training and follow up the action plan made by participants									■	■	■	■	■	■	■	■		
3-5 Deliver training programs for third countries																		
(a) Formulate course schedule							■	■										
(b) Select lecturers								■	■									
(c) Arrange logistics									■	■								
(d) Deliver the training and follow up the action plan made by participants										■	■			■	■			
3-6 Observe the training performance and feed-back to training courses										■	■	■	■	■	■	■		
4. Monitoring and management capacity of ECG Training Centre is improved																		
4-1 Observe and analyze the current capacity for monitoring and management of training			■															
4-2 Prepare plan for methodologies and procedures for improvement				■	■													
4-3 Improve ECG capacity for training monitoring and management					■	■	■	■	■	■	■	■	■	■	■	■		
Evaluations																		
Mid-term Evaluation of the project								▲										
Final Evaluation of the project														▲				

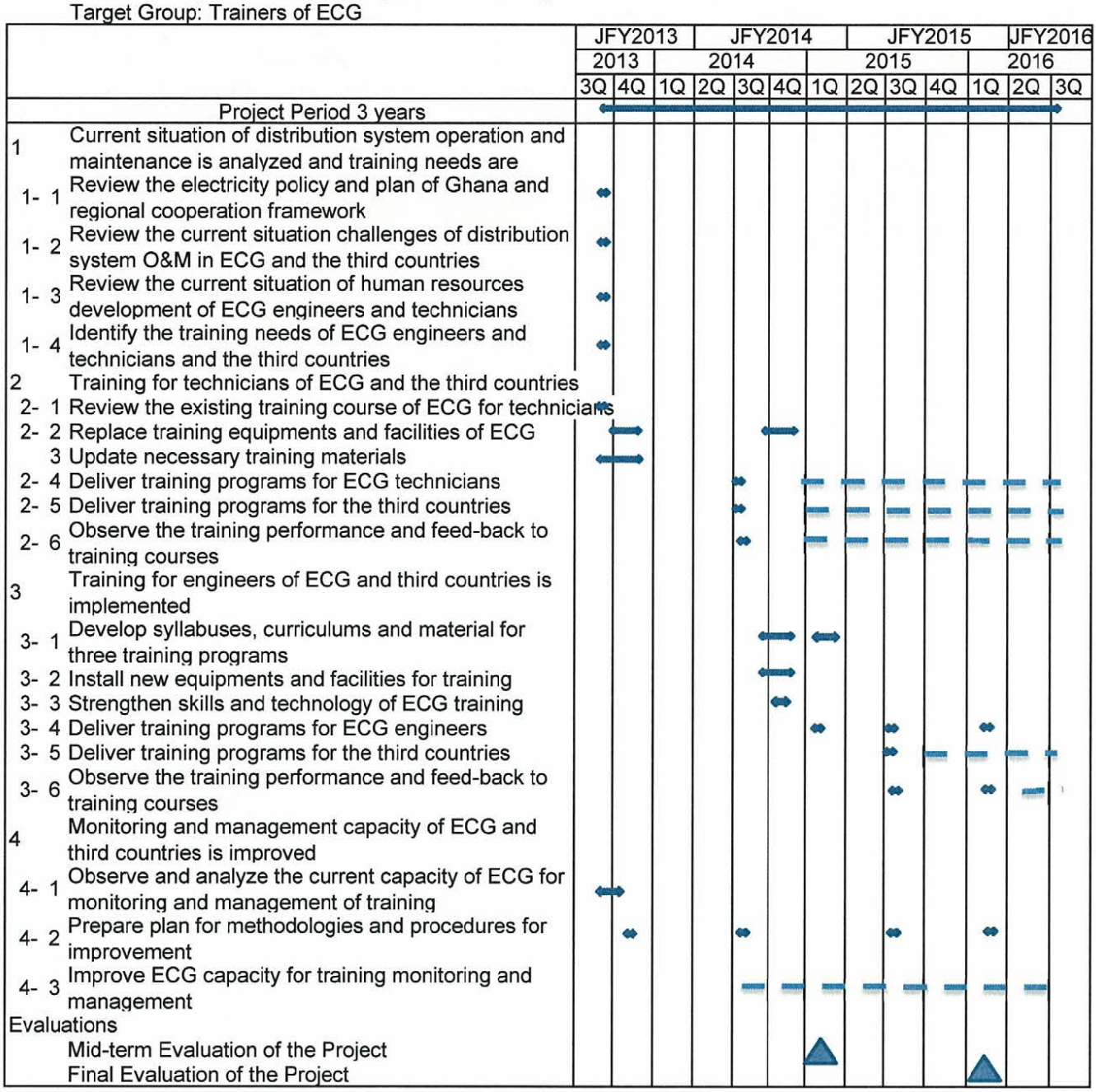
PDM (Project Design Matrix) Ver.2.0
1. Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
2. Terms of Cooperation: From Sep. 2013 to Sep.2016
3. Target Group: Trainers of ECG

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Overall Goal Distribution System operation and maintenance in ECG and third countries is improved	・Distribution loss and SAIFI (The System Average Interruption Frequency Index) will decrease in Ghana and third countries.	・Annual report of ECG and third countries	・There is no drastic change in Energy Policy in Ghana. ・Necessary budget shall be allocated for the training.
Project Purpose Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened	・Number of training courses for technicians and engineers will increase. ・Syllabus, curriculum and training materials will be revised or newly developed.	・Annual report of ECG and third countries ・Quarterly Report of ECG and third countries	・Trained trainers continue to work for ECG. ・Stakeholders fulfill their responsibilities in maintaining cooperation framework.
Outputs 1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified	・Report compiled training needs	・Quarterly Report of ECG and third countries ・Project Progress Report	・Trainees from third countries continue to participate in the training courses in ECG. ・ Equipment will be properly maintained for the training courses.
2. Training for technicians of ECG and the third countries is improved	・ Number of trainees for technicians courses will increase. ・Number of certificated trainees (Ghana: a more than 30, third countries: more than 36)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Inventory list ・Result of the Monitoring	
3. Training for engineers of ECG and third countries is implemented	・Number of training courses for engineers will increase programs ・Number of trainees (Ghana: a more than ○, third countries: more than 12)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Result of the Monitoring	
4. Monitoring and management capacity of ECG and third countries is improved	・Quality of revised texts ・Quality of revised tools ・Number of JCC meetings	・Quarterly Report of ECG and third countries ・Project Progress Report ・Manuals and tools	

Activities	Inputs (Means and Cost)	Important Assumptions
1. Current situation of distribution system operation and maintenance is analyze and training needs are identified 1-1 Review the electricity policy and plan of Ghana and regional cooperation framework 1-2 Review the current situation challenges of distribution system O&M in ECG and the third countries 1-3 Review the current situation of human resources development of ECG engineers and technicians 1-4 Identify the training needs of ECG engineers and technicians and the third countries 2. Training for technicians of ECG and the third countries is improved 2-1 Review the existing training course of ECG for technicians 2-2 Replace training equipments and facilities of ECG 2-3 Update necessary training materials 2-4 Deliver training programs for ECG technicians 2-5 Deliver training programs for the third countries 2-6 Observe the training performance and feed-back to training courses 3. Training for engineers of ECG and third countries is implemented 3-1 Develop syllabuses, culliculum and material for three training programs 3-2 Install new equipments and facilities for training 3-3 Strengthen skills and technology of ECG training 3-4 Deliver training programs for ECG engineers 3-5 Deliver training programs for the third countries 3-6 Observe the training performance and feed-back to training courses 4. Monitoring and management capacity of ECG and third countries **is improved** 4-1 Observe and analyze the current capacity of ECG for monitoring and management of training 4-2 Prepare plan for methodologies and procedures for improvement 4-3 Improve ECG capacity for training monitoring and management	**(Japanese Side)** A. Assignment of Experts -Chief Advisor/ Training Planning -Power Distribution Planning/ Design -Power Distribution System Operation -Substation Maintenance -Training Monitoring/ Assistant for Power Distribution -Substation Equipment/ Procurement -Coordinator B. Training in Japan About ten (10) counterpart personnel are planning to be accepted to the training program in Japan in the three years of the Project. C. Provision of Equipment Equipment will be provided based on the R/D. D. Allocation of the necessary budget of trainings for third countries. - Allowance for third countries` trainees are provided by JICA. - Transportation fee of trainees is arranged by own (Ghanaian Side) A. Assignment of Counterpart personnel - Project Director - Project Manager - Project Coordinator - Technical Manager - Technical Counterpart B. Joint Coordinating Committee C. Office Space and others ECG will provide necessary office facilities including electricity, air-conditioning, water and internet during the duration of the Project. D. Allocation of the necessary budget for the activities described in PDM. E. Training for trainees of third countries ECG assigns necessary lecturers in order to implement trainings for third countries.	**(Pre-conditions)** ・Counterparts are assigned. ・Necessary budget, office space and facilities for the Project are allocated.

Plan of Operation

Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
Terms of Cooperation: From Sep. 2013 for three years
Target Group: Trainers of ECG



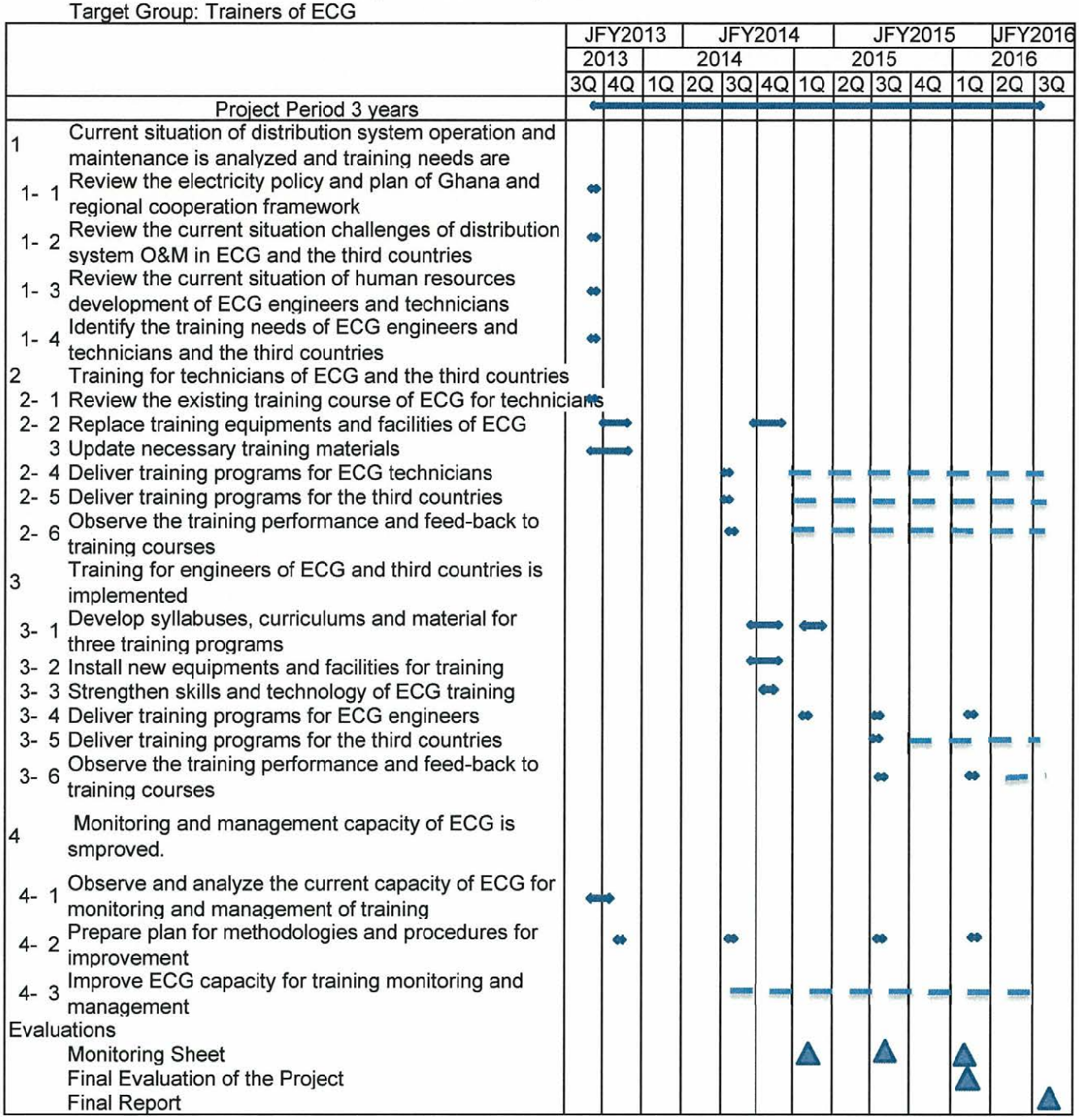
PDM (Project Design Matrix) Ver.3.0
1. Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
2. Terms of Cooperation: From Sep. 2013 to Sep.2016
3. Target Group: Trainers of ECG

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Overall Goal Distribution System operation and maintenance in ECG and third countries is improved	・Distribution loss and SAIFI (The System Average Interruption Frequency Index) will decrease in Ghana and third countries.	・Annual report of ECG and third countries	・ There is no drastic change in Energy Policy in Ghana. ・ Necessary budget shall be allocated for the training.
Project Purpose Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened	・Number of training courses for technicians and engineers will increase. ・Syllabus, curriculum and training materials will be revised or newly developed.	・Annual report of ECG and third countries ・Quarterly Report of ECG and third countries	・ Trained trainers continue to work for ECG. ・ Stakeholders fulfill their responsibilities in maintaining cooperation framework.
Outputs 1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified	・Report compiled training needs	・Quarterly Report of ECG and third countries ・Project Progress Report	・Trainees from third countries continue to participate in the training courses in ECG. ・ Equipment will be properly maintained for the training courses.
2. Training for technicians of ECG and the third countries is improved	・ Number of trainees for technicians courses will increase. ・Number of certificated trainees (Ghana: a more than 30, third countries: more than 36)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Inventory list ・Result of the Monitoring	
3. Training for engineers of ECG and third countries is implemented	・Number of training courses for engineers will increase. ・Number of trainees (Ghana: a more than 50, third countries: more than 12)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Result of the Monitoring	
4. Monitoring and management capacity of ECG is improved.	・Quality of revised texts ・Quality of revised tools ・Number of JCC meetings	・Quarterly Report of ECG and third countries ・Project Progress Report ・Manuals and tools	

Activities	Inputs (Means and Cost)	Important Assumptions
1. Current situation of distribution system operation and maintenance is analyz and training needs are identified 1-1 Review the electricity policy and plan of Ghana and regional cooperation framework 1-2 Review the current situation challenges of distribution system O&M in ECG and the third countries 1-3 Review the current situation of human resources development of ECG engineers and technicians 1-4 Identify the training needs of ECG engineers and technicians and the third countries 2. Training for technicians of ECG and the third countries is improved 2-1 Review the existing training course of ECG for technicians 2-2 Replace training equipments and facilities of ECG 2-3 Update necessary training materials 2-4 Deliver training programs for ECG technicians 2-5 Deliver training programs for the third countries 2-6 Observe the training performance and feed-back to training courses 3. Training for engineers of ECG and third countries is implemented 3-1 Develop syllabuses, culliculum and material for three training programs 3-2 Install new equipments and facilities for training 3-3 Strengthen skills and technology of ECG training 3-4 Deliver training programs for ECG engineers 3-5 Deliver training programs for the third countries 3-6 Observe the training performance and feed-back to training courses 4 Monitoring and management capacity of ECG is improved. 4-1 Observe and analyze the current capacity of ECG for monitoring and management of training 4-2 Prepare plan for methodologies and procedures for improvement 4-3 Improve ECG capacity for training monitoring and management	**(Japanese Side)** A. Assignment of Experts -Chief Advisor/ Training Planning -Power Distribution Planning/ Design -Power Distribution System Operation -Substation Maintenance -Training Monitoring/ Assistant for Power Distribution -Substation Equipment/ Procurement -Coordinator B. Training in Japan Seven(7) counterpart personnel are planning to be accepted to the training program in Japan in the first years of the Project. C. Provision of Equipment Equipment will be provided based on the R/D. D. Allocation of the necessary budget of trainings for third countries. - Allowance for third countries` trainees are provided by JICA. - Transportation fee of trainees is arranged by own (Ghanaian Side) A. Assignment of Counterpart personnel - Project Director - Project Manager - Project Coordinator - Technical Manager - Technical Counterpart B. Joint Coordinating Committee C. Office Space and others ECG will provide necessary office facilities including electricity, air-conditioning, water and internet during the duration of the Project. D. Allocation of the necessary budget for the activities described in PDM. E. Training for trainees of third countries ECG assigns necessary lecturers in order to implement trainings for third countries.	**(Pre-conditions)** ・Counterparts are assigned. ・Necessary budget, office space and facilities for the Project are allocated.

(2) Plan of Operation (Ver.3.0)

Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
Terms of Cooperation: From Sep. 2013 for three years
Target Group: Trainers of ECG



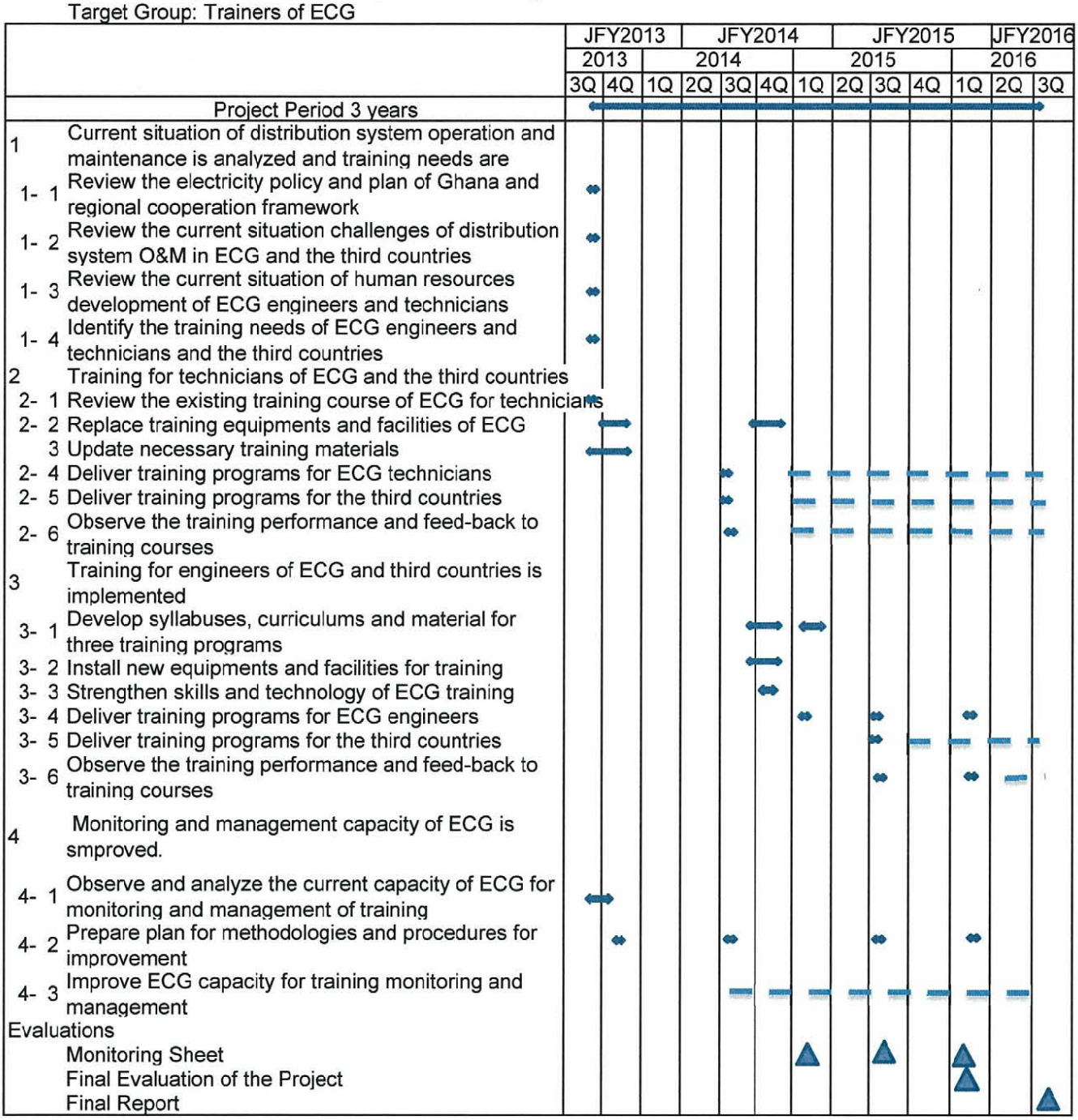
PDM (Project Design Matrix) Ver.4.0
1. Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
2. Terms of Cooperation: From Sep. 2013 to Sep.2016
3. Target Group: Trainers of ECG

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Overall Goal Distribution System operation and maintenance in ECG and third countries is improved	・Distribution loss and SAIFI (The System Average Interruption Frequency Index) will decrease in Ghana and third countries.	・Annual report of ECG and third countries	・ There is no drastic change in Energy Policy in Ghana. ・ Necessary budget shall be allocated for the training.
Project Purpose Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened	・Number of training courses for technicians and engineers will increase. ・Syllabus, curriculum and training materials will be revised or newly developed.	・Annual report of ECG and third countries ・Quarterly Report of ECG and third countries	・ Trained trainers continue to work for ECG. ・ Stakeholders fulfill their responsibilities in maintaining cooperation framework.
Outputs 1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified	・Report compiled training needs	・Quarterly Report of ECG and third countries ・Project Progress Report	・Trainees from third countries continue to participate in the training courses in ECG. ・ Equipment will be properly maintained for the training courses.
2. Training for technicians of ECG and the third countries is improved	・ Number of trainees for technicians courses will increase. ・Number of certificated trainees (Ghana: a more than 30, third countries: more than 36)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Inventory list ・Result of the Monitoring	
3. Training for engineers of ECG and third countries is implemented	・Number of training courses for engineers will increase. ・Number of trainees (Ghana: a more than 50, third countries: more than 12)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Result of the Monitoring	
4. Monitoring and management capacity of ECG is improved.	・Quality of revised texts ・Quality of revised tools ・Number of JCC meetings ・Number of Monitoring Reports PDCA cycle of Monitoring Activities will be establised.	・Quarterly Report of ECG and third countries ・Project Progress Report ・Manuals and tools ・Monitoring Reports	

Activities	Inputs (Means and Cost)	Important Assumptions
1. Current situation of distribution system operation and maintenance is analyz and training needs are identified 1-1 Review the electricity policy and plan of Ghana and regional cooperation framework 1-2 Review the current situation challenges of distribution system O&M in ECG and the third countries 1-3 Review the current situation of human resources development of ECG engineers and technicians 1-4 Identify the training needs of ECG engineers and technicians and the third countries 2. Training for technicians of ECG and the third countries is improved 2-1 Review the existing training course of ECG for technicians 2-2 Replace training equipments and facilities of ECG 2-3 Update necessary training materials 2-4 Deliver training programs for ECG technicians 2-5 Deliver training programs for the third countries 2-6 Observe the training performance and feed-back to training courses 3. Training for engineers of ECG and third countries is implemented 3-1 Develop syllabuses, culliculum and material for three training programs 3-2 Install new equipments and facilities for training 3-3 Strengthen skills and technology of ECG training 3-4 Deliver training programs for ECG engineers 3-5 Deliver training programs for the third countries 3-6 Observe the training performance and feed-back to training courses 4 Monitoring and management capacity of ECG is improved. 4-1 Observe and analyze the current capacity of ECG for monitoring and management of training 4-2 Prepare plan for methodologies and procedures for improvement 4-3 Improve ECG capacity for training monitoring and management	**(Japanese Side)** A. Assignment of Experts -Chief Advisor/ Training Planning -Power Distribution Planning/ Design -Power Distribution System Operation -Substation Maintenance -Training Monitoring/ Assistant for Power Distribution -Substation Equipment/ Procurement -Coordinator B. Training in Japan Seven(7) counterpart personnel are planning to be accepted to the training program in Japan in the first years of the Project. C. Provision of Equipment Equipment will be provided based on the R/D. D. Allocation of the necessary budget of trainings for third countries. - Allowance for third countries` trainees are provided by JICA. - Transportation fee of trainees is arranged by own (Ghanaian Side) A. Assignment of Counterpart personnel - Project Director - Project Manager - Project Coordinator - Technical Manager - Technical Counterpart B. Joint Coordinating Committee C. Office Space and others ECG will provide necessary office facilities including electricity, air-conditioning, water and internet during the duration of the Project. D. Allocation of the necessary budget for the activities described in PDM. E. Training for trainees of third countries ECG assigns necessary lecturers in order to implement trainings for third countries.	**(Pre-conditions)** ・Counterparts are assigned. ・Necessary budget, office space and facilities for the Project are allocated.

(2) Plan of Operation (Ver.4.0)

Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
Terms of Cooperation: From Sep. 2013 for three years
Target Group: Trainers of ECG



RECORD OF DISCUSSIONS BETWEEN JAPAN INTERNATIONAL COOPERATION AGENCY AND THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF GHANA ON JAPANESE TECHNICAL COOPERATION FOR THE PROJECT ON ELECTRICAL ENGINEERS TRAINING FOR AFRICAN COUNTRIES

With regard to the Minutes of Meeting of the Japanese Detailed Planning Study Team (hereinafter referred to as "the Team") signed on the 16th of September 2010, the Japan International Cooperation Agency (hereinafter referred to as "JICA") had series of discussions through JICA Ghana Office with the Electricity Company of Ghana (hereinafter referred to as "ECG") and other authorities concerned on desirable measures to be taken by JICA and the Government of Ghana (hereinafter referred to as " the GOG") for the successful implementation of the Project for Electrical Engineers Training for African Countries (EETA) (hereinafter referred to as "the Project").

As a result of the discussions, the Team and the authorities concerned agreed on the matters referred to in the document attached hereto.

Accra, 30th November, 2010

Mr. Kunihiro Yamauchi
Chief Representative
Japan International Cooperation Agency
Ghana Office

Mr. Okyere-Darko Ababio,
Chief Director,
Ministry of Energy

Mr. Cephas Gakpo
Managing Director,
Electricity Company of Ghana (ECG)

THE ATTACHED DOCUMENT

I. COOPERATION BETWEEN JICA AND THE GOG

1. The GOG will implement the improvement of the Project in cooperation with JICA.

2. The Project will be implemented in accordance with the Project Design Matrix and Plan of Operation which are given in Annex I and Annex II.

II. MEASURES TO BE TAKEN BY JICA

In accordance with the laws and regulations in force in Japan, JICA will take, at its own expense, the following measures according to the normal procedures.

1. DISPATCH OF JAPANESE EXPERTS
JICA will provide the services of the Japanese experts as listed in Annex III.

2. PROVISION OF MACHINERY AND EQUIPMENT
JICA will provide such machinery, equipment and other materials (hereinafter referred to as "the Equipment") necessary for the implementation of the Project as listed in Annex IV. The Equipment will become the property of the GOG upon being delivered C.I.F (cost, insurance and freight) to the Ghana authorities concerned at the ports and/or airports of disembarkation.

3. TRAINING OF THE GHANAIAN COUNTERPART PERSONNEL IN JAPAN
JICA will receive the Ghanaian personnel connected with the Project for technical training in Japan within the project budget.

III. MEASURES TO BE TAKEN BY THE GOG

1. The GOG will take necessary measures to ensure that the self-reliant operation of the Project will be sustained during and after the period of Japanese technical cooperation, through full and active involvement in the Project by all related authorities, beneficiary groups and institutions.

2. The GOG will ensure that the technologies and knowledge acquired by the Ghanaian counterparts as a result of the Japanese technical cooperation will contribute to the economic and social development of the Ghana.

3. The GOG will grant in the privileges, exemptions and benefits to the Japanese experts referred to in

II-1 above and their families, which are no less favorable than those accorded to experts of third countries working in Ghana.

4. The GOG will ensure that the Equipment referred to II-2 above will be utilized effectively for the implementation of the project in consultation with the Japanese Experts referred to in Annex III.

5. The GOG will take necessary measures to ensure that the knowledge and experience acquired by the Ghanaian personnel from technical training in Japan will be utilized effectively in the implementation of the Project.

6. In accordance with the laws and regulations in force in Ghana, the GOG will take necessary measures to provide at its own expense:

(1) Services of the Ghanaian counterpart personnel and administrative personnel as listed in Annex V
(2) Office Space and Facilities as listed in Annex VI and
(3) Supply or replacement of machinery, equipment, institutions, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the Equipment provided by JICA under II-2.

7. In accordance with the laws and regulations in force in Ghana, the GOG will take necessary measures to meet:

(1) Expenses necessary for transportation within Ghana of the Equipment referred to in II.-2 above as well as for the installation, operation and maintenance thereof;
(2) Customs duties, internal taxes and any other charges, imposed in Ghana on the Equipment referred to in II.-2 above; and
(3) Running expenses necessary for the implementation of the project.

IV. ADMINISTRATION OF THE PROJECT

1. Chief Director, Ministry of Energy, as the Project Director, will bear overall responsibility for the administration and implementation of the Project.

2. Managing Director of ECG HQ as the Project Manager will be responsible for the managerial matters of the Project

3. Principal of ECG Training Centre, as the Project Coordinator, will be responsible for coordination and administration of the Project.

4. Technical manager of ECG Training Centre, as the Technical Manager will be responsible for the technical matters of the Project.

5. The Japanese Chief Advisor will provide necessary recommendations and advices to the Project Director, the Project Manager and the Technical Manager on any matters pertaining to the implementation of the Project.

6. The Japanese experts will give necessary technical guidance and advices to Ghanaian counterpart personnel on technical matters pertaining to the implementation of the Project.

7. The project implementation structure is shown in Annex VII

8. For the effective and successful implementation of technical cooperation for the Project, a Joint Coordinating Committee will be established whose functions and composition are described in Annex VIII.

V. JOINT EVALUATION

Evaluation of the project will be conducted jointly by JICA and the Ghanaian authorities concerned, during the last six months of the cooperation term in order to examine the level of achievement.

VI. CLAIMS AGAINST JAPANESE EXPERTS

The GOG undertakes to bear claims, if any arises, against the Japanese experts engaged in technical cooperation for the Project resulting from, occurring in the course of, or otherwise connected with the discharge of their official functions in Ghana except for those arising from the willful misconduct or gross negligence of the Japanese experts.

VII. MUTUAL CONSULTATION

There will be mutual consultation between JICA and the GOG on any major issues arising from, or in connection with this Attached Document.

VIII. MEASURES TO PROMOTE UNDERSTANDING OF AND SUPPORT FOR THE PROJECT

For the purpose of promoting support for the Project among the people of Ghana, the GOG will take appropriate measures to make the Project widely known to the people of Ghana.

IX. TERMS OF COOPERATION

The duration of the technical cooperation for the Project under this Attached Document will be three (3) years commencing from the first visit of Japanese Experts.

ANNEX I	PROJECT DESIGN MATRIX
ANNEX II	PLAN OF OPERATION
ANNEX III	LIST OF JAPANESE EXPERTS
ANNEX IV	LIST OF MACHINERY AND EQUIPMENT
ANNEX V	LIST OF GHANAIAN COUNTERPART AND ADMINISTRATIVE PERSONNEL
ANNEX VI	OFFICE SPACE AND FACILITIES
ANNEX VII	PROJECT IMPLEMENTATION STRUCTURE
ANNEX VIII	JOINT COORDINATING COMMITTEE

4

Project Design Matrix

Project Title: The Project for Electrical Engineers Training for African Countries (EETA) **Version 0**
Implementing Agency: Electricity Company of Ghana (ECG) **Duration: 2010- 2013(Three Years)**
Project Site: Tema, Ghana **Target Group: Trainers of ECG**

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS*	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Overall Goal Distribution system operation and maintenance in ECG and third countries is improved	• Technical loss of distribution systems (Ghana •%, third countries •%) • Outage statistics(Ghana •%, third countries •%)	• Annual report of ECG and third countries	
Project Purpose: Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened	• Number of certified trainers of ECG (more than •) • Satisfactory rate for training (more than •%)	• Annual report of ECG and third countries • Quarterly Report of ECG and third countries	a. There is no drastic change in Energy Policy in Ghana. b. Necessary budget shall be allocated for training.
Outputs: 1 Current situation of distribution system operation and maintenance is analyzed and training needs are identified	• Report compiled training needs	• Quarterly Report of ECG and third countries • Project Progress Report	a. Trained trainers continue to work for ECG. b. Stakeholders fulfill their responsibilities in maintaining cooperation framework
2 Training for technicians of ECG and third countries is improved	• Number of certified trainees (Ghana: more than •, third countries: more than •) • Number of equipment and facilities identified for replacement, repair and new installation	• Quarterly Report of ECG and third countries • Project Progress Report • Inventory lists	
3 Training for engineers of ECG and third countries is implemented	• Number of implemented training programs • Number of trained trainees • Number of equipment and facilities identified for replacement, repair and new installation • Number of certified trainees (Ghana: more than •, third countries: more than •)	• Quarterly Report of ECG and third countries • Project Progress Report • Manuals and tools • Result of training assessment test	
4 Monitoring and management capacity of ECG training centre is improved	• Quality of revised texts • Quality of revised tools • Number of JCC meetings	• Quarterly Report of ECG and third countries • Project Progress Report • Questionnaire	

* • should be set up within three (3) months after the Project launched

Activities:	Inputs (Means and Cost)	IMPORTANT ASSUMPTIONS
1 Current situation of distribution system operation and maintenance is analyzed and training needs are identified 1-1 Review the electricity policy and plan of Ghana and regional cooperation framework 1-2 Review the current situation and challenges of distribution system O&M in ECG and the third countries 1-3 Review the current situation of human resources development of ECG engineers and technicians 1-4 Identify the training needs of ECG engineers and technician and the third countries 2 Training for technicians of ECG and third countries is improved 2-1 Review the existing training courses of ECG for technicians 2-2 Replace training equipments and facilities of ECG 2-3 Update necessary training materials 2-4 Deliver training programs for ECG technicians 2-5 Deliver training programs for the third countries 2-6 Observe the training performance and feed-back to training courses 3 Training for engineers of ECG and third countries is implemented 3-1 Develop syllabuses, curriculum and material for three training programs 3-2 Install new equipments and facilities for training 3-3 Strengthen skills and technology of ECG trainers 3-4 Deliver training programs for ECG engineers 3-5 Deliver training programs for the third countries 3-6 Observe the training performance and feed-back to training courses 4 Monitoring and management capacity of ECG training centre is improved 4-1 Observe and analyze the current capacity for monitoring and management of training 4-2 Prepare plan for methodologies and procedures for improvement 4-3 Improve ECG capacity for training monitoring and management	Japanese Side A. The personnel will be provided, as enumerated below: Assignment of Chief Advisor / Electrical Engineer for Distribution Planning (33kV/11kV) Electrical Engineer for Distribution System Operation (33kV/11kV) Electrical Engineer for Substation Operation Electrical Engineer for Substation Maintenance Equipment Specialist for Planning and Procurement Equipment Specialist for Operational Instruction Training Planning Coordinator B. Training Counterpart Training (ECG staff) in Japan C. Equipment etc. The equipment and tools will be provided depending on the necessity for effective implementation of the Project. Details will be discussed during the Project. D. Allocation of the necessary budget of trainings for third countries Allowances for third countries' trainees are provided by JICA. Transportation fee of trainees is arranged by own organization. The Ghanaian Side: A. Counterpart personnel will be provided, as enumerated below: Project Director Project Manager Project Coordinator Technical Manager Members of Technical Counterpart B. Joint Coordinating Committee (JCC) C. Office Space and others ECG will provide necessary office facilities including electricity, air-conditioning, water and internet during the duration of the project. D. Allocation of the necessary budget for the Project ECG allocates necessary budget for the activities described in PDM. E. Training for trainees of third countries ECG assigns necessary lecturers in order to implement trainings for third countries	Pre-conditions • Counterparts are assigned. • Necessary budget, office space and facilities for the Project are allocated.

ANNEX II

Plan of Operation

Project Title: The Project for Electrical Engineers Training for African Countries (EETA)
Implementing Agency: Electricity Company of Ghana (ECG)
Target Group: Trainers of ECG
Project period: 3 years (2010-2013)

Activities	JFY 2010		JFY 2011				JFY 2012				JFY 2013					In Charge	
	2010		2011				2012				2013				2014		
	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	GH	JPN
Project period: 3 years (2010-2013)			→												→			
1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified																		
1-1 Review the electricity policy and plan of Ghana and regional cooperation framework			■															
1-2 Review the current situation and challenges of distribution system O&M in ECG and the third countries			■															
1-3 Review the current situation of human resources development of ECG engineers and technicians			■															
1-4 Identify the training needs of ECG technicians and engineers and the third countries			■															
2. Training for technicians of ECG and third countries is improved																		
2-1 Review the existing training courses of ECG for technicians			■															
2-2 Replace training equipments and facilities of ECG																		
(a) Select equipments and facilities to be replaced			■															
(b) Procure equipments and facilities				■	■	■												
(c) Install and setup procured equipments and facilities						■												
(d) Maintain properly the replaced equipments and facilities							■	■	■	■	■	■	■	■	■	■		
2-3 Update necessary training materials						■												
2-4 Deliver of training programs for ECG technicians			■	■	■	■	■	■	■	■	■	■	■	■	■	■		
2-5 Deliver of training programs for the third countries			■	■			■	■			■	■						
2-6 Observe the training performance and feed-back to training courses			■	■	■	■	■	■	■	■	■	■	■	■	■	■		
3. Training for engineers of ECG and third countries is implamented																		
3-1 Develop syllabuses, curriculum and material for three training programs																		
(a) Review the existing syllabuses, curriculum and material for training			■															
(b) Prepare plan for methodologies and procedures for implementation				■														
(c) Upgrade syllabuses, curriculum and material for training					■	■	■	■	■	■								
3-2 Install new equipments and facilities for training																		
(a) Select equipment and facilities to be replaced			■	■														
(b) Procure equipment and facilities					■	■	■	■	■	■								
(c) Install and setup procured equipment and facilities									■	■								
(d) Maintain properly the renewed equipment and facilities										■	■	■	■	■	■	■		
3-3 Strengthen skills and technology of ECG trainers																		
(a) Select trainers and define the target skills and technology for strengthening			■															
(b) Prepare plan for methodologies and procedures for training of trainers				■	■													
(c) Implement training for trainers						■	■	■	■	■	■							
(d) Conduct trainer assessment test for certification									■	■								
3-4 Deliver training programs for ECG engineers																		
(a) Formulate course schedule								■	■									
(b) Select lecturers									■	■								
(c) Arrange logistics										■	■							
(d) Deliver the training and follow up the action plan made by participants											■	■	■	■	■	■		
3-5 Deliver training programs for third countries																		
(a) Formulate course schedule									■	■								
(b) Select lecturers										■	■							
(c) Arrange logistics											■	■						
(d) Deliver the training and follow up the action plan made by participants												■	■		■	■		
3-6 Observe the training performance and feed-back to training courses											■	■	■	■	■	■		
4. Monitoring and management capacity of ECG Training Centre is improved																		
4-1 Observe and analyze the current capacity for monitoring and management of training			■	■														
4-2 Prepare plan for methodologies and procedures for improvement				■	■													
4-3 Improve ECG capacity for training monitoring and management					■	■	■	■	■	■	■	■	■	■	■	■		
Evaluations																		
Mid-term Evaluation of the project									▲									
Final Evaluation of the project														▲				

ANNEX III

LIST OF JAPANESE EXPERTS

Experts will be dispatched as needed.

The fields of experts will be described as needed including the following fields:

<Technical expert Team >

Chief Advisor / Electrical Engineer for Distribution Planning (33kV/11kV)

Electrical Engineer for Distribution System Operation (33kV/11kV)

Electrical Engineer for Substation Operation

Electrical Engineer for Substation Maintenance

Equipment Specialist for Planning and Procurement

Equipment Specialist for Operational Instruction

Training Planning

Coordinator

ANNEX IV

LIST OF MACHINERY AND EQUIPMENT

Part of the machinery and equipment necessary for the effective implementation of the Project will be provided by the Japanese side within the budget allocated for technical cooperation. Necessary equipment for the project implementation will be decided upon mutual agreement.

Current requested equipment are as listed below,

- Equipment and installation of 33kV substation for training
- Computers, coulor printer and accessory for the library
- Primary and secondary injection test set
- Transformer oil tester
- Power analyser
- Dynamometer for linesmen
- Survey equipment complete
- Portable cable fault locator
- Electronic boards
- Bus
- Teaching aids

Other facilities will be decided upon mutual agreement.

ANNEX V

LIST OF THE GHANAIAN COUNTERPARTS AND ADMINISTRATIVE PERSONNEL

1. Counterpart personnel

(1) Project Director

Chief Director, Ministry of Energy

(2) Project Manager

Managing Director, ECG

(3) Project Coordinator

Principal of ECG Training Centre

(4) Technical Manager

Technical Manager, ECG Training Centre

(5) Members of Technical Counterpart

5 (five) Technical Engineers and Instructors, ECG

2. Administrative personnel

(1) Administrative Coordinator

(2) Other supporting staff necessary for the project implementation

ANNEX VI

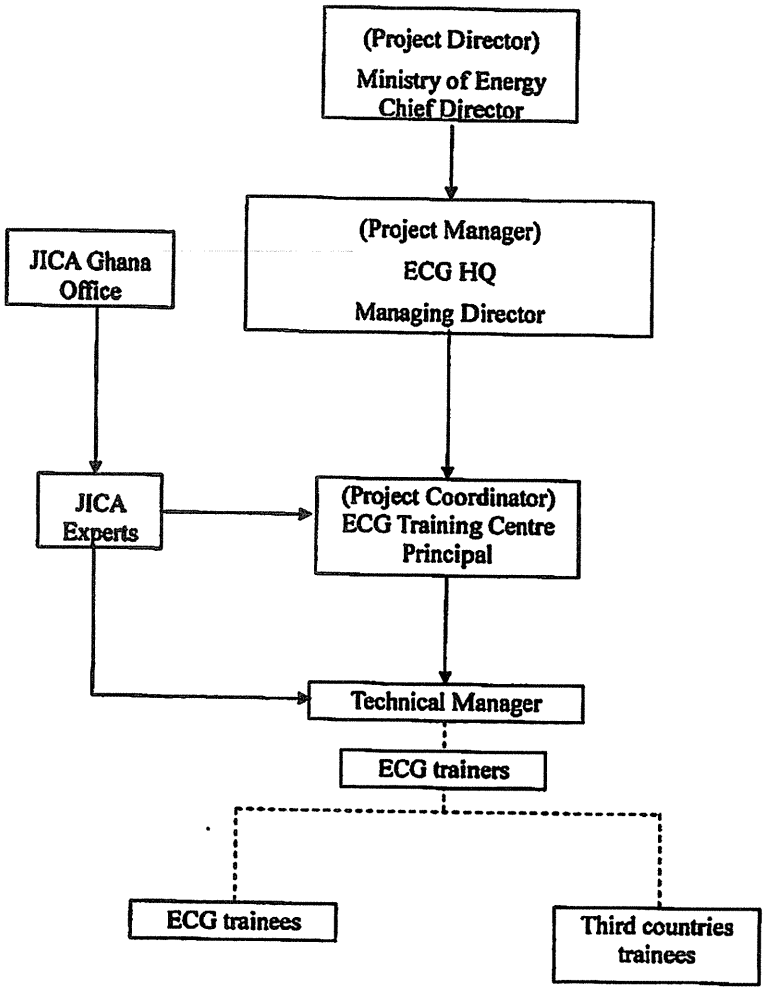
OFFICE SPACE AND FACILITIES

The following will be provided by the Ghanaian side for the project implementation.

1. Office space and facilities at ECG training centre in Tema for the implementation of the project;
2. Electricity, air conditioning, water supply and internet facilities;
3. Other facilities agreed upon as necessary.

ANNEX VII

PROJECT IMPLEMENTATION STRUCTURE



ANNEX VIII

JOINT COORDINATING COMMITTEE

1. Function

The Joint Coordinating Committee (JCC) will meet at least once a year or whenever necessity arises. The main functions of JCC are:

(1) To approve the Annual Plan of Operation formulated by the Project in accordance with the Record of Discussions.

(2) To review the overall progress of the Project and activities carried out under the above-mentioned Annual Plan of Operation in particular,

(3) To review and exchange views on major issues arising from or concerning the Project,

(4) To facilitate coordination with other relevant authorities.

2. Membership

(1) Chairperson:	Project Director
(2) Co chairperson:	Chief Representative, JICA Ghana Office
(3) Vice Chairperson:	Project Manager
(4) Ghanaian side (others):	a. Director of Power, MOE
	b. Project Coordinator
	c. Technical Manager
(5) Japanese side:	a. Representative of JICA Ghana Office
	b. Japanese Experts of the Project
(6) Related Organization:	Representative of WAPP secretariate

(7) Other relevant personnel mutually agreed upon

Note: Official(s) of Embassy of Japan may attend the JCC as observer(s)

Minutes of Understandings
for
the Project on Electrical Engineers Training for African Countries

1. Counterpart Training in Japan

(1) Course Title : Human Resource Development in Power Distribution

(2) Duration of the Training : 25 May (arrival date) ~ 7 June (departure date)

(3) Total Number : Seven (7)

Candidate Participants of the Training

1) Mr. George Yaw Marfo : Principal, ECG Training Center
2) Mr. Andoh Samuel : Instructor, ECG Training Center
3) Mr. Agbi Bless Worlanyo : Instructor, ECG Training Center
4) Mr. Peter King Asare : Instructor, ECG Training Center
5) Mr. Maxwell Essel : Instructor, ECG Training Center
6) Mr. Isaac K. Nukpezah : Instructor, ECG Training Center
7) Mr. Kingsford Amoako : Instructor, ECG Training Center

(4) Others

If you have the request to the contents of the training course, please inform us until the end March 2014.

2. Training Course for Technicians of ECG

(1) Course Title: Maintenance Techniques for Power Equipment and Implementation Procedure

(2) Duration of the Training : 23 June ~ 27 June 2014

(3) Nominee Qualifications

Junior Technician less than 3 years' experience in the relevant field

(4) Total Number : Ten (10)

(5) All the preparation work such as recruitment and selection of the nominee would be done by ECG.

3. Training Course for Technicians of Third countries

(1) Course Title: Maintenance Techniques for Power Equipment (Overhead Line)

(2) Duration of the Training : 30 June ~ 11 July 2014

(3) Nominee Qualifications

- Technical school graduate
- more than one or two years' experience

(4) Total Number : Twelve (12) (Liberia 3, Sierra Leone 3, Gambia 6)

(5) Official invitation letter would be send to the relevant countries by ECG until the end of March 2014 and deadline date of the application would be end of May 2014.

(6) The distribution equipment and tools necessary for the practical training should be prepared by the ECG side by the middle of May 2014.

(7) All undertakings for the implementation of the training would be followed in accordance with the MOU on 29th of Sep. 2011 between Ghana and relevant countries.

4. Second Joint Coordinating Committee

At the end of the first year of the Project, Second Joint Coordinating Committee would be held in order to review the overall progress of the Project.

Both sides confirmed the date of the meeting would be 18th July 2014.

5. Assignment of the Counterpart personnel in the field of "Protection and Control" and "Distribution Planning"

In the second year of the Project, training course titled "Protection and Control" would be prepared for the engineers of ECG and Third countries.

The Expert Team requested to assign the counterpart for this training course.

Mr. Marfo answered that Mr. Maxwell Essel and Mr. George Hommey would be assigned to the "Protection and Control" and Mr. Godfred Mensah would be assigned to "Distribution Planning".

The Expert Team requested to have the meeting with them in the duration of the next visit in June

Both Sides confirmed the above mentioned matters.

Date : 11 March 2014

At: ECG training Center in Tema, Ghana

Mr. George Yaw Marfo	Mr. Hiroshi Kurakata
Principal	Chief Advisor
ECG Training Center	JICA Expert Team

Minutes of Understandings
for
the Project on Electrical Engineers Training for African Countries

1. Training Course for Engineers of ECG "System Protection and Control"

(1) Member of the Counterpart Group

- Mr. George Hommey
- Mr. Rodnell Bilson
- Mr. Maxwell Essel
- Mr.Frank Osei Owusu
- Mr.Kingsford Amoako
- Mr.Isaac Nukpezah

(2) Syllabus and Curriculum

The syllabus and curriculum of this training course are shown in Annex-1(1),(2).

A textbook would be prepared based on this syllabus and curriculum.

(3) Duration of the Training Course : 23 Feb.~27 Feb. 2015 (5 days)

(4) Qualifications: Regional Engineer less than 40 years old

(5) Number of the Trainee: Ten(10)

2. Training Course for Engineers of Third Countries "System Protection and Control"

(1) Member of the Counterpart Group are same as above 1.(1).

(2) Syllabus and Curriculum

The syllabus and curriculum of this training course are shown in Annex-2.

A same textbook would be used as above 1 for this training course.

(3) Duration of the Training Course : Two (2) weeks in the second half of July 2015

But at this moment it is considered to be postponed due to Ebola fever.

(4) Qualifications

Engineer from Protection Department

(5) Number of the trainee:

Two (2) each from Liberia, Sierra Leone and Gambia (Total six (6))

3. Training Course for Engineers of ECG "Distribution Planning"

(1) Member of the Counterpart Group

- Mr. Godfred Mensah
- Mr.Ekow Appiah Kwofie
- Mr. Frank Antwi Boakye

(2) Syllabus and Curriculum

The syllabus of this training course is shown in Annex-3.

A textbook would be prepared based on this syllabus.

(3) Duration of the Training Course : 5 days in the first half of July 2015

(4) Qualifications: Engineer less than 40 years old

(5) Number of the trainee: Ten (10)

4. Monitoring Activities

Expert Team requested ECG to follow the monitoring activities of the following training courses conducted in the first year of the Project.

ECG agreed to send the questionnaires to the trainees and collect the answers.

(1) Training Course for Technicians of ECG : 23 June ~ 27 June 2014

"Maintenance Techniques for Power Equipment and Implementation Procedure"

1) Questionnaire for trainees Supervisors
2) Post- training Review (to follow up Action Plan)

(2) Training Course for Technicians of Third Countries : 30 June ~ 11 July 2014

"Maintenance Techniques for Power Equipment (Overhead Line)"

1) Questionnaire for trainees Supervisors
2) Post- training Review (to follow up Action Plan)

(3) Country Focused Training in Japan : 27 May ~ 7 June 2014

1) Post- training Review (to follow up Action Plan): After 7 Dec..2014

Both Sides confirmed the above mentioned matters.

Date : 27th October 2014

Place: ECG Training Center in Tema, Ghana

Mr. George Yaw Marfo	Mr. Hiroshi Kurakata
Principal	Chief Advisor
ECG Training Center	JICA Expert Team

Annex-1(1) Syllabus System Protection and Control

- Course Title: Protection and Operation of Power Distribution System (Protection Technology of Power System)
- Duration: 1 Week (5 days)
- Target of Training: Newly Employeed Engineers
- To understand the basics of the protection system of the power system, and to learn the procedures of relay setting
- Text Book: (Newly prepared)

< Syllabus (Tentative) >

	Large Item	Middle Item	Contents
1	Overview of Electric Power System	Overview of basic configuration & features of Transmission and Distribution systems	Configuration and Characteristics of Transmission and Distribution system
		Configuration of Substation Equipment	Function of Substations, Types of substations, Busbar Arrangement, Main Substation Equipment and its Function
		Instrument Transformers	Purpose of Use, Structure of VT,CT, Operating Suggestions of VT,CT
2	Overview of protection relay system	Basic Objectives of Protection System	Basic Objectives of Protection System
		Configuration of Protection Relay System	System Configuration, Fail-safe System, Protection Zone and Blind Spot
		Type of Protection Relay System	Classification of Objectives, Type of Protective Relays, Type of detection method (Outline of Over-current, Directional, Distance, Differential Relay)
3	Neutral Grounding System	Objectives of Neutral Grounding	Overview of neutral grounding system
		Classification of Neutral Grounding System	-Overview of Each Method and Characteristics (Solidly, Resistance, Ungrounded grounding system) - Fault type and Vector Diagram of Voltage and Current for Each Neutral Grounding System - Voltage rise of Sound Phase at the time of Single line Ground Fault and Effective Grounding System
		Neutral Grounding System and Waveform of Voltage and Current	To understand how to analyze the fault and operating status of the protective relay, from the relay signal and the operating voltage and current waveforms which are recorded in the oscilloscope, when the system fault occurs.
4	Protection System for Substation	Transformer Protection System	Outline of Differential Relays and Mechanical Relays
		Bus Protection System	Characteristics of Bus Protection System, Bus Protection by Bus Configuration, Countermeasures against CT Saturation
5	Transmission Line Protection System	Outline of Transmission Line Protection System	- Outline of Transmission Line Protection System - Outline of Transmission Line Protection without Signal Transmission (Overcurrent, Distance, Directional Grounding Relays) - Outline of Transmission Line Protection with Signal Transmission (Pilot-wire, Current Differential, Directional Comparison, Phase Comparison Protection)
		Outline of High-speed Reclosing System	Purpose of High-speed Reclosing System and Outline of each method of reclosing
6	Distribution line Protection System	Outline of Distribution Line Protection System	Outline of Distribution Line Protection
		Short Circuit Protection	Outline of Short Circuit Protection (Overcurrent, Directional Overcurrent)
		Ground Fault Protection	Outline of Ground Fault Protection (Ground Overcurrent, Directional Ground, SEF[Sensitive Earth Fault Protection])
		Automatic Reclosing Equipment for Distribution Line	- Outline of Reclosing System of Distribution Lines - Reclosing System of Distribution Line in Japan
7	Fault Calculation	Fault calculation by the percent-impedance method	Outline of Percent impedance and Per-unit method and Exercise
		Impedance Map	Outline of Management of Impedance Map
		Fault calculation by the method of symmetrical components	Outline of Symmetrical Components and Fault Calculation Example
8	Relay Setting	Overview of Relay setting	Work flow of Relay Setting, Basic Policy of Relay Setting, General Consideration for Relay Setting
		Protection Coordination	Point of view for Time Coordination and Sensitivity Coordination
		Example of Relay setting for Overcurrent relay	Example of Relay setting for Overcurrent relay
		Example of Relay setting for Distance Relay	Example of Relay setting for Distance Relay

Annex1(2) Curriculum "System Protection and Control "

DAYS	8:30am – 9:00am	9:00am – 10:00am	10:00am-10:15am	10:15am –12noon	12noon - 1pm	1pm – 3:30pm
Day 1	**Registration and Opening Ceremony**	0. Orientation 1. Overview of Electric Power System ***Name (lecturer):*** ***ING. George Hommey***	Snack Break	1. Overview of Electric Power System ***Name:*** ***ING. George Hommey***	Lunch Break	2. Overview of protection relay system ***Name:*** ***ING. George Hommey***
Day 2	3. Neutral Grounding System ***Name:*** ***ING. Rodnell Bilson***			4. Protection System for Substation (Transformer Protection System) ***Name:*** ***ING. Rodnell Bilson***		4. Protection System for Substation (Transformer Protection System) ***Name:*** ***ING. Rodnell Bilson***
Day 3	4. Protection System for Substation (Bus Protection System) 5. Transmission Line Protection System ***Name:*** ***ING. Rodnell Bilson***			5. Transmission Line Protection System ***Name:*** ***ING. Rodnell Bilson***		6. Distribution line Protection System ***Name:*** ***ING. Frank Osei Owusu***
Day 4	6. Distribution line Protection System ***Name:*** ***ING. Frank Osei Owusu***			7. Fault Calculation ***Name:*** ***ING. Frank Osei Owusu***		8. Relay Setting ***Name:*** ***ING. Frank Osei Owusu***
Day 5	8. Relay Setting (Practice using Simulator) ***Name:*** ***ING. Frank Osei Owusu*** ***Engr. Maxwell Essel***			8. Relay Setting (Practice using Simulator) ***Name:*** ***ING. Frank Osei Owusu*** ***Engr. Maxwell Essel***		8. Relay Setting (Practice using Simulator) ***Name:*** ***ING. Frank Osei Owusu*** ***Engr. Maxwell Essel*** Evaluation

Note: Name in bold means a name of Instructor

Annex-2. Curriculum for Third Countries "System Protection and Control" (First week)

DAYS	8:30am – 9:00am	9:00am – 10:00am	10:00am-10:15am	10:15am –12noon	12noon - 1pm	1pm – 3:30pm
Day 1	**Registration and Opening Ceremony**	0. Orientation 1. Overview of Electric Power System ***Name (lecturer):*** ***ING. George Hommey***	Snack Break	1. Overview of Electric Power System ***Name:*** ***ING. George Hommey***	Lunch Break	2. Overview of protection relay system ***Name:*** ***ING. George Hommey***
Day 2	3. Neutral Grounding System ***Name:*** ***ING. Rodnell Bilson***			4. Protection System for Substation (Transformer Protection System) ***Name:*** ***ING. Rodnell Bilson***		4. Protection System for Substation (Transformer Protection System) ***Name:*** ***ING. Rodnell Bilson***
Day 3	4. Protection System for Substation (Bus Protection System) 5. Transmission Line Protection System ***Name:*** ***ING. Rodnell Bilson***			5. Transmission Line Protection System ***Name:*** ***ING. Rodnell Bilson***		6. Distribution line Protection System ***Name:*** ***ING. Frank Osei Owusu***
Day 4	6. Distribution line Protection System ***Name:*** ***ING. Frank Osei Owusu***			7. Fault Calculation ***Name:*** ***ING. Frank Osei Owusu***		8. Relay Setting ***Name:*** ***ING. Frank Osei Owusu***
Day 5	8. Relay Setting (Practice using Simulator) ***Name:*** ***ING. Frank Osei Owusu*** ***Engr. Maxwell Essel***			8. Relay Setting (Practice using Simulator) ***Name:*** ***ING. Frank Osei Owusu*** ***Engr. Maxwell Essel***		8. Relay Setting (Practice using Simulator) ***Name:*** ***ING. Frank Osei Owusu*** ***Engr. Maxwell Essel*** **Evaluation**

Note: Name in bold means a name of Instructor

Annex-2. Curriculum for Third Countries "System Protection and Control" (Second week)

DAYS	8:30am – 10:00am	10:00am-10:15am	10:15am –12noon	12noon - 1pm	1pm – 3:30pm
Day 6	Introduction of the substation for the training ***Name (lecturer):*** ***ING.***	Snack Break	Fault calculation for relay setting of the substation (for short circuit) ***Name:*** ***ING.***	Lunch Break	Fault calculation for relay setting of the substation (short circuit) ***Name:*** ***ING.***
Day 7	Fault calculation for relay setting of the substation (for short circuit) ***Name:*** ***ING.***		Fault calculation for relay setting of the substation (for ground fault) ***Name:*** ***ING.***		Fault calculation for relay setting of the substation (for ground fault) ***Name:*** ***ING.***
Day 8	Instruction of distance relay of the substation and set or confirm the relay setting ***Name:*** ***ING.***		Characteristic test of distance relay (Practice using measuring instrument) ***Name:*** ***ING.***		Characteristic test of distance relay (Practice using measuring instrument) ***Name:*** ***ING.***
Day 9	Instruction of differential relay of the substation and set or confirm the relay setting ***Name:*** ***ING.***		Characteristic test of differential relay (Practice using measuring instrument) ***Name:*** ***ING.***		Characteristic test of differential relay (Practice using measuring instrument) ***Name:*** ***ING.***
Day 10	Instruction of overcurrent and earth fault relay of the substation and set or confirm the relay setting ***Name:*** ***ING.***		Characteristic test of overcurrent relay (Practice using measuring instrument) ***Name:*** ***ING.***		Characteristic test of overcurrent relay (Practice using measuring instrument) ***Name:*** ***ING.*** **Evaluation**

Note: Name in bold means a name of Instructor

Annex3. Syllabus of "Distribution Planning"

・Course Title: Distrinution Planning
・Duration 3Days
・Target Trainee of the training: Newly engaged Engineer
・Aimed result : To understand the basic concept of power distribution planning work and to learn the
・Text: Newly Devoloped

Table2.2.3-5 「Distrinution Planning」 Syllabus

No.	Large item	middle item	Contents
1	The purpose and the outline of the power distribution planning work	・Aims of power distribution planning ・Implementation procedure of power distribution planning work ・Considerations in power distribution planning	・Understanding the significance of the power distribution planning ・Explaining the key points of each element and the flow of the major implementation elements in the power distribution planning work ・Organizing the important matters to be considered in planning.
2	Basic configuration of distribution system and its characteristics	・Basic configuration of distribution system ・Characteristics of different configuration of primary distribution system ・Loss generation characteristics of the low-voltage distribution systems	Organizing in viewpoint shown in the middle item the characteristics of distribution system which is basic information for forming proper facilities.
3	Power distribution facilities of ECG (Reconfirmation)	Overview of the power distribution facilities	Understanding of the basic conditions and properties through Reconfirmation
		Configuration of Medium voltage (33 kV power distribution system.	Ditto
		Configuration of Medium voltage (11 kV) power distributuion system.	Ditto
		Configuration of Low voltage (400 V) power distributuion system.	Low voltage system including distribution transformer
		Configuration of all underground power distribution system	11kV and Low voltage system including distribution transformer
		Unit construction cost of standard facilities	Setting the standard unit construction cost of each voltage class and facilities installation manner. (Setting at least approximate value assumed by ECG) These data are used to make and compare the alternative plans.
4	Quality of power distribution	The following items should be considered as a constraint condition in order to appropriately form facilities.	
		electricity supply reliability	Understanding the definition in ECG or international standards
		voltage standards and regulation	Understanding the definition in ECG or international standards
		supply frequency	Understanding the definition in ECG or international standards
		Flicker	Understanding the definition in ECG or international standards
		Harmonics (Voltage wave distortion)	Understanding the definition in ECG or international standards
		Instantaneous power failure	Understanding the definition in ECG or international standards
5	Load characteristics of power distribution lines	Indicators of demand characteristics	To understand the definition of load factor, demand rate, diversity factor etc.
		Load types and their characteristics	To describe the characteristics of various loads that compose the load curve of a distribution line. For example, the type of load (contract type, industry, etc.), examples of demand structure analysis by region. Based on this, to explain the relationship of diversity factor among distribution lines with various load curve.
6	Demand projection	Basic theory of demand projection	To understand the overview of projention methods such as assumption by the trend or correlation analysis etc.
		Examples of the specifically regional demand projection	To get better understanding of the methods based on concrete case of the demand forecast.

7	Analysis of System characteristics and Evaluation	・System Loss Analysis ・Voltage Regilation Analysis ・Fault Level Analysis	・Explaining the principle of power flow calculation and loss generation caracteristic of distribution system ・Explaining fault calculation method for the system with resistance erthing of neutral , and the application of the method for various system configulations (circuit topology) ・Explaining the voltage drop calculation method and voltage regulation technology for each voltage level (ECG should make several exercises based on expansion project examples of ECG.
8	Reliability Analysis and evaluation of system	Reliability evaluation index	・Explaining the definitions of various reliability index and the significance of them. . ・Understanding the relation between each reliability index and equipment, and the method of utilizing an index.
9	Economic evaluation (Engineering Economics)	Economic calculation methods	Method of calculating present value considering interest rate (Engineering-Economy Method)
		Economic comparison (Applied Cost -benefit method)	Cost accounting method and Annual Value Model method
		Specifications of Economic calculation	Calculation period and expenses (facility-related costs. loss cost)
10	The procedure of Power distribution facilities planning	Basic concepts	Issues to consider in the distribution planning such as ensuring availability and reliability (Reconfirmation)
		Expansion planning method	Bbasic policy for power distribution line expansion and detailed procedures
		Indicators for facility management	To understand objective indicators for measuring and analyzing actual demand, facilities, services and how to use these indicators. (Normal capacity and Emergency capacity , Divercity factor, compression rate, Load factor)
11	Practice of planning	Exercise (comparison using system analysis, profitability calculations and investment appraisasls)	Through the case studies using the model cases, understanding the way of thinking(concept of forming facilities and break even colculations) and investigation procedures of ECG. (ECG should make several exercises based on expansion project examples of ECG.

Minutes of Understandings
for
the Project on Electrical Engineers Training for African Countries

1. Training Course for Engineers of ECG "Distribution Planning"

(1) Syllabus and Curriculum

The syllabus and curriculum of this training course are shown in Annex-1(1), (2).

A textbook was developed based on this syllabus and curriculum.

(2) Duration of the Training Course : 6th ~10th July 2015 (5 days)

(3) Qualifications: Regional Engineer less than 40 years old

(4) Number of the Trainee: Ten(10)

2. Training Course for Technicians of ECG "Maintenance Techniques for Power Equipment and Implementation Procedure" (2nd)

(1) Duration of the Training Course : 22nd ~ 26th June 2015 (5 days)

(2) Qualifications: Junior Technician less than three (3) years` experience and under the age of 40 is favorable.

(3) Number of the Trainee: Ten(10)

(4) Monitoring Activities

Monitoring Activities for this training Couse will be conducted by the Ghanaian C/P with the assistance of JICA Expert Team.

3. Assignment of the C/P for the Training Course for Engineers of ECG "Distribution Design"

This training course is planning to be held in the third year of the Project.

(1) Member of the Counterpart Group

Main C/P is Mr.Osei Adofo, General Manager of Distribution Design and he will appoint the other C/P personnel.

4. Third (3) Joint Coordinating Committee

At the end of the Project Activities of the 2nd year, we will have the Joint Coordinating Committee to discuss and exchange views on the progress of the Project.

Both side confirmed that the date would be around 17th July 2015.

The date will be fixed by the convenience of related people.

5. Recommendation to the ECG Training Center

JICA Expert Team would like to recommend to ECG Training Center to maximize the utilization of the Simulator as follows.

The SCADA system should be connected to the Simulator for better training.

(Notes: The SCADA system can display conditions and parameters of the Power System Models and Relays on the Simulator.)

Both Sides confirmed the above mentioned matters.

Date : 20th March 2015

Place: ECG Training Center in Tema, Ghana

Mr. George Yaw Marfo	Mr. Hiroshi Kurakata
Principal	Chief Advisor
ECG Training Center	JICA Expert Team

Annex-1 (1)

Syllabus of【Distribution Planning】

- Course Title: Distrinution Planning
- Duration 3Days
- Target Trainee of the traini
- Aimed result : To understand the basic concept of power distribution planning work and to learn the implementation procedures.
- Text: Newly Devoloped

No.	Large item	middle item	Contents
1	Purpose and the outline of distribution planning tasks	・Aims of power distribution planning ・Implementation procedure of power distribution planning work ・Considerations in power distribution planning	・Understanding the significance of the power distribution planning ・Explaining the key points of each element and the flow of the major implementation elements in the power distribution planning work ・Organizing the important matters to be considered in
2	Basic configuration and characteristics of distribution systems	・Basic configuration of distribution system ・Characteristics of different configuration of primary distribution system ・Loss generation characteristics of the low-voltage distribution systems	Organizing in viewpoint shown in the middle item the characteristics of distribution system which is basic information for forming proper facilities.
3	Configuration of distribution facilities in ECG (Reconfirmation)	Overview of the power distribution facilities	Understanding of the basic conditions and properties through Reconfirmation
		Configuration of Medium voltage (33 kV power distribution system.	Ditto
		Configuration of Medium voltage (11 kV) power distributuion system.	Ditto
		Configuration of Low voltage (400 V) power distributuion system.	Low voltage system including distribution transformer
		Configuration of all underground power distribution system	11kV and Low voltage system including distribution transformer
		Unit construction cost of standard facilities	Setting the standard unit construction cost of each voltage class and facilities installation manner. (Setting at least approximate value assumed by ECG) These data are used to make and compare the alternative plans.
4	Quality of power distribution	The following items should be considered as a constraint condition in order to appropriately form facilities.	
		electricity supply reliability	Understanding the definition in ECG or international standards
		voltage standards and regulation	Understanding the definition in ECG or international standards
		supply frequency	Understanding the definition in ECG or international standards
		Flicker	Understanding the definition in ECG or international standards
		Harmonics (Voltage wave distortion)	Understanding the definition in ECG or international standards
		Instantaneous power failure	Understanding the definition in ECG or international standards
5	Load characteristics of distribution lines	Indicators of demand characteristics	To understand the definition of load factor, demand rate, diversity factor etc.
		Load types and their characteristics	To describe the characteristics of various loads that compose the load curve of a distribution line. For example, the type of load (contract type, industry, etc.), examples of demand structure analysis by region. Based on this, to explain the relationship of diversity factor among distribution lines with various load curve.
6	Demand projection	Basic theory of demand projection	To understand the overview of projention methods such as assumption by the trend or correlation analysis etc.
		Examples of the specifically regional demand projection	To get better understanding of the methods based on concrete case of the demand forecast.

7	Analysis and Evaluation of System characteristics	・System Loss Analysis ・Voltage Regilation Analysis ・Fault Level Analysis	・Explaining the principle of power flow calculation and loss generation caracteristic of distribution system ・Explaining fault calculation method for the system with resistance erthing of neutral , and the application of the method for various system configulations (circuit topology) ・Explaining the voltage drop calculation method and voltage regulation technology for each voltage level (ECG should make several exercises based on expansion project examples of ECG.)
8	Reliability Analysis and evaluation of the distribution system	Reliability evaluation index	・Explaining the definitions of various reliability index and the significance of them. . ・Understanding the relation between each reliability index and equipment, and the method of utilizing an index.
9	Economic evaluation (Engineering Economics)	Economic calculation methods	Method of calculating present value considering interest rate (Engineering-Economy Method)
		Economic comparison (Applied Cost -benefit method)	Cost accounting method and Annual Value Model method
		Specifications of Economic calculation	Calculation period and expenses (facility-related costs, loss cost)
10	How to proceed with distribution facilities planning	Basic concepts	Issues to consider in the distribution planning such as ensuring availability and reliability (Reconfirmation)
		Expansion planning method	Bbasic policy for power distribution line expansion and detailed procedures
		Indicators for facility management	To understand objective indicators for measuring and analyzing actual demand, facilities, services and how to use these indicators. (Normal capacity and Emergency capacity , Divercity factor,
11	Practice of distribution planning	Exercise (comparison using system analysis, profitability calculations and investment appraisals)	Through the case studies using the model cases, understanding the way of thinking(concept of forming facilities and break even colculations) and investigation procedures of ECG. (ECG should make several exercises based on expansion project examples of ECG.

Annex-1(2) Program of the Training for ECG Engineer "Distribution Planning"

DAYS	8:30am – 9:00am	9:00am – 10:00am	10:00am-10:15am	10:15am –12noon	12noon - 1pm	1pm – 3:30pm
Day 1	Registration , Opening Ceremony, and Questionnaire		Snack Break	1.Purpose and the outline of distribution planning tasks 3.Configuration of distribution facilities in ECG	Lunch Break	2.Basic configuration and characteristics of distribution systems 4.Quality of power distribution
Day 2	5.Load characteristics of distribution lines 6.Demand projection			*7.Analysis and Evaluation of System characteristics*		7.Analysis and Evaluation of System characteristics
Day 3	*7.Analysis and Evaluation of System characteristics*			8.Reliability Analysis and evaluation of the distribution system 9. Economic evaluation		10.How to proceed with distribution facilities planning
Day 4	11. Practice of planning (Network Modeling and Analysis 1)			11. Practice of planning (Network Modeling and Analysis 2)		11. Practice of planning (Network Modeling and Analysis 3)
Day 5	11. Practice of planning (Economic Engineering)			*Evaluation, Making Action plan, and Closing Ceremony*		

Note: ECG System Planning is in charge of this training course.

Minutes of Understandings
for
the Project on Electrical Engineers Training for African Countries

1. Training Course for Engineers of ECG "Distribution Design"
   (1) Duration of the Training Course : 15th ~19th February 2016 (5 days)
   (2) Qualifications: Regional Engineer less than 10 years' experience
   (3) Number of the Trainee: Ten(10)
   (4) Instructor: Mr. Osei Adofo Sectional Manager Distribution Design

2. Training Course for Engineers of ECG " System Protection and Control " (2nd)
   (1) Duration of the Training Course : 1st ~ 5th February 2016 (5 days)
   (2) Qualifications: Regional Engineer engaging technical occupation of system protection and control
   (3) Number of the Trainee: Ten(10)
   (4) Monitoring Activities
   Monitoring Activities for this training Couse will be conducted by the Ghanaian C/P with the assistance of JICA Expert Team.

3. Joint Evaluation
   Joint Evaluation of the Project will be conducted jointly by JICA and ECG in Feb. 2016 in order to examine the level of achievement of the PDM.

Both Sides confirmed the above mentioned matters.

Date : 1st December, 2015
Place: ECG Training Center in Tema, Ghana

Mr. George Yaw Marfo
Principal
ECG Training Center

Mr. Hiroshi Kurakata
Chief Advisor
JICA Expert Team

Minutes of Understandings
for
the Project on Electrical Engineers Training for African Countries

1. Training Course for Engineers of ECG "Distribution Planning" (2nd)
   (1) Duration of the Training Course : 18th ~22th July 2016 (5 days)
   (2) Qualifications: Regional Junior Engineer less than ten (10) years` experience is favorable.
   (3) Number of the Trainee: Ten(10)
   (4) Monitoring Activities
   Monitoring Activities for this training Couse will be mainly conducted by the Ghanaian C/P with the assistance of JICA Expert Team.

2. Training Course for Technicians of ECG "Maintenance Techniques for Power Equipment and Implementation Procedure" (3rd)
   (1) Duration of the Training Course : 11th ~ 15th July 2016 (5 days)
   (2) Qualifications: Junior Technician less than five or six (5 or 6) years` experience and under the age of 40 is favorable.
   (3) Number of the Trainee: Ten(10)
   (4) Monitoring Activities
   Monitoring Activities for this training Couse will be mainly conducted by the Ghanaian C/P.

3. Fifth (5) Joint Coordinating Committee
   At the end of the Project, we will have the Joint Coordinating Committee to review the whole activities of the Project and check the performance of the Project. Both side confirmed that the date will be around 28th July 2016.
   The date will be fixed by the convenience of related people.

Both Sides confirmed the above mentioned matters.

Date : 9th March 2016
Place: ECG Training Center in Tema, Ghana

Mr. George Yaw Marfo
Principal
ECG Training Center

Mr. Hiroshi Kurakata
Chief Advisor
JICA Expert Team

ANNEX 4 (3) Minutes of JCC

Minutes of the First Joint Coordinating Committee for the Project on Electrical Training for African Countries (EETA)

1. **Date:** 9th December, 2013
2. **Time:** 10.00 am ~ 12.00 pm
3. **Venue:** Conference room at the ECG Training Centre
4. Participants: As attached in Annex-5

5. **Major Objectives of the Committee**
   - To review the overall progress of the project and its activities carried out under the Annual Plan of Operation; and
   - To review and exchange views on major issues arising from or concerning the Project.

6. **Framework of the Project**
   Mr. Kurakata, the Chief Advisor of the consultant team, presented the project activities that are and will be implemented based on the Record of Discussions (hereinafter referred to as "R/D") signed on 30th November, 2010. The following training courses would be formulated in the Project in order to achieve the project purpose. The documents are herewith attached as Annex-1.

   For ECG Technicians:
   1) Training course on Maintenance of Electrical Equipment

   For ECG Engineers:
   2) System Protection and Control
   3) Distribution Network Planning
   4) Distribution Design

   For Technicians in Liberia, Sierra Leone, and Gambia:
   5) Training course on Maintenance of Electrical Equipment

   For Engineers in Liberia, Sierra Leone, and Gambia
   6) System Protection and Control for Engineers

7. **Report of Project activities (Sep. 2013 - Dec. 2013)**
   Mr. Nukpezak, a technical instructor for substation maintenance and network operation and safety, made a presentation on the Project activities in connection with the development of syllabus, curriculum and training materials for the training courses in the field of substation. The Power Point slides are herewith attached as Annex-2.

   Mr. Andoh, a technical instructor for overhead lines reported the progress of the project activities related to the development of syllabus, curriculum and training materials for the training courses in the field of distribution network with the Power Point slides. The documents of the presentation are herewith attached as Annex-3.

   Training course on maintenance for electrical equipment for technicians of ECG and three countries would be provided with a fresh developed syllabus, curriculum and training materials.

8. **Tentative Schedule of the Project in the First year (Sep. 2013 – Aug. 2014)**
Mr. Kurakata explained the tentative schedule of the project in the first year as follows:

1) Counterpart training in Japan: 2 weeks at the end of May 2014 for 5 persons
2) Implementation of training course on maintenance of electrical equipment for ECG Technicians: 1 week at the end of June 2014 for 10 trainees
3) Implementation of training course on maintenance of electrical equipment for technicians for three countries: 2 weeks at the beginning of July for 12 trainees (Allocation of trainees: 3 persons for Liberia, 3 persons for Sierra Leone, and 6 persons for Gambia)

9. **Revision of the Project Design Matrix (PDM Ver. 1.0)**
Mr. Kurakata elucidated the revised draft of the PDM which is herewith attached as Annex-4 considering the result of the needs survey in neighboring countries into consideration.

As a result of the meeting, the Project Team clarified the framework, activities, and schedule of the project and agreed to the matters referred to in the documents attached hereto.

Tema, 9th December, 2013

Mr. Hiroshi Sumiyoshi
Senior Representative
Japan International Cooperation Agency (JICA)
Ghana Office

for Rev. Ing. William Hutton-Mensah
Managing director
Electricity Company of Ghana

Mr. Hiroshi Kurakata
Chief Advisor
JICA Expert Team

Mr. George Yaw Marfo
Principal
ECG Training Centre

Annex - 1

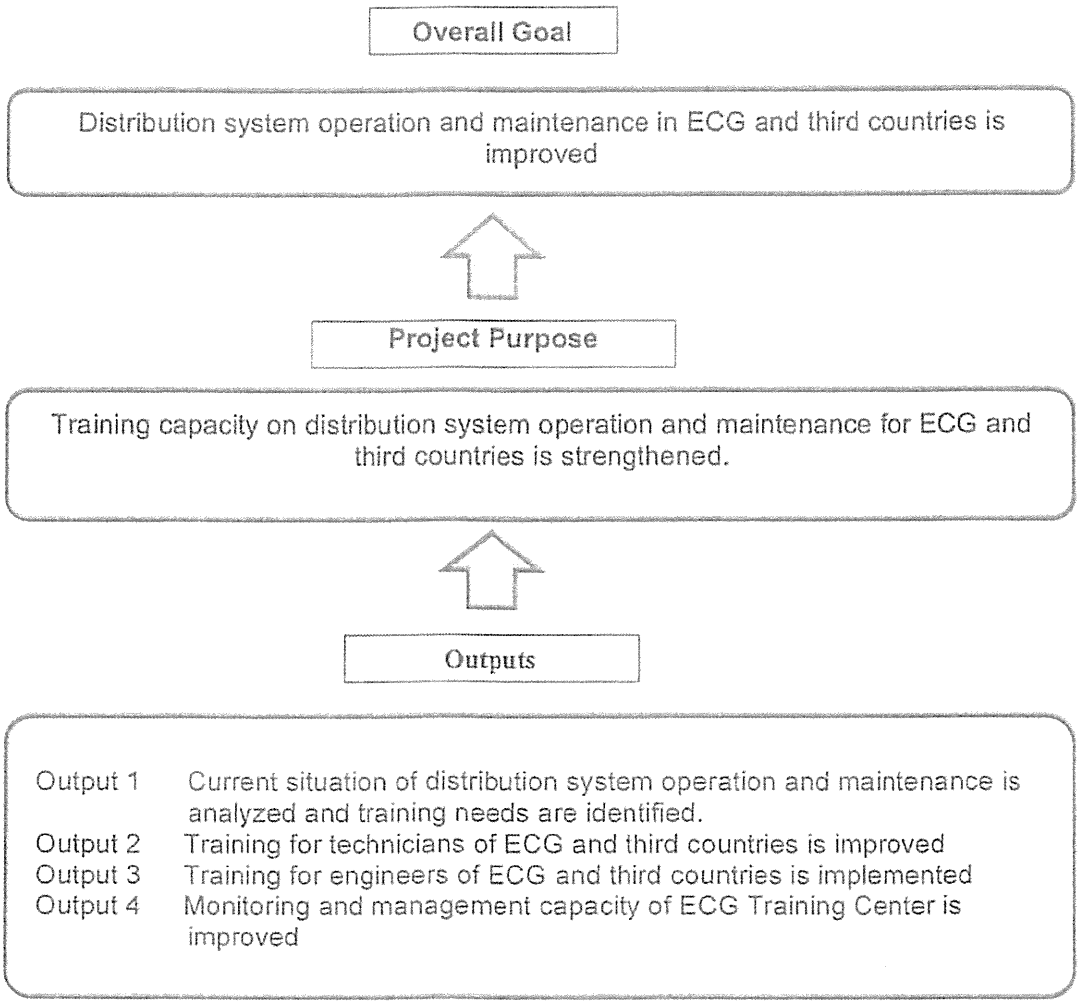
Brief Explanation of the Project

1. Purpose of the Project

This Project shall be carried out based on the record of discussions (R/D) agreed among Japan International Cooperation Agency (JICA), Ministry of Energy in Ghana and Electricity Company of Ghana (ECG) on September 16, 2010.

The purpose of the Project is to enhance the capability of the operation and maintenance of a power distribution system of ECG and the third countries (Sierra Leone, Liberia, Gambia) through strengthening the training capability of ECG.

The relation among the Overall Goal, Project Purpose and Outputs is shown below.



The project activities for achieving the above-mentioned outputs are shown in the following.

Activities

Output 1 Current situation of distribution system operation and maintenance is analyzed and training needs are identified.

1-1 Review the electricity policy and plan of Ghana and regional cooperation framework
1-2 Review the current situation and challenges of distribution system of O&M in ECG and third countries
1-3 Review the current situation of human resources development of ECG engineers and technicians
1-4 Identify the training needs of ECG engineers and technicians and third countries

Output 2 Training for technicians of ECG and third countries is improved

2-1 Review the existing training courses of ECG for technicians
2-2 Replace training equipment and facilities of ECG
2-3 Update necessary training materials
2-4 Deliver training programs for ECG technicians
2-5 Deliver training programs for the third countries
2-6 Observe the training performance and feed-back to training courses

Output 3 Training for engineers of ECG and third countries is implemented

3-1 Develop syllabuses, curriculum and material for three training programs
3-2 Install new equipment and facilities for training
3-3 Strengthen skills and technology of ECG trainers
3-4 Deliver training programs for ECG engineers
3-5 Deliver training programs for the third countries
3-6 Observe the training performance and feed-back to training courses

Output 4 Monitoring and management capacity of ECG Training Center is improved

4-1 Observe and analyze the current capacity for monitoring and management of training
4-2 Prepare plan for methodologies and procedures for improvement
4-3 Improve ECG capacity for training monitoring and management

2. Implementation of the Project

(1) Development of Training Courses

Following training courses will be developed in the Project.

a. Development of Training Course for Technicians of ECG
Training Course on Maintenance Procedure for Electrical Equipment
··· 1st year

b. Development of Training Courses for Engineers of ECG
b-1 Training Course on System Protection and Control ···2nd year
b-2 Training Course on Distribution Network Planning ····2nd year
b-3 「Training Course on Distribution Design ·····3rd year

c. Development of Third Countries Training
c-1 Third Countries Training for Technicians·····1st year
c-2 Third Countries Training for Engineers ·····2nd year

(2) Provision of Equipment

1) Procurement of substation equipment for training and installation of 33kV Substation. (1st to 2nd year)

2) Procurement of Measurement Instruments and Devices (1st year)
The Measurement Instruments to be supplied will be ①Primary and secondary injection test set ②Transformer oil tester ③Power quality analyzer ④Potable cable fault locator.

(3) Training in Japan (1st ~ 2nd year)

About ten (10) counterpart personnel are planning to be accepted to the training program in Japan in the Project. The duration will be two (2) weeks.

In the training program in Japan, we want counterpart personnel to learn the power distribution technology which is difficult to learn in Ghana and the systematic development of engineers by the Japanese Power company.

(4) Monitoring of training courses

As training courses carry out, the expert team will establish monitoring framework for the training course and measure the effect of training from following three perspectives. Result of monitoring will feed back to training courses.

a. Effectiveness measurement of the training courses
b. Confirmation of accordance with needs of electrical engineers/technicians training
c. Assessment on utilization of trained skills at practical work

3. Implementation Schedule

Implementation Schedule of the Project is shown in Fig.3-1.

4. Allocation Plan of the Expert Team

The Project Implementation Structure is shown as follows.

The composition of the Expert team and the field in charge are shown in Table 4-1.

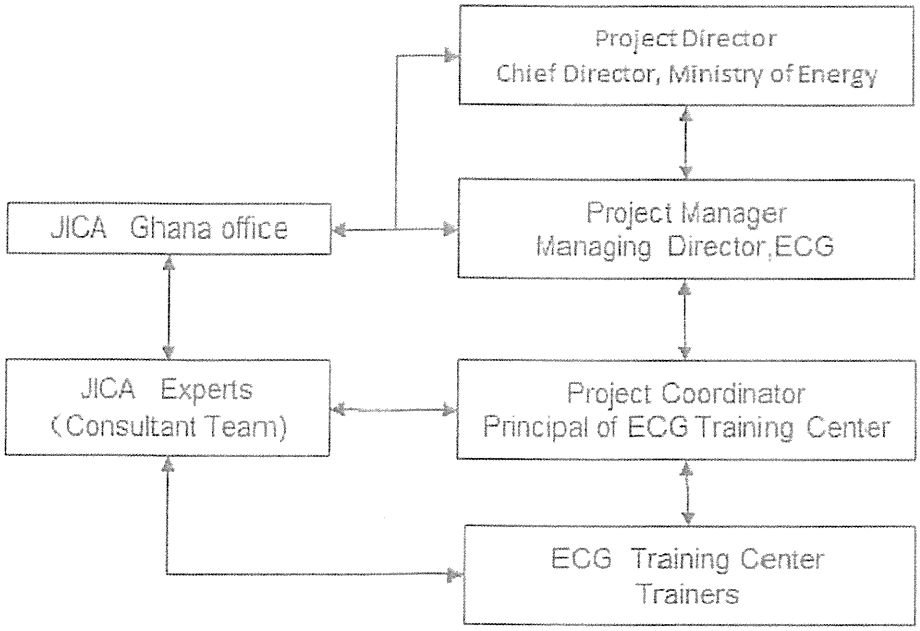


Fig.4-1 Project Implementation Structure

Table.4-1 Composition of the Expert Team and the field in charge

Field in charge		Name
(1)	Chief Advisor/Training Planning	Hiroshi Kurakata
(2)	PowerDistributionPlanning/Design	Takamu Genji
(3)	PowerDistributionSystemOperation	TatsuhiroTamura
(4)	Substation Maintenance	Tsuguhiro Yamada
(5)	TrainingMonitoring/Assistant for Power Distribution	Seiji Ito
(6)	Substation Equipment/Procurement	Shinichi Tohjoh
(7)	Coordinator/Training Management	Ritsuko Kawabe

Allocation Plan of the Expert Team is shown in Fig.4-2.

Fig. 3-1 Implementation Schedule

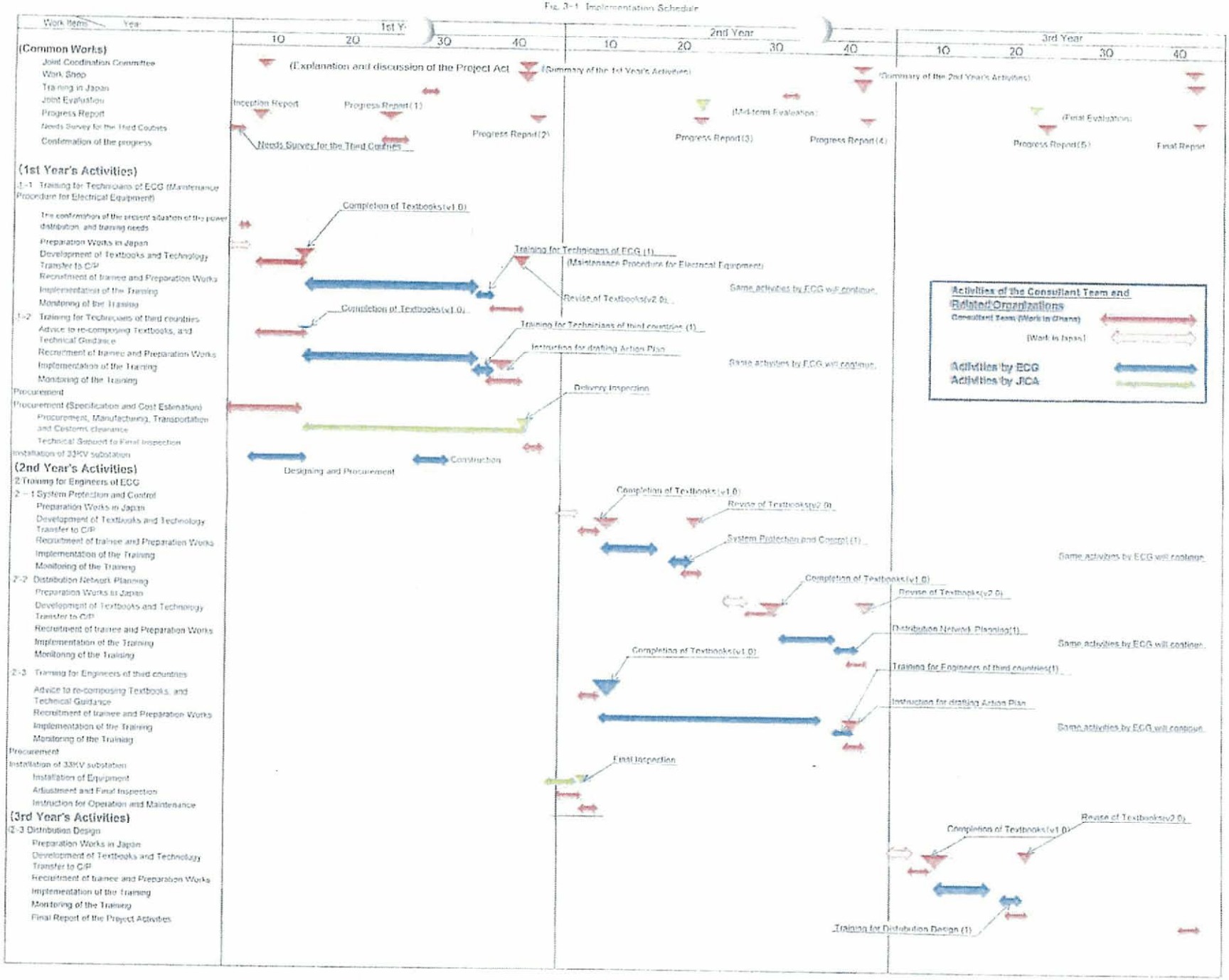
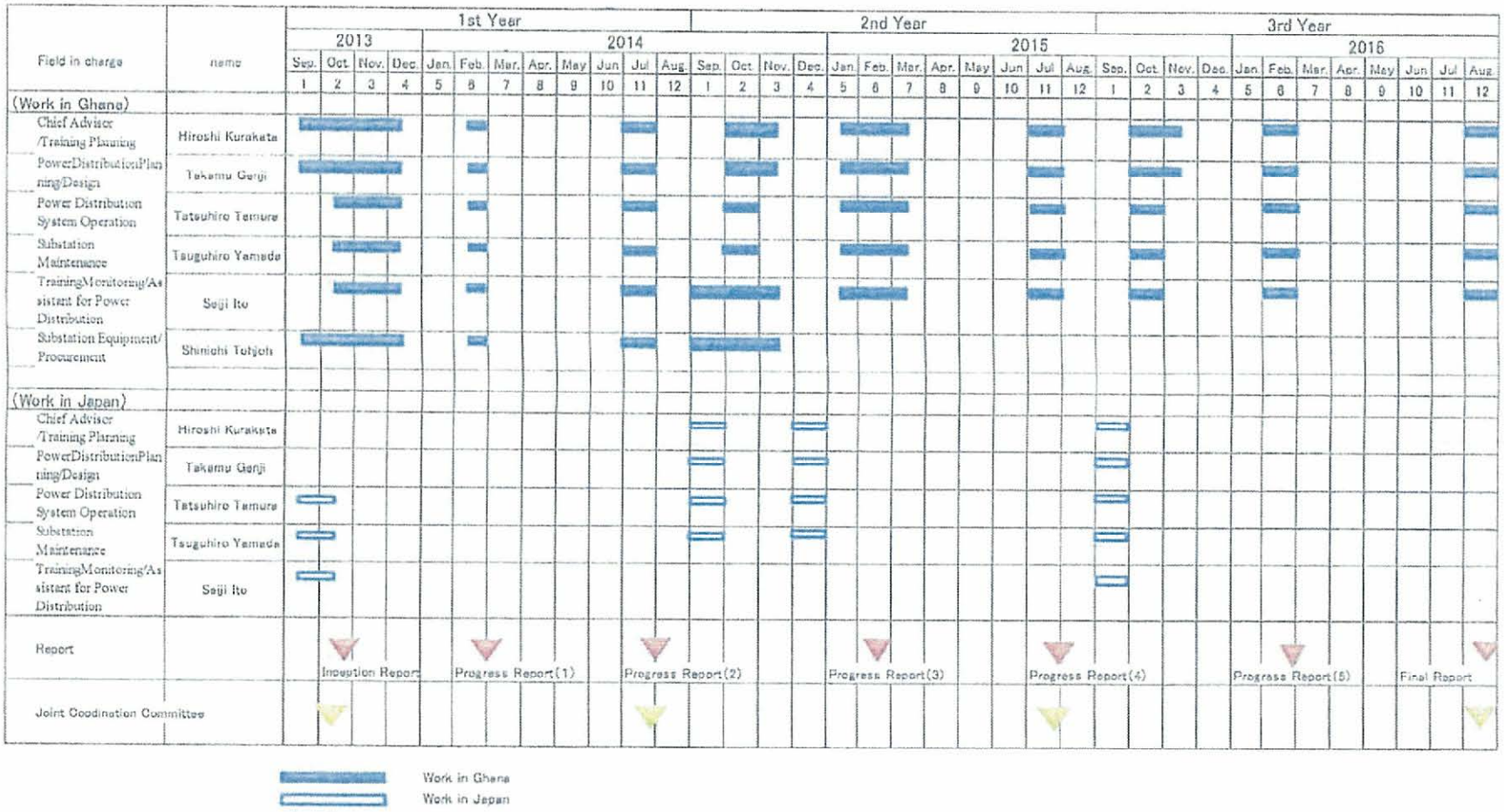


Fig.4-2 Allocation Plan of the Consultant Team



Annex – 2

PRESENTATION ON DEVELOPMENT OF TRAINING MANUAL (TEXT BOOK) FOR SUBSTATION MAINTENANCE

DEVELOPED BY THE SUBSTATION MAINTENANCE TEAM

PRESENTED BY MR ISAAC NUKPEZAH A TEAM MEMBER

TEAM MEMBERS

1. MR ISAAC NUKPEZAH (INSTRUCTOR ECG TRAINING SCHOOL)
2. MR KINGSFORD AMOAKO (INSTRUCTOR ECG TRAINING SCHOOL)
3. MR MAXWELL ESSEL (INSTRUCTOR ECG TRAINING SCHOOL)
4. MR TSUGUHIRO YAMADA (JICA EXPERT)

PROJECT ASSIGNED TO THE TEAM

TO DEVELOP A TRAINING MANUAL (TEXT BOOK)

FOR SUBSTATION MAINTENANCE;

THEORY AND PRACTICAL TRAINING

BY THE EFFECTIVE COLLABORATION BETWEEN :

a. JICA EXPERT AND

b. THREE TECHNICAL INSTRUCTORS FROM THE ECG TRAINING SCHOOL

LEVEL OF COLLABORATION BETWEEN JICA EXPERT AND INSTRUCTORS

- 1. JICA EXPERT DEVELOPED A COMPREHENSIVE SUBSTATION TRAINING MANUAL (TEXT BOOK)
- 2. JICA EXPERT DISCUSES TEXT BOOK WITH THREE ECG TECHNICAL INSTRUCTORS
- 3. INSTRUCTORS PROVIDE SUGGESTIONS , CORRECTIONS AND RECOMMENDATION TO ENRICH THE TEXBOOK
- 4.JICA EXPERT TASKED INSTRUCTORS TO PROVIDE
- VARIOUS INFORMATION ON ECG'S .SYSTEM
- E.G : 1. SUBSTATION ARRANGEMENT, 2. 33KV NETWORK GAIGRAM, 3 . PICTURES OF VARIOUS EG'S SUBSTATION EQUIPMENT; E.G. CTS , VTS, POWER TRANSFOMERS, SWITCHGEARS ETC.

LEVEL OF COLLABORATION BETWEEN JICA EXPERT AND INSTRUCTORS

- 5. JICA EXPERT ALSO REQUESTED INSTRUCTORS TO DEVELOP A PRACTICAL (HANDS ON TRAINING ON POWER POINT INVOLVING THE USE OF PICTURES OF HEALTHY S/S EQUIPMENT AND FAULTY S/S EQUIPMENT AS A RESULT OF SHORT CIRCUIT. FLASHOVER AND TRACKING TROUBLE SHOOTING PROCEDURE ON VARIOUS S/S EQUIPMENT WERE ALSO PROVIDED

PURPOSE OF TRAINING MANUAL (TEXTBOOK)

THE PURPOSE OF THE SUBSTATION TRAINING MANUAL IS:

TO BE USED TO DELIVER TRAINNING TO SUBSTATION MAINTENANCE TECHNICIANS OF :

- 1. ECG (ELECTRICITY COMPANY OF GHANA)
- 2. NEIBOURING COUNTRY NAMELY :
- A. LIBERIA
- B. SIERRA _LEONE
- C. GAMBIA

LEVEL OF COLLABORATION BETWEEN JICA EXPERT AND INSTRUCTORS

JICA EXPERT USED THESE INFORMATION TO COMPARE WITH AND REVISE THE TRAINING MANUAL(TEXTBOOK)

7. JICA EXPERT GAVE COPIES OF THE TEXTBOOK TO INSTRUCTORS TO REVIEW ,CORRECT AND RECOMMEND

8. INSTRUCTORS, REVIEW, CORRECT, RECOMMEND AND GIVE TEXTBOOK TO JICA EXPERT FOR FINAL COMPLETION

CONTENT OF TEXTBOOK

THE CONTENT OF THE TEXT BOOK IS STRUCTURED TO CONTAIN THE FOLLOWING 10 MODULES :

MODULE 01: OVERVIEW OF SUBSTATION EQUIPMENT
MODULE 02: TRANSFORMER DETERIORATION DIAGNOSIS BY DISSOLVED GAS ANALYSIS IN INSULATION OIL
MODULE 03: PATROL FOR SUBSTATION EQUIPMENT
MODULE 04: PERIODIC INSPECTION ITEMS FOR SUBSTATION EQUIPMENT
MODULE 05: DATA MANAGEMENT OF SUBSTATION EQUIPMENT
MODULE 06: FAILURE OF MAIN SUBSTATION EQUIPMENT AND METHOD OF FAILURE STATISTICS
MODULE 07: STANDARD INFORMATION TO BE MONITORED AND FAULT RESTRATION OF SUBSTATION
MODULE 08: HUMAN ERROR AND NEAR-ACCIDENT REPORTING ACTIVITY WITH EXAMPLE OF ELECTRICAL FAILURE
MODULE 09: OVERLOAD OPERATION OF OIL IMMERSED TRANSFORMER
MODULE 10: SAFETY WORK AT SUBSTATION

CONTENT OF MODULE 01 :

- MODULE 01
- OVERVIEW OF SUBSTATION EQUIPMENT

❑ CHAPTER 1
❑ GENERAL DESCRIPTION OF SUBSTATION EQUIPMENT
❑ FUNCTION OF SUBSTATION
❑ TYPES OF SUBSTATIONS

❑ BUSBAR SYSTEM
❑ SINGLE BUS ARRANGEMENT
❑ DOUBLE BUS ARRANGEMENT
❑ MAIN EQUIPMENT AND ITS FUNCTION DISTRIBUTION SUBSTATION)
❑ CHAPTER 2
❑ FUNCTION AND STRUCTURE OF SUBSTATION FACILITIES
❑ 1. MAIN TRANSFORMER (POWER TRANSFORMER)
❑ (1) PURPOSE OF USE

CONTENT OF MODULE 01 :CONT.

❑ 2) TRANSFORMER PRINCIPLE

❑ (3) TYPES OF TRANSFORMERS
❑ (4) ON-LOAD TAP CHANGER

❑ (5) EQUIPMENT ON TRANSFORMERS

❑ (6) MECHANICAL PROTECTIVE DEVICE ON TRANSFORMERS
❑
❑ (7) INRUSH CURRENT

❑ 2. CIRCUIT BREAKER
❑ (1) PURPOSE OF USE
❑ (2) FUNDAMENTAL PRINCIPLE

❑ (3) OPERATING SEQUENCE OF CIRCUIT BREAKERS
❑ 3. DISCONNECT

CONTENT OF MODULE 01 :CONT.

❖ DISCONNECTING SWITCH (DISCONNECTOR/ISOLATOR)
❖ (1) PURPOSE OF USE
❖ (2) TYPES OF DISCONNECTING SWITCHES CONFIGURATION
❖ (3) EARTHING SWITCH
❖ (4) INTERLOCK SYSTEM

❖ INSTRUMENT TRANSFORMER
❖ (1) PURPOSE OF USE
❖ (2) VOLTAGE TRANSFORMER (VT, CVT)
❖ (3) CURRENT TRANSFORMER (CT)

❖ LIGHTNING ARRESTER (LA (1) PURPOSE OF USE
❖ (2) TERMS RELATED TO LIGHTNING ARRESTERS
❖ (3) TYPES OF LIGHTNING ARRESTERS

❖ REACTIVE POWER SUPPLIER
❖ (1) PURPOSE OF USE

CONTENT OF MODULE 01 :CONT.

❖ (2) POWER CAPACITOR (PC)

❖ (3) SHUNT REACTOR (SHR)

❖ (1) PURPOSE OF USE

❖ 7. DC POWER SUPPLY SYSTEM

❖ (2) BATTERY

❖ (3) BATTERY CHARGER
❖
❖ 8. SWITCHBOARD

❖ (1) PROTECTION SYSTEM FOR A TRANSFORMER AND A DISTRIBUTION LINE

THE END OF PRESENTATION

THANK YOU

Annex - 3

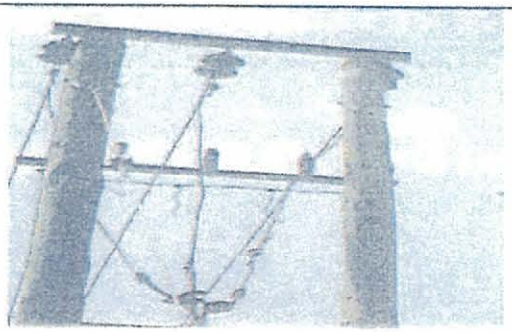
PRESENTATION
ON
THE TEXTBOOK PREPARED FOR E.C.G TRAINING CENTRE BY JICA TECHNICAL EXPERTS AND E.C.G INSTRUCTORS

WHOLE ACTIVITIES:
To DEVELOP TEACHING MATERIALS and
to CONDUCT TRAINING for TECHNICIANS

Role of E.C.G Team	Role of JICA Team
⌐ Example of defect Equipment ⌐ Metring Method of Power Quality ⌐ Fault Data Collection and Analysis SHOWING IN THE FOLLOWING SIDE To Conduct Training for Technicians (Next Step)	<Distribution Line Maintenance> 1 Outline of Power Distribution Facilities 2 Outline of Deterioration and Maintenance of Power 3 Inspection and Preventative Maintenance of Distribution Lines 4 Management and Utilization of Data of Inspection and Check-ups 5 Fault Locating in Distribution Line and Restoration 6 Operation/Management of Power Distribution System 7 Practice 1) Cable fault location 2) Measurement

Faults occurring on the overhead networks are either permanent or transient and can cause permanent damage.
These faults are caused by tree branches, stray birds, etc.

In this presentation we are going to look at some common faults on the overhead network, the causes and the solution for the various faults.



Broken Jumpers on the arresters

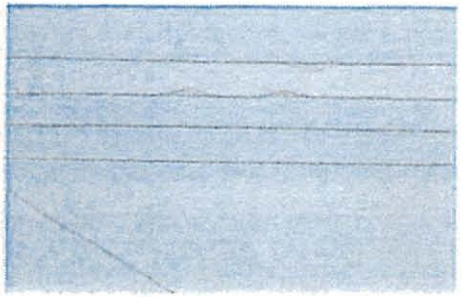
This could be due to aging of the arresters, indirect lightning strike, loose contact at the termination point on the arresters.
This fault exposes the transformer to the dangers of lightning strikes.
Arresters must be inspected constantly for any defects and replaced.
Jumpers on arresters must be well tighten to avoid loose contact.

Bad connection

Aside the jumper- cut on the arresters which has earlier been discuss ,the blue phese of this picture shows a bad connection that has been done. This must be corrected as a means of preventive maintenance. Above all the right material must be used for the right job. This shows poor workmanship.

Jumper-cut(IV-line)

Jumper-cut on the yellow phase shows how poor workmanship can affect our network. Non-tension connectors must be used instead of bindings.



Improper handling of conductor(wire)

Abrasions and kinks must be avoided. This increases the resistance of the affected area thereby causing voltage drops. Abrasion is caused by improper handling of the conductor during stringing. Abrasion and kinked areas must be cut and proper joint made within the network.

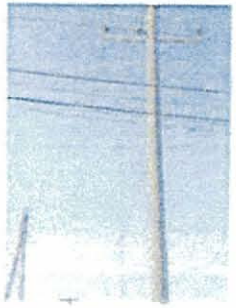
Improper handling of conductor(cable)

Cable drums must be stored horizontally not vertically. When the insulation of the cable is affected it breaks down the insulation when the cable is powered.

Conductor cut

Conductor cut results in over-voltage and phase-off over-tensioning. Tree falling on conductor, short circuit can cause conductors to cut.

Over-voltage can result in damage to customers appliances. Lines must be well tension but not over-tension. Tree pruning must be done consistently especially those close to the line.



Touch of branches and birds

About 80% of fault occurring on rural 11kv or 33kv overhead network are of transient nature and cause no permanent damage. These faults are caused by such as tree branches, stray birds to reduce the duration of the outages automatic re-closing is used.

Deterioration progress

Deterioration progress mechanism for transformers is classified into that of cases, packing, bushing, lead wires and windings. Oil leakage leads to layer-short-circuit and finally di-electric breakdown.

Thank you for your attention

Revise of the Project Design Matrix (PDM Ver. 1.0)

Annex - 4

1. Project Title: Project for Electrical Engineers Training for African Countries (EETA)
2. Terms of Cooperation: From Sep. 2013 to Sep 2016
3. Target Group: Trainers of ECG

Blue letters: original indicator Red letters: proposed indicator

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Overall Goal Distribution System operation and maintenance in ECG and third countries is improved	・Technical loss of distribution systems (Ghana ○%, third countries ○%) ・Outage statistics (Ghana ○%, third countries ○%) ・Distribution loss and SAIFI (The System Average Interruption Frequency Index) will decrease in Ghana and third countries	・Annual report of ECG and third countries	・ There is no drastic change in Energy Policy in Ghana. ・ Necessary budget shall be allocated for the training.
Project Purpose Training capacity on distribution system operation and maintenance for ECG and third countries is strengthened	・Number of certificated trainers of ECG (more than ○) ・Satisfactory rate for training (more than ○%) ・Number of training courses for technicians and engineers will increase ・Syllabus, curriculum and training materials will be revised or newly developed	・Annual report of ECG and third countries ・Quarterly Report of ECG and third countries	・ Trained trainers continue to work for ECG. ・Stakeholders fulfill their responsibilities in maintaining cooperation framework
Outputs 1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified	・Report compiled training needs	・Quarterly Report of ECG and third countries ・Project Progress Report	・Trainees from third countries continue to participate in the training courses in ECG ・ Equipment will be properly maintained for the training courses
2. Training for technicians of ECG and the third countries is improved	・Number of certificated trainees (Ghana: a more than ○, third countries: more than ○) ・Number of equipment and facilities for replacement, repair and new installation ・ Number of trainees for technicians courses will increase ・Number of certificated trainees (Ghana: a more than 30, third countries: more than 36)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Inventory list ・Result of the Monitoring	
3. Training for engineers of ECG and third countries is implemented	・Number of implemented training programs ・Number of trained trainees ・Number of equipment and facilities identified for replacement, repair and new installation ・Number of certificated trainees (Ghana: a more than ○, third countries: more than ○) ・Number of training courses for engineers will increase ・Number of trainees (Ghana: a more than ○, third countries: more than 12)	・Quarterly Report of ECG and third countries ・Project Progress Report ・Syllabus, curriculums and Training materials for the training courses ・Result of the Monitoring	
4. Monitoring and management capacity of ECG and third countries is improved	・Quality of revised texts ・Quality of revised tools ・Number of JCC meetings	・Quarterly Report of ECG and third countries ・Project Progress Report ・Manuals and tools	

Activities	Inputs (Means and Cost)	Important Assumptions
1. Current situation of distribution system operation and maintenance is analyzed and training needs are identified 1-1 Review the electricity policy and plan of Ghana and regional cooperation framework 1-2 Review the current situation challenges of distribution system O&M in ECG and the third countries 1-3 Review the current situation of human resources development of ECG engineers and technicians 1-4 Identify the training needs of ECG engineers and technicians and the third countries 2. Training for technicians of ECG and the third countries is improved 2-1 Review the existing training course of ECG for technicians 2-2 Replace training equipments and facilities of ECG 2-3 Update necessary training materials 2-4 Deliver training programs for ECG technicians 2-5 Deliver training programs for the third countries 2-6 Observe the training performance and feed-back to training courses 3. Training for engineers of ECG and third countries is implemented 3-1 Develop syllabuses, curriculum and material for three training programs 3-2 Install new equipments and facilities for training 3-3 Strengthen skills and technology of ECG training 3-4 Deliver training programs for ECG engineers 3-5 Deliver training programs for the third countries 3-6 Observe the training performance and feed-back to training courses 4. Monitoring and management capacity of ECG and third countries is improved 4-1 Observe and analize the current capacity of ECG for monitoring and management of training 4-2 Prepare plan for methodologies and procedures for improvement 4-3 Improve ECG capacity for training monitoring and management	(Japanese Side) A. Assignment of Experts - Chief Advisor/Training Planning - Power Distribution Planning/Design - Power Distribution System Operation- Substation Maintenance - Training Monitoring/Assistant for Power Distribution - Substation Equipment/Procurement - Coodinator B. Training in Japan About ten (10) counterpart personnel are planning to be accepted to the training program in Japan in the three years of the Project. C. Provision of Equipment Equipment will be provided based on the R/D D. Allocation of the necessary budget of training for third countries - Allowance for third countries' trainees are provided by JICA. - Transportation fee of trainees is arranged by own organization (Ghanaian Side) A. Assignment of Counterpart personnel - Project Director - Project Manager - Project Coordinator - Technical Manager - Technical Counterpart B. Joint Coordinating Committee C. Office Space and others ECG will provide necessary office facilities including electricity, air-conditioning, water and internet during the duration of the Project. D. Allocation of the necessary budget for the activities described in PDM. E. Training for trainees of third countries ECG assigns necessary lecturers in order to implement training for third countries.	(Pre-conditions) ・Counterparts are assigned ・Necessary budget, office space and facilities for the Project are allocated

Plan of Operation

Project Title: The Project for Electrical Engineers Training for African Countries (EETA)

Terms of Cooperation: From Sep. 2013 for three years

Target Group: Trainers of ECG

	JFY 2013		JFY 2014				JFY 2015				JFY 2016		
	2013		2014				2015				2016		
	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q
Project Period 3 years													
1 Current situation of distribution system operation and maitenance is analyzed and training needs are identified													
1- 1 Review the electricity policy and plan of Ghana and regional cooperation framework													
1- 2 Review the current situation and challenges of distribution system O&M in ECG and the third countries													
1- 3 Review the current situation of human resources development of ECG engineers and technicians													
1- 4 Identify the training needs of ECG engineers and technicians and the third countries													
2 Training for technicians of ECG and the third countries													
2- 1 Review the exisiting training course of ECG for technicians													
2- 2 Replace training equipments and facilities of ECG													
3 Update necessary training materials													
2- 4 Deliver training programs for ECG technicians													
2- 5 Deliver training programs for the third countries													
2- 6 Observe the training performance and feed-back to training courses													
3 Training for engineers of ECG and third countries is implemented													
3- 1 Develop syllabuses, cullículums and materials for three training programs													
3- 2 Install new equipments and facilities for training													
3- 3 Strengthen skills and technology of ECG training													
3- 4 Deliver training programs for ECG engineers													
3- 5 Deliver training programs for the third countries													
3- 6 Observe the training performance and feed-back to training courses													
4 Monitoring and management capacity of ECG and third countries is improved													
4- 1 Observe and analize the current capacity of ECG for monitoring and management of training													
4- 2 Prepare the plan for methodologies and procedures for improvement													
4- 3 Improve ECG capacity for training monitoring and management													
Evaluations													
Mid-term Evaluation of the Project													
Final Evaluation of the Project													

List of Participants **Annex - 5**

Name	Title	Orgnisation
Flora Colerangle	Divisional Manager - Manpower Planning	ECG Headquarter
George Yaw Marfo	Principal	ECG Training Centre
Ama Otu-Ansah	Ag. Sectional Manager Training Centre	ECG Training Centre
Issac K. Nukpezak	Technical Instructor (Substation Maintenance)	ECG Training Centre
Samuel Andoh	Technical Instructor (Overhead Lines)	ECG Training Centre
Hiroshi Sumiyoshi	Senior Representative	JICA Ghana Office
Hajime Usukura	Representative	JICA Ghana Office
Hiroshi Kurakata	JICA Expert	EETA Project
Takamu Genji	JICA Expert	EETA Project
Tatsuhiro Tamura	JICA Expert	EETA Project
Tsuguhiro Yamada	JICA Expert	EETA Project
Seiji Ito	JICA Expert	EETA Project
Shinichi Tohjoh	JICA Expert	EETA Project
Ritsuko Kawabe	JICA Expert	EETA Project

Minutes of the Second Joint Coordinating Committee for the Project on Electrical Training for African Countries (EETA)

1. **Date**: 16th July, 2014
2. **Time**: 11.30 am ~ 13.30 pm
3. **Venue**: Conference room at the ECG Training Centre
4. Participants: As attached in Annex-11

5. **Major Objectives of the Committee**
   - To review the overall progress of the project and its activities carried out under the Annual Plan of Operation; and
   - To review and exchange views on major issues arising from or concerning the Project.

6. **Report of Project Activities in the first year**
   (1) Implementation of the training courses
      1) Training course for technicians of ECG
         The training course for technicians of the ECG entitled "Maintenance Techniques for Power Equipment and Implementation Procedure" was conducted from 23rd to 27th June, 2014. The Human resource department of the ECG nominated ten trainees from each region. Mr. Agbi, a technical instructor for overhead lines & Underground Cables presented the result of the project activity related to the training course. The Power Point slides are herewith attached as Annex – 1.

      2) Training course for technicians of third countries
         The training course for technicians of the third countries entitled "Maintenance Techniques for Power Equipment (Overhead Line) was implemented from 30 June to 11 July, 2014. Twelve trainees from Gambia (6 trainees), Liberia (3 trainees), and Sierra Leone (3 trainees) were invited for the training course. Mr. Andoh, a technical instructor for overhead lines made a presentation on the project activity in relation to the training course for the third countries. The documents of the presentation are herewith attached as Annex – 2.

   (2) Monitoring of training courses
      Mr. Ito elucidated the results of the monitoring in connection with the training courses conducted for technicians of ECG and third countries as follows. The contents of the presentation are herewith shown in Annex – 3.

      1) Training course for technicians of ECG
         The training course on "Maintenance Techniques for Power equipment and Implementation Procedure" for technicians of ECG was monitored by the pre-training and post-training questionnaire during the course.

      2) Training course for technicians of the third countries
         The monitoring of the training course on "Maintenance Techniques for Power Equipment (overhead line) for technicians of the third countries was implemented by the pre-training and post-training questionnaires.

      Mr. Tamura presented the feedback of the training courses in the area of electrical power distribution as Annex - 4. Mr. Yamada reported the outcome from the substation

maintenance programme as Annex – 5. Mr. Genji summarized the training courses for the ECG and third countries. The documents of the presentation are herewith attached as Annex – 6.

(3) Report of training in Japan
The counterpart training for the Principal and six instructors of ECG Training Centre carried out from 26th May to 6th June, 2014 at JICA Kansai in Japan. Mr. Amoako, a technical instructor for substation maintenance reported the result of the training in Japan. The Power Point slides are herewith attached as Annex – 7.

(4) Report of procurement of equipment
Mr. Tohjoh described the progress of the procurement of the construction of the substation and tool for the training of cable maintenance implemented in the second year by JICA office in order to implement the training at ECG training centre with the Power Point slides. The documents of the presentation are herewith attached as Annex – 8.

7. Plan of Project Activities in the second year (Sep. 2014 – Aug. 2015)
Mr. Kurakata stated the tentative schedule of the project activities in the second year as follows:

(1) Plan of technology transfer
The training courses "System Protection and Control" for engineers of the ECG and third countries, and "Distribution Network Planning for engineers of the ECG will be implemented in the second year of the Project.

Moreover, the training course "Maintenance Techniques for Power Equipment and Implementation Procedure" for technicians of the ECG conducted in the first year will be continue to implement in the second year. And also, the training course entitled "Maintenance Techniques for Power Equipment (Cable Maintenance)" will be conducted for technicians of the third countries. The documents of the presentation are herewith attached as Annex – 9 (1) and (2).

Mr. George Hommey and Mr. Maxwell Essel were allocated as a counterpart in terms of the training course "System Protection and Control" and Mr. Godfred Mensah was appointed as a counterpart for the training course "Distribution Network Planning" in order to establish new training courses In addition, Mr. Kurakata requested that the counterpart group composed of three or four members would be established for the daily activities for the sake of development of the textbooks and promotion of the transfer of technology. Mr. Marfo agreed with this request.

(2) Plan for procurement of equipment
Mr. Tohjoh stated the tentative schedule for the procurement of the equipment for the construction of substation and tool for the training of cable maintenance implemented in the second year by JICA office shown in Annex – 10.

8. Others
Some issues that have arisen during the training courses and concerning the Project were discussed in the meeting. Mr. Marfo stated that safety overalls and shoes JICA prepared for the third countries should have been given off to the trainees in order to protect others from the second year catching any infectious diseases. Mr. Takeuchi responded that it would be

difficult to donate them to trainees on consideration of the policy of JICA during the technical cooperation project. JICA Ghana office, however, could consider that in future.

As a result of the meeting, the Project Team clarified the activities and schedule of the project and agreed to the matters referred to in the documents attached hereto.

Tema, 16th July, 2014

Mr. Hiroshi Sumiyoshi
Senior Representative
Japan International Cooperation Agency (JICA)
Ghana Office

Mr. George Yaw Marfo
Principal
ECG Training Centre

Mr. Hiroshi Kurakata
Chief Advisor
JICA Expert Team

Second Joint Coordinating Committee (JCC) of the Project on Electrical Engineers Trainingfor African Countries (EETA)

Date: Wednesday, 16 July, 2014
Time: 11.30 am ~ 13.30 pm
Venue: Conference room, ECG Training Centre in Tema

Agenda of the Meeting

Opening Remarks	Ghana side	JICA side
1. Report of Project Activities in the 1st year		
(1) Implementation of the training courses		ECG side
1) Training course for technicians of ECG "Maintenance Techniques for Power Equipment and Implementation Procedure"		
2) Training course for technicians of third countries "Maintenance Techniques for Power Equipment (Overhead line)		
(2) Monitoring of training courses		JICA side
1) Training courses for technicians of ECG "Maintenance Techniques for Power Equipment and Implementation Procedure"		
2) Training course for technicians of third countries "Maintenance Techniques for Power Equipment (Overhead line)		
(3) Report of training in Japan		ECG side
(4) Report of procurement of equipment		JICA side
2. Plan of Project Activities in the 2nd year		JICA side
(1) Plan of technology transfer		
(2) Plan for procurement of equipment		
3. Others		
Closing Remarks		ECG HQ

Signature of the Minutes of JCC

(Lunch)

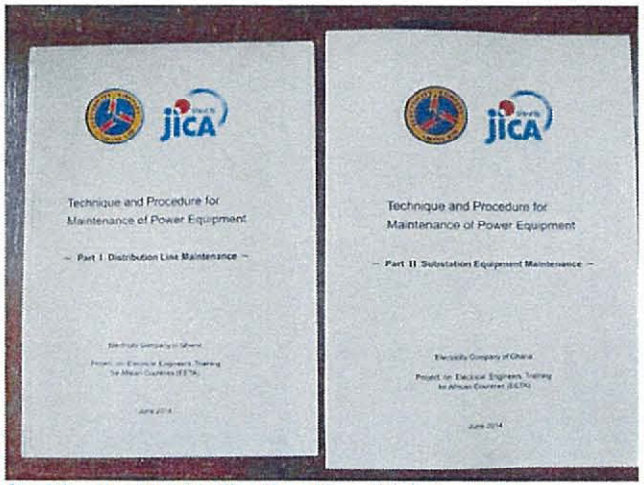
Annex – 1

TRAINING PROGRAMME FOR ECG TECHNICIANS

TOPIC:MAINTENANCE OF POWER DISTRIBUTION FACILITIES

PRESENTED BY MR.BLESS AGBI
(INSTRUCTOR)

Textbooks for this course
(Training Course for Technicians of ECG)



(Left) Part1 Distribution Line Maintenance
(Right)Part2 Substation Equipment Maintenance

DURATION OF PROGRAMME

- FIVE (5) DAYS WAS USED FOR THE TRAINING;THUS FROM MONDAY 23RD JUNE TO FRIDAY 27TH JUNE 2014.
- PARTICIPANT: TEN (10) TECHNICIANS FROM ALL ECG REGIONS PARTICIPATED IN THE TRAINING PROGRAMME.

COURSE CONTENT

- THE PARTICIPANTS WERE TAKEN THROUGH
- THE FOLLOWING COURSES:
- 1. OUTLINE OF DISTRIBUTION FACILITIES.
- 2. DETERIORATION MECHANISM OF POWER DISTRIBUTION EQUIPMENT
- 3. INSPECTION AND PREVENTIVE MAINTENANCE. (TYPES AND MTHODS)
- Eg. TRANSFORMER,OVERHEAD LINE/ UNDERGROUD CABLE.

- 4.MANAGEMENT & APPLICATION OF MAINTENANCE DATA.
- 5. DISTRIBUTION LINE FAULTS AND FAULT INVESTIGATION.
- 6. PROCEDURE OF CABLE FAULT LOCATION.
- 7. OPERATION AND MANAGEMENT OF POWER DISTRIBUTION SYSTEM.
- Eg.1. MANAGEMENT OF VOLTAGE & CURRENT, 2.MEASUREMENT OF EARTH &RESISTANCE.







FEEDBACK

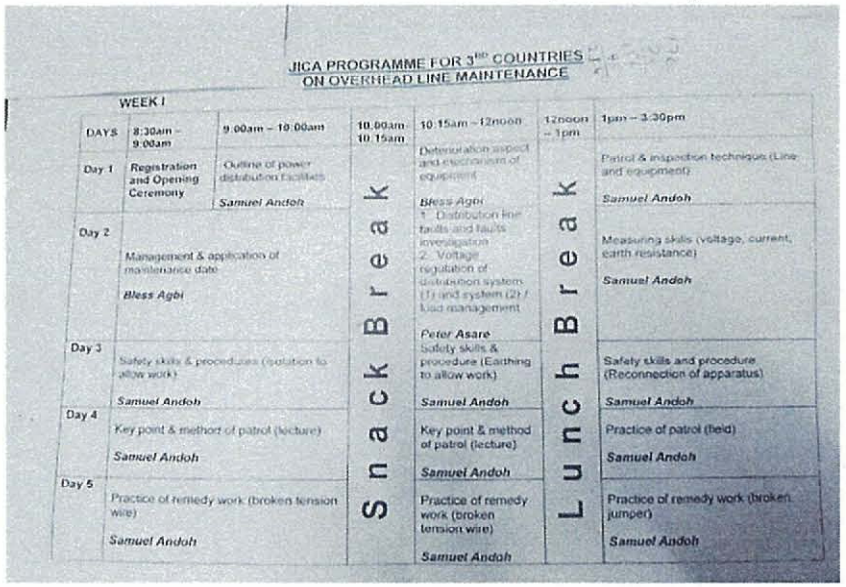
- FEEDBACK DURING AND AFTER THE TRAINING SECTION INDICATES THAT THE PARTICIPANT WERE SATISFY ABOUT THE TRAINING PROGRAMME AND HOPE TO PUT THEM TO GOOD USE.
- DURATION OF TRAINING SHOULD BE EXTENDED.
- NUMBER OF PARTICIPANT SHOULD BE INCREASE.

Annex-2

JICA/ECG PROGRAMME FOR 3RD COUNTRIES ON OVERHEAD LINES MAINTENANACE.

- DURATION:
- 30TH JUNE TO 11TH JULY 2014.
- NO. OF TRAINEES: TWELVE(12)

COURSE CONTENTS (WEEK 1)

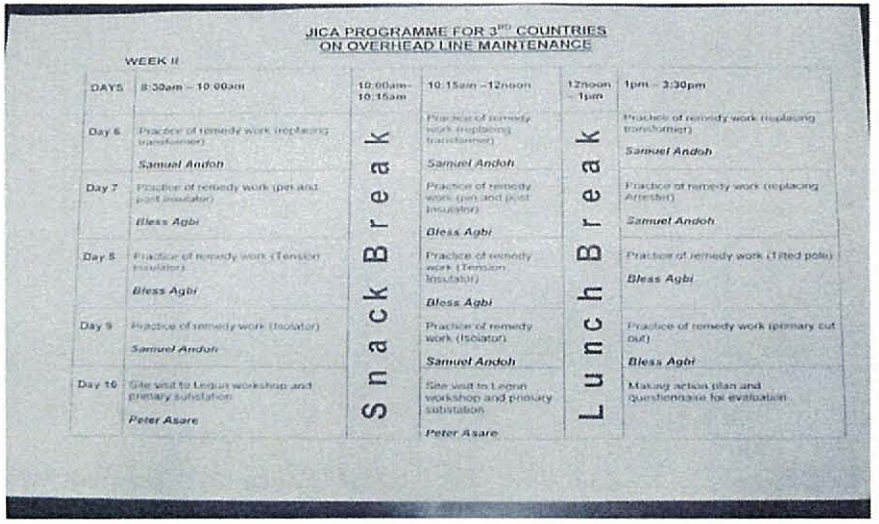


JICA PROGRAMME FOR 3RD COUNTRIES ON OVERHEAD LINE MAINTENANCE

WEEK I

DAYS	8:30am – 9:00am	9:00am – 10:00am	10:00am – 10:15am	10:15am – 12noon	12noon – 1pm	1pm – 3:30pm
Day 1	Registration and Opening Ceremony	Outline of power distribution facilities *Samuel Andoh*	Snack Break	Deterioration aspect and environment of equipment *Bless Agbi*	Lunch Break	Patrol & inspection technique (Line and equipment) *Samuel Andoh*
Day 2	Management & application of maintenance date *Bless Agbi*			1. Distribution line faults and faults investigation 2. Voltage regulation of distribution system (1) and system (2) / load management *Peter Asare*		Measuring skills (voltage, current, earth resistance) *Samuel Andoh*
Day 3	Safety skills & procedures (isolation to allow work) *Samuel Andoh*			Safety skills & procedure (Earthing to allow work) *Samuel Andoh*		Safety skills and procedure (Reconnection of apparatus) *Samuel Andoh*
Day 4	Key point & method of patrol (lecture) *Samuel Andoh*			Key point & method of patrol (lecture) *Samuel Andoh*		Practice of patrol (field) *Samuel Andoh*
Day 5	Practice of remedy work (broken tension wire) *Samuel Andoh*			Practice of remedy work (broken tension wire) *Samuel Andoh*		Practice of remedy work (broken jumper) *Samuel Andoh*

COURSE CONTENTS (WEEK II)



JICA PROGRAMME FOR 3RD COUNTRIES ON OVERHEAD LINE MAINTENANCE

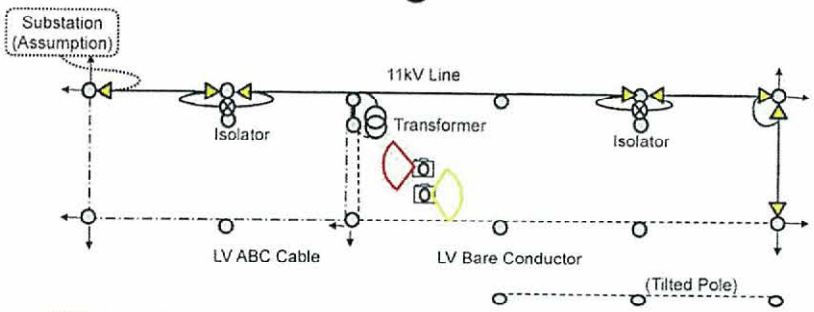
WEEK II

DAYS	8:30am – 10:00am	10:00am – 10:15am	10:15am – 12noon	12noon – 1pm	1pm – 3:30pm
Day 6	Practice of remedy work (replacing transformer) *Samuel Andoh*	Snack Break	Practice of remedy work (replacing transformer) *Samuel Andoh*	Lunch Break	Practice of remedy work (replacing transformer) *Samuel Andoh*
Day 7	Practice of remedy work (pin and post insulator) *Bless Agbi*		Practice of remedy work (pin and post insulator) *Bless Agbi*		Practice of remedy work (replacing Arrester) *Samuel Andoh*
Day 8	Practice of remedy work (Tension insulator) *Bless Agbi*		Practice of remedy work (Tension insulator) *Bless Agbi*		Practice of remedy work (Tilted pole) *Bless Agbi*
Day 9	Practice of remedy work (Isolator) *Samuel Andoh*		Practice of remedy work (Isolator) *Samuel Andoh*		Practice of remedy work (primary cut out) *Bless Agbi*
Day 10	Site visit to Legon workshop and primary substation *Peter Asare*		Site visit to Legon workshop and primary substation *Peter Asare*		Making action plan and questionnaire for evaluation

Lecture in the classroom

Training in the Field

Training Field



Training in the Field

FEEDBACK.

I. COURSE DURATION WAS TOO SHORT.

II. TRAINEES FULLY PARTICIPATED IN THE PRACTICAL ACTIVITIES.

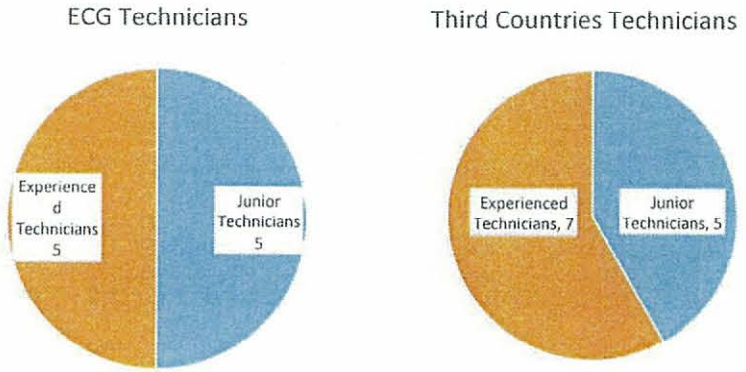
III. TRAINEES ADMITS THE COURSE WAS VERY BENEFICIAL BECAUSE THEY LEARNT A LOT OF NEW TECHNIQUES.

IV. FOLLOW-UP TRAINING IN THEIR RESPECTIVE COUNTRIES WAS SERIOUSLY ADVOCATED BY TRAINEES.

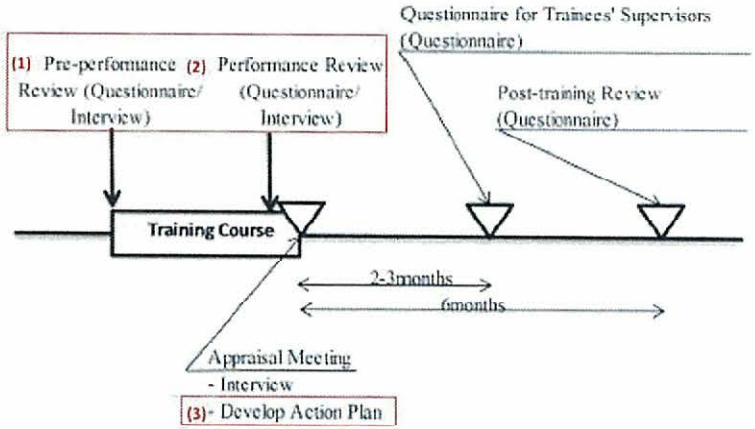
Annex-3

Results of Training Courses Monitoring

Composition of Trainees

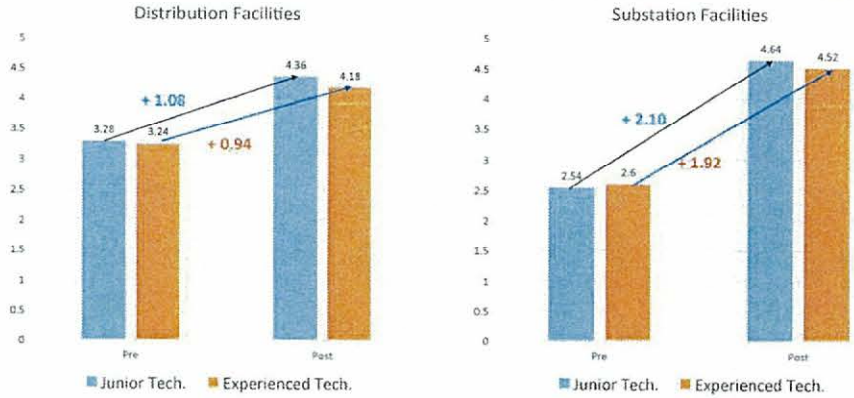


Monitoring Framework



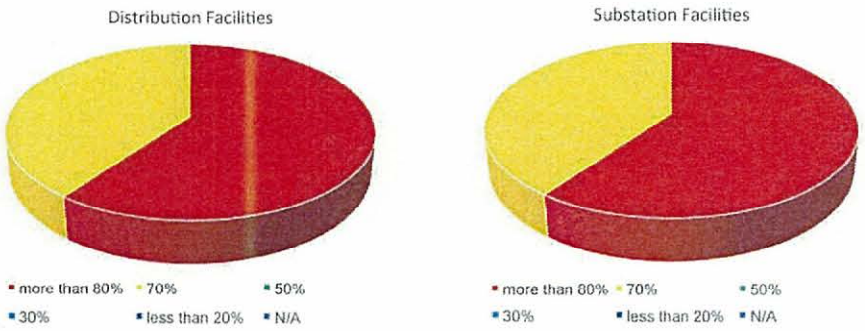
Results of ECG's Technicians Training

Novelty of the program contents



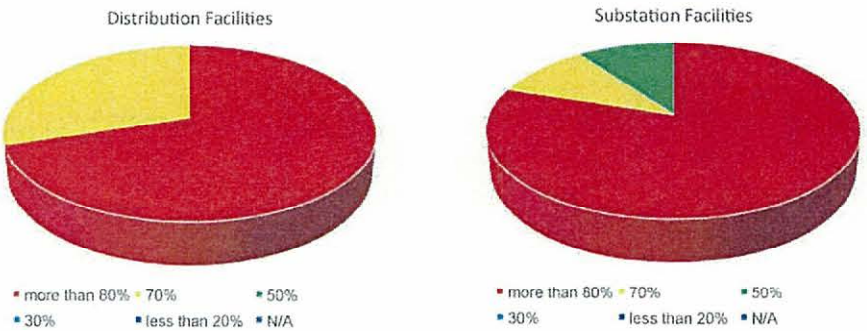
Results of ECG's Technicians Training

Possibility of practical use of acquired knowledge



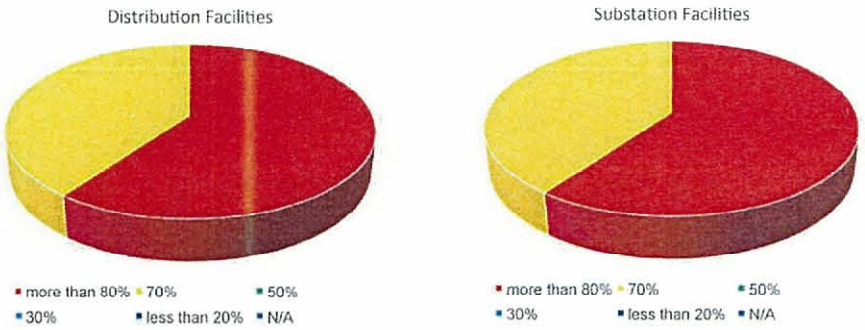
Results of ECG's Technicians Training

Advanced level of the technical content



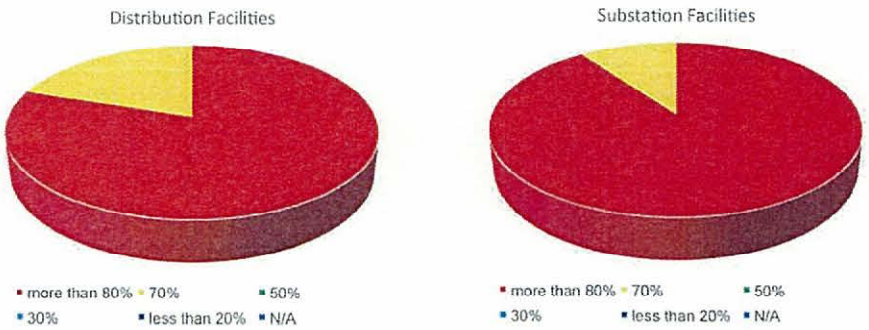
Results of ECG's Technicians Training

Usefulness in the future



Results of ECG's Technicians Training

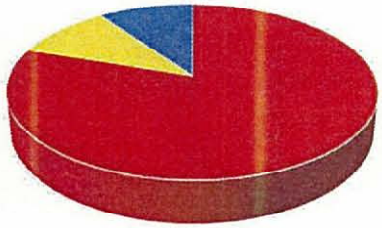
Intelligibility of the lectures



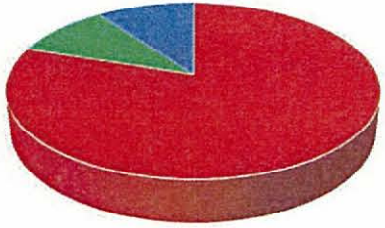
Results of ECG's Technicians Training

Satisfaction (Total evaluation)

Distribution Facilities



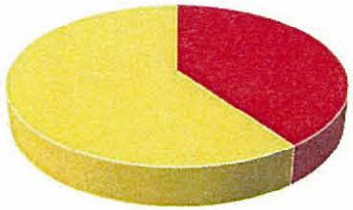
Substation Facilities



Results of Third Countries' Technicians Training

Distribution Facilities

Possibility of practical use of acquired knowledge

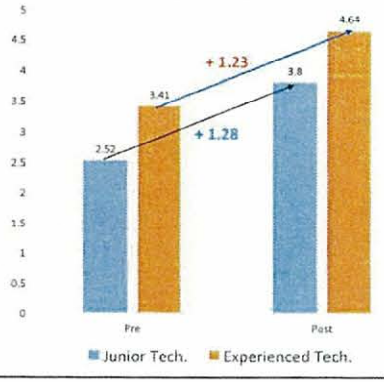


Usefulness in future

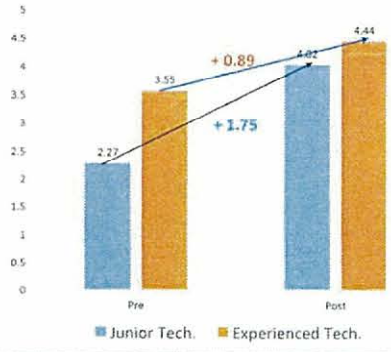
Results of Third Countries' Technicians Training

Novelty of the program contents

Distribution Facilities



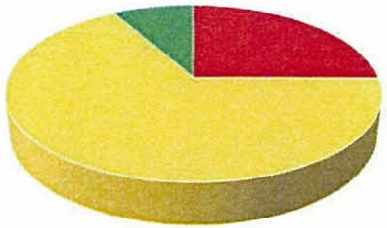
Maintenance skills of distribution facilities (practical training)



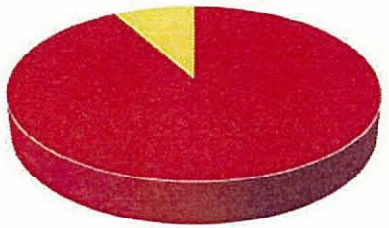
Results of Third Countries' Technicians Training

Distribution Facilities

Advanced level of the technical content

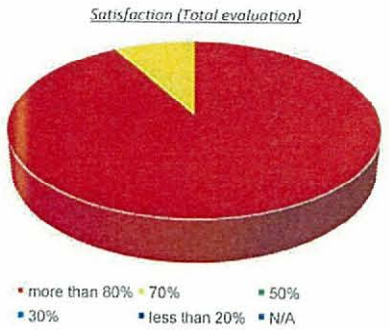


Intelligibility of the lectures



Results of Third Countries' Technicians Training

Distribution Facilities



Annex-4

Amendments of Textbooks of "Distribution Line Maintenance" based on the Result of the Training Course for Technicians of ECG

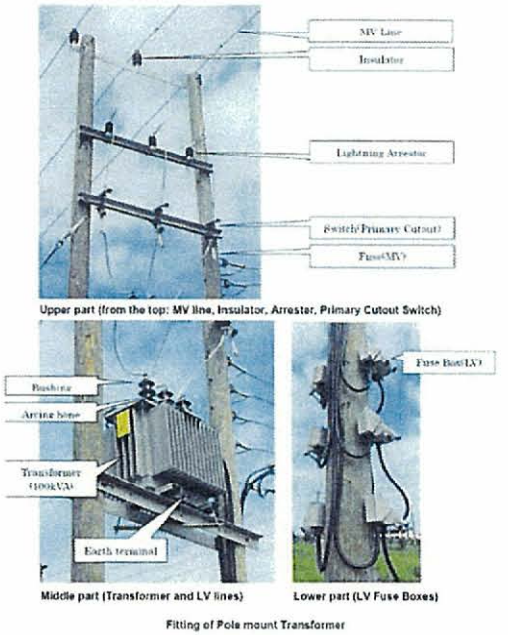
(3-2. Methods of Inspection and Preventative maintenance)

BEFORE	AFTER
(1) Distribution Transformers (a) Inspection Recommended Schedules : Quarterly Equipment / Items to be Inspected | Points to be checked / noted | Remarks a) Supports | Check for proper supporting and level of the transformer | b) Connections | Check for tightness of connections | Tighten; add conductive grease and cover with petrolatum tape c) Fuses (HT & LT) | 1. Check for tightness & continuity. 2. Check for correct ratings | Refer Table-I for fuse ratings. d) Oil | Check for leakages of oil. 1. From drain-off valve. 2. From gaskets. 3. From tank leak etc | In case of appreciable leakage of oil, check up its level and report immediately. e) Bushings | Check for chipped & broken porcelain | f) Arcing horns | Check for the following. 1. Any damage due to flash over. 2. Correct alignment and proper gap adjustment between arcing rods | Note. If the transformer is equipped by Lightning Arrester – check whether the arcing horns are required at all.	(1) Distribution Transformers (a) Inspection Recommended Schedules : Quarterly Photos of the equipment are added.

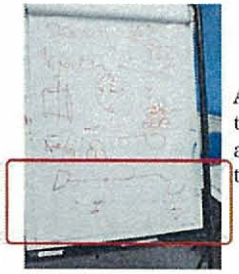
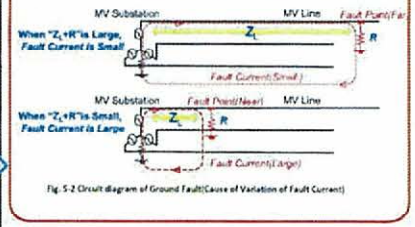
(3-2. Methods of Inspection and Preventative maintenance)

BEFORE	AFTER
(2) Overhead Lines (a) Inspection Recommended Schedules : Quarterly Equipment / Items to be Inspected | Points to be checked / noted | Remarks Poles ... | Check for the following in case of all the 4 types: 1. Damaged/broken poles or for ground-level erosion and corrosion – check the pole is not ... capacity of safety supporting its load. 2. Bowed or leaning poles due to improper ... guying or overloading. 3. Unauthorised attachments such as fencing, aerial wires etc. 4. Poles are very much exposed to ... accident due their being near or in common way. 5. Condition of foundation 6. Missing parts or bracings (lattice steel pole only) 7. Ground level erosion or rotting of poles (wooden only) | Stays | Check the following: 1. Correct direction and proper angle of the stays 2. Loose, broken or any other damage ... done to stays 3. Whether stay insulator is intact–rather ... stay is properly earthed 4. If stay – rods are corroded | NOT APPLICABLE FOR LATTICE STEEL POLES Cross Arms | Check the following: 1. If the cross arms / Clamps have slipped 2. Bending of cross arms due to uneven tension 3. Twisting or other deformation of wooden crossarms | Insulators and Fittings | Check the following: 1. Broken or chipped porcelain, flash over marks 2. Tried pollutin insulators 3. Excessive rusting of fittings 4. Whether glass insulators 5. Damaged composite insulator | Conductors | Check the following: 1. Excessive, if severely tied to the insulator/pole/ Crossarm 2. Proper sag 3. Proximity of trees and other objects including building etc. 4. Sufficient clearances between conductors and earth/cross, and also from the ground 5. Sufficient clearances from other electric/ telephone lines passing above, below or ... above it 6. If bonds in the turnovers and	(2) Overhead Lines (a) Inspection Recommended Schedules : Quarterly Photos of the equipment are added.

(expand)



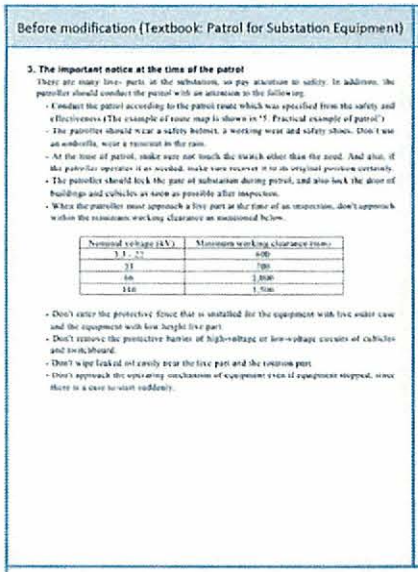
(5-1 Types of Faults)

BEFORE	AFTER
The magnitude of the electrical current varies depending on the line distance and conditions of the ground fault point.  An illustration on the sheet is added to the textbook	The magnitude of the fault current varies depending on the line distance and conditions of the ground fault point. As is shown in the Circuit diagram of Fig 2, Fault current depends on "ZL+R" where 1) ZL Line Impedance(The value is rather large when fault point is far from the Substation) 2) R Resistance of Fault Point(The value depends on the Condition of Fault Point)  Fig. 5-2 Circuit diagram of Ground Fault(Cause of Variation of Fault Current)
	Circuit Diagram is added to help understanding the cause of variation of Fault Current.

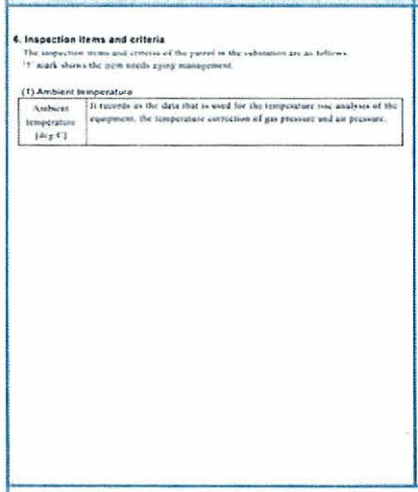
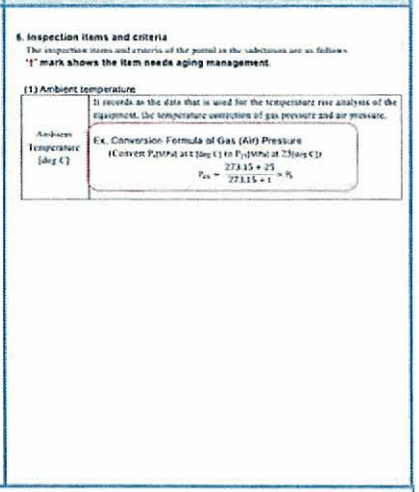
Annex -5

Amendments of Textbooks of Substation Maintenance based on the Result of the Training Course for Technicians of ECG

In this training, most participants were Lineman. Therefore, some contents in textbooks that deal with technical items of substation equipment, such as “Patrol for Substation Equipment” and “Periodic Inspection Items for Substation Equipment” seemed to be difficult .
From the above results, we modified the above textbooks.

Before modification (Textbook: Patrol for Substation Equipment)	After modification (Textbook: Patrol for Substation Equipment)
	

Regarding expressions which seem to be difficult to understand, we added photos and comments about the cases for easy understanding.

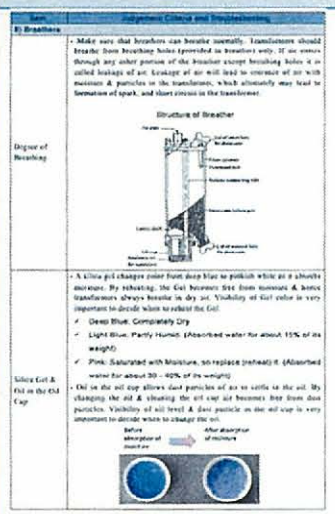
Before modification (Textbook: Patrol for Substation Equipment)	After modification (Textbook: Patrol for Substation Equipment)
	

Regarding ambient temperature that is one of inspection items, it is used for the temperature correction of gas pressure that is measured in the patrol. Therefore, we added conversion formula of gas pressure to show the concrete way of temperature correction.

Before modification (Textbook: Patrol for Substation Equipment)	After modification (Textbook: Patrol for Substation Equipment)

Item	Judgement criteria and troubleshooting
3) Breather	
Degree of breathing	- Make sure that breathers can breathe normally. Transformers should breathe from breathing holes (provided on breathers) only. If air enters through any other portion of the breather except breathing holes it is called leakage of air. Leakage of air will lead to entrance of air with moisture & particles in the transformer, which ultimately may lead to formation of spark, and short circuit in the transformer.

Item	Judgement criteria and troubleshooting
Silica gel & Oil in the oil cup	- A silica gel changes color from deep blue to pinkish white as it absorbs moisture. By reheating, the Gel becomes free from moisture & hence transformers always breathe in dry air. Visibility of Gel color is very important to decide when to reheat the Gel. [Deep Blue: Completely dry, Light Blue: Partly humid (Absorbed water for about 15% of its weight), Pink: Saturated with moisture, so replace (reheat) it. (Absorbed water for about 30 - 40% of its weight)] - Oil in the oil cup allows dust particles of air to settle in the oil. By changing the oil & cleaning the oil cup air becomes free from dust particles. Visibility of oil level & dust particle in the oil cup is very important to decide when to change the oil.



Regarding inspection items about breathers of transformers which seem to be difficult to understand, we added equipment diagram and the photo of silica gel that shows the replacement period.

Before modification (Periodic Inspection Items for Substation)	After modification (Periodic Inspection Items for Substation)

6. Measurement of Opening and Closing Characteristics

(1) Contact opening time and closing time

Contact opening time and closing time shall be measured and checked if they are within the manufacturers' standards.

(2) Minimum operational voltage (pressure)

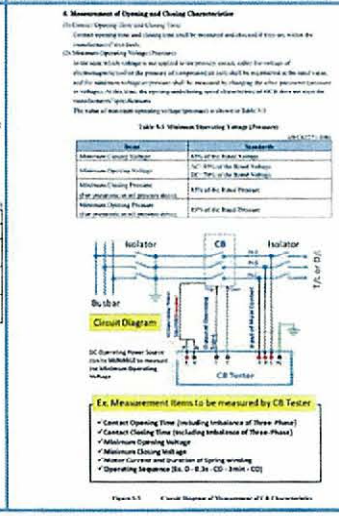
In the state which voltage is not applied to the primary circuit, either the voltage of electromagnetic coil or the pressure of compressed air (oil) shall be maintained at the rated value, and the minimum voltage or pressure shall be measured by changing the other parameter (pressure or voltage). At this time, the opening-and-closing speed characteristic of GCB does not meet the manufacturers' specifications.

The value of minimum operating voltage (pressure) is shown in Table 5-3.

Table 5-3 Minimum operating voltage (pressure)

(IEC 62271-100)

Items	Standards
Minimum closing voltage	85% of the rated voltage
Minimum opening voltage	85% of the rated voltage if AC 70% of the rated voltage if DC
Minimum closing pressure (For pneumatic or oil pressure drive)	85% of the rated pressure
Minimum opening pressure (For pneumatic or oil pressure drive)	85% of the rated pressure



Regarding the measurement of switching characteristics that is one of the periodical inspection items for Circuit Breakers, we added the circuit diagram of inspection and the explanation for easy understanding.

Annex-6

Evaluation (opinion) on the monitoring of ECG technician training

1

Here, I will talk about the evaluation based on the observation of the lecture during the training course.

1. Modification of the text book

(1) Need to be modified according to the actual situation of the ECG
In the text book made this time, there are several items that describe methods and systems of Japan.
These techniques are assumed to be used in the future in Ghana (ECG).
However, in order to utilize the training in this text book for the present works, it is necessary to modify this portion to the contents or methods currently carried out in Ghana (ECG).
If that portion of the text book is not modified, it is necessary to explain positioning and meaning of the technology in the ECG.

(2) Up-to-date of the publication data
The statistical data of the fault printed in the text book is offered from the Operation section of Sub-T.
In order to recognize the importance of maintenance works, it is necessary to replace this data with the latest data of the whole ECG.

2

2. The method of lecture (presentation)

(1) The duration for explanation on technical contents should lengthened
Much time was spent for the explanation of the introduction or the fundamental view.
In order to enhance trainee's technological knowledge level and skills, it is necessary to increase the ratio of concrete explanation (technical know-how).

(2) Making of various training texts is possible
The instructor Maxwell performed the lecture about watt hour meter as measures in case of rainy weather during the third country training. That lecture was very intelligible.
Because, the presentation used not a display in text but the figure and photograph effectively, and explained the technical essentials efficiently.
One text book can be made when some explanation is added to this presentation.
I think that this will be property of the ECG training center from now on.
It is possible to make various texts by the same method if other instructors have such presentation slides.

3

Evaluation (opinion) on the monitoring of technician training for the 3rd countries

Here, I will talk about required improvements in the training.

1. Appropriate preparation is required.

Damaged pulley caused by lack of preparation (The pulley must stand the weight)

2. Instruction of remedy work should be carried out from the synthetic viewpoint.

(1) Keeping safety work (The work based on forecasting dangerous factors)
(2) The work for high quality (How to implement high-quality results)
(3) The efficient work (How to implement efficiently the work as an individual or a team)

4

1. The standards of work procedures have not been established as the ECG.

(1) Improper action

(a) A method of replacing pole mounted transformer

✓The shortage of strength of a transformer hanging pulley

✓Improper use of guide rope

Wrong action

One rope – not effective

Position – unstable

Correct action

Two ropes – effective

Position– Controllable

(2) Unsafe work

5

(a) Work of lifting isolator

Abnormal action

9 people lifting isolator
(more than 6 people)

Difficult to lift up,
Position --- Uncontrollable

Necessary 2 people except
9 people

(2) Unsafe work

6

(b) Work on a cross arm

Wrong belt position and Unsafe work

Safe position

The support point of the safety belt is
located above the center of gravity.

Conclusion :
As mentioned above, you ECG should establish the working method considered safety. That is the standardization is necessary.