The Arab Republic of Egypt

Ministry of Electricity and Renewable Energy

The Project for Capacity Development for Operation and Maintenance of Thermal Power Stations in the Arab Republic of Egypt

Final Report

(October 2017 to August 2019)

October 2019

Japan International Cooperation Agency (JICA)

The Kansai Electric Power Co., Inc.

List of abbreviations

No.	Abbreviation	Definition
1	APUA	African Power Utility Association
2	ATD	Advanced Technology Development
3	CEPC	Cairo Electricity Production Company
4	COD	Commercial Operation Date
5	EEHC	Egyptian Electricity Holding Company
6	EOH	Equivalent Operating Hours
7	EP	Electrostatic Precipitator
8	EPC	Engineering, Procurement and Construction
9	FAC	Flow Accelerated Corrosion
10	GE	General Electric
11	GEN	Generator
12	GT	Gas Turbine
13	GTCC	Gas Turbine Combined Cycle
14	HRSG	Heat Recovery Steam Generator
15	IPP	Independent Power Producer
16	JICA	Japan International Cooperation Agency
17	LTSA	Long Term Service Agreement
18	MDEPC	Middle Delta Electricity Production Company
19	MHI	Mitsubishi Heavy Industry
20	MHPS	Mitsubishi Hitachi Power Systems
21	MOM	Minutes of Meeting
22	MW	Megawatt
23	NG	Nature Gas
24	O&M	Operation and Maintenance
24	O&M	Operation and Maintenance
25	OEM	Original Equipment Manufacturer
26	OJT	On the Job Training
27	PC	personal Computer
28	PLC	Programmable Logic Controller
29	RE	Renewable Energy
30	RH	Re-heater
31	SH	Super Heater
32	ST	Steam Turbine
33	TPP	Thermal Power Plant
34	UEEPC	Upper Egypt Electricity Production Company
35	WDEPC	West Delta Electricity Production Company

1 Project Overview

1.1 Overview (Backgrounds)

In the Arab Republic of Egypt (hereinafter referred to as Egypt), a significant increase in the demand of electric power has become evident in association with recent population and economic growth. Especially, while the "Energy Strategy for Integrated and Sustainable Development to the Year 2035" was announced in October 2016 to undertake a reform of electrical power sector, an efficient use of energy is stressed in this strategy. As evidenced in this example, the development of energy and power supply sources is a pressing task in Egypt to continue a sustainable development and it is necessary to achieve a stable supply of power while securing the power supply sources required by giving a consideration to the economic efficiency.

On the other hand, as represented by the "Promotion of Actions against Climate Change" in Goal 13 of SDGs proposed by the United Nations, the consideration to low-carbon development and global environment is recognized as an important development issue. It is also necessary in Egypt to advance the power sector development under the coordination of 3E, i.e. energy security, economical efficiency and environment. Especially after the adoption of Paris Agreement, a new framework set in the 21st Conference of Parties to the United Nations Framework Convention on Climate Change (COP21), it is required to undertake actions towards the achievement of low-carbon emitting society throughout the world and it is a pressing task to undertake a low-carbon development in the field of power generation, which contributes to approximately 40% of CO_2 emission of energy origin.

By utilizing a high-efficiency thermal power generation, which is one of the power generation technologies to undertake a low-carbon development by coordinating a stable supply and economic efficiency, up to 55,213 MW total installed capacity has been attained in Egypt as of June 30, 2018, by an aggressive promotion of power supply source developments of "Fast Track Plan" and "Siemens Project" based on the above mentioned strategy. As a result, the current power demand is at the maximum load of 30,800 MW (an increase of 4.8% from the previous year) and the power generation of 196,760 GWh (an increase of 3.8% from the previous year), which is sufficient to satisfy the demand. In the EEHC Annual Report, it has been stated that no additional thermal power station is required for the 8th 5-year plan (2017-2022).

1.2 Project history

On the other hand, speaking of types of power supply sources in Egypt, there is a problem in the energy security as approximately 90% of installed power capacity is occupied by the thermal power generation. Therefore, open cycle gas turbine units are modified to GTCC, new renewable energy power stations are built and new coal-fired power stations are built for the purpose of enhancing the thermal efficiency to eliminate the excessive reliance on thermal power generation and diversify the types of power supply sources.

As a result, it is considered that the proportion of thermal power will fall relatively in the future and, by considering the excess supply of power as stated above, it is easy to assume that the operation and roles of thermal power stations will change significantly. In other words, it is possible that the basic operation of many existing thermal power stations in the past will be switched to middle operation and peak operation modes or decommissioned.

In general, in developing countries, there are many instances in which the operation and maintenance capabilities of power-related facilities are not sufficient and lead to an aging of facilities and a high rate of power loss in each stage of power generation, transmission and distribution. For this reason, in developing the electric power sector under the coordination of 3E, it is important to operate the power related facility efficiently for a long term by enhancing the operation and maintenance capabilities in addition to undertaking an efficient and low-carbon power supply development.

In Egypt, it is necessary to develop man power suitable for a rapid development of power supply sources along with eliminating future concerns by enhancing the operation and maintenance capabilities of power related facilities with a consideration to aged power generation facilities and a future aging of many power stations built in recent years. Now, the Japan International Cooperation Agency (hereinafter referred to as JICA) has been requested to offer a technical assistance concerning the Operation-Maintenance Capability Improvement Program for Thermal Power Plants (training by countries) by Egypt and, after performing an on-site investigation, acknowledged the need and legitimacy for it. After reaching a basic agreement on the project with Egypt, it has been concluded to proceed based on the framework. Since similar requests have been received from other countries, it was decided to aim for a synergistic effect by implementing the program including other countries.

1.3 Objectives and introduction of JICA Expert Team (Kansai Electric Power)

Important issues assumed by changing the operation mode of thermal power plants expected in the future in Egypt, i.e. basic operation to other modes of operation, include a reduction in the thermal efficiency more than necessary due to the partial load operation and a repeated fatigue damage due to an increase in the number of startups and stops. In addition, the expected risk in the future would be greater when recently built high-efficiency power plants age and an adequate O&M was not provided.

Therefore, the objective of this project has been set to enhance the O&M capability at thermal power plants by offering a continued technical support to Egyptian Electricity Holding Company (hereinafter referred to as EEHC). In order to achieve this objective, an operator adept in the maintenance of thermal power plants and development of human resources is required.

Kansai Electric Power, which is the JICA Expert Team for the project, has a proven track record in building adequate power generation facilities and performing the maintenance on them mainly in Japan. It has also performed optimum configuration and operation of facilities in accordance with social demands of the time. Examples of such operations include the departure from an excessive dependence on oil and a review on plant configuration associated with the oil-shock and, more recently, securing power supply capacity after the Great East Japan Earthquake and an economic plant operation suitable for the deregulation of electric utilities that took place thereafter. It also has excellent human resources required for such operations. In the project, the JICA Expert Team (Kansai Electric Power) is capable of offering a software support in the operation and maintenance of power plants in addition to offering a hardware support for the development of highly efficient and low-carbon power generation facilities to Egypt.

1.4 Project goals

In order to achieve the objectives stated above, the overall goal, project goal and expected outputs have been set in the project as follows and agreed upon with EEHC during the 1st on-site work.

1.4.1 Overall goal

The overall goal of project is to enhance the O&M capability of the thermal power plant.

1.4.2 Project goal

The project goal is to enhance the O&M training capability of EEHC.

1.4.3 Expected outputs

(1) Output 1
Output that identifies the needs of training according to the current situation of O&M

(2) Output 2
Output that enhances the ability of instructors at EEHC.

(3) Output 3
Output that reviews the O&M training activities at thermal power plants

1.5 Project personnel and period

The following table lists the personnel involved in this project during the reporting target period.

Table 1.5.1 Personnel involved in this project

No.	Name	Responsibility	Target period	Affiliated organization in Japan
1	Hiroki Hirahata	Overall project management	October 2017 to August 2019	Kansai Electric Power Co., Inc.
2	Toru Kawai	Thermal power generation (Operation)	October 2017 to June 2018	
3	Akira Kozakai		July 2018 to August 2019	
4	Shigeru Yoshitake	Thermal power generation (Machine maintenance)	October 2017 to August 2019	
5	Yoshihiro Doi		October 2017 to August 2019	
6	Hidenobu Ichioka	Thermal power generation (Electrical maintenance)	October 2017 to August 2019	
7	Haruaki Furukawa		October 2017 to August 2019	
8	Takeo Fujii	Thermal power generation (Control maintenance)	October 2017 to June 2018	
9	Kazuyo Kitagawa		July 2018 to March 2019	
10	Yuuki Obe		October 2017 to August 2019	

During the 23 month period from October 2017 to August 2019, which is the target period for reporting the performed activities, two on-site works were performed and two training sessions in Japan were provided.

2 Description of Project Activities (Japan Trainings and On-site Works)

2.1 First Japan training

2.1.1 Trainees

Based on the preliminary study of JICA, training sessions for engineers and technicians in Egypt are as follows.

> In Egypt, a training center is provided for electric utility companies in each area, where full-time instructors are appointed to provide training, to offer relatively high level of training programs. However, many training programs are for technicians and training programs for engineers are not offered frequently.

Therefore, in the training program for technicians, it was intended to enhance the training features aimed at instructors and trainees actually involved in the training in Egypt and, in the training program for engineers, it was intended to increase the level of operation and maintenance capabilities for engineers at leading positions and develop officers with a potential to provide guidance in the future. These activities are expected to contribute to effective operation and maintenance of power plants.

2.1.2 Training method

(1) Forms of training

Concerning the organization responsible for the operation and maintenance of thermal power plants, the method to enhance the ability of staffs and development programs for instructors, two types of trainings, OJT and OFF-JT, are offered. The features of each type of training are as listed in Table 2.1.2.1 and OJT is suitable for practical issues such as “actual tasks and their procedures” and “power plant specific technologies,” while OFF-JT is suitable for “basic techniques” and “principles.” This project is targeted for various public electric utility companies in Egypt and the form of OFF-JT (in the training center) was adopted because the training would not be adequate because the target will be eccentric if the training was provided for power plant specific technologies.

Table 2.1.2.1 OJT and OFF-JT comparison

Category	On-the-job Training	Off-the-job Training
Location	Imparted at the actual job location (work space)	At a place other than the real job location (conference room/ training center)
Approach	Practical	Theoretical and principle
Main target	• C&I for main equipment and Operation (tailor-made / original skill) • Work procedures in all field (actual work)	• Mechanical, electrical, C&I for BOP and common (from basic to specialized knowledge)
Time Consumption	Less time	More Time
Learning Method	Learning by doing the task	Learning by acquiring knowledge
Effect on Production	No, because trainees produce the products during learning	Yes, because first training is provided which is followed by a performance
Who Performs the Training	Trainer (mentor, supervisor or manager) and vendor (tailor-made / original /unique skill)	Expert trainer outside of the TPP (Training center lecturer, vendors)

Prepared by JICA Expert Team (Kansai Electric Power)

(2) Training locations

If abilities are developed through an OFF-JT training, two forms of training are available to provide it at the on-site training center or by inviting trainees to Japan. From the perspective of training facilities available in Egypt and proficiency of Japanese instructors in using the training facilities, it was decided to provide it at a training facilities owned by JICA Expert Team (Kansai Electric Power) and other organizations. At the same time, by offering the training in Japan, following side effects can be expected.

- Trainees can focus on the training by leaving the power plant in Egypt.
- Through the experiences at the training centers, power plants and factories in Japan, it will be possible to gain hands-on experiences on Japanese technologies and use them as references in executing action plans in Egypt.
- Through the daily life and cultural programs in Japan, experience the backgrounds of Japanese technologies (act 5-minutes in advance, sociality, etc.), feel the effectiveness of them and use them as references in executing action plans in Egypt.

2.1.3 Fields of training (expertise)

In enhancing the operating and maintenance capabilities for thermal power plants, there are following major fields of expertise.

- ✓ Operation
  - Operation (normal operations, emergency operations, system isolation, operational status monitoring, etc.)
  - Chemistry (water supply control, waste water control, environmental management, etc.)
  - Others (thermal efficiency control, negotiations with the load dispatching center, etc.)
- ✓ Maintenance
  - Mechanical (gas turbine, steam turbine, boiler, exhaust heat recovery boiler, pump, fan, etc.)
  - Electrical (generator, transformer, motor, relay, etc.)
  - Instrumentation (computer, control device, etc.)

Among these, especially in the operation and instrumentation, many operations and knowledge unique to each equipment vendor contributing to the power plant are included, making the training unfit for OFF-JT except for the fundamental area and, therefore, it is normal to familiarize with them through an OJT. Also, based on the experience of JICA Expert Team (Kansai Electric Power), once a mechanical device fails, the scope of spread and damage would be generally large in comparison with electrical devices and it is often the case that the thermal efficiency and the power output are often affected by mechanical failures.

In order to develop human resources more quickly and effectively, it was decided to make the target of training (expertise) to be mechanical engineers and technicians and, as for specific programs, a preliminary study shall be made prior to each training and reflect the results to other countries in the same program whenever possible to improve the program.

2.1.4 Description of training

(1) Study on the training level

Because no specific training needs were proposed by the Egyptian organizations for the training and also because it was not possible for JICA Expert Team (Kansai Electric Power) to conduct a direct survey, an analysis was made using following materials to determine specific training program.

- EEHC annual report 2013/14, EEHC annual report 2014/15, EEHC annual report 2015/16
- Addressing Egypt's Electricity Vision (Minister of Electricity & Renewable Energy: Dr. Mohamed Shaker El-Markabi, 2015)

(2) Description of the study and its result

As analyzed in Chapter 1, as an aggressive construction of new power supply sources in recent years in Egypt, the shortage of supply experienced several years ago has been overcome and the current supply capacity is significantly larger than the demand. Because more renewable energy and coal fired power plants, along with nuclear power plants are planned in the future, it is easy to assume that the role of existing thermal power plants will change drastically.

To be more specific, frequent output adjustments would be made in accordance with the change in demand in the operation of thermal power plants with a high level of adjustment capability, resulting in more brutal use of equipment and accelerated deterioration. Although there are many power plants with satisfactory operational status in Egypt partly because there are many relatively new power sources, drops in the output power and efficiency were observed at aging power plants. In considering the future operation, it is important to execute a consistent O&M now while new power sources are running as planned and a fundamental knowledge is required for that purpose.

Hence JICA Expert Team (Kansai Electric Power) has decided to offer trainings mainly for the "fundamental technology," "quality," "safety," "technique to determine the deterioration of equipment" and "mechanisms required for sustainable operation." Also, without being limited to a mere classroom study, curriculum is made including hands-on training and experiences to facilitate understanding and make it possible to experience the technical capabilities of Japan through the tour of power plants and factories. Additional training programs based on the study results are described in the next section.

In accordance with the roles of each power plant, in principle, engineers shall study theories and trainings mainly consisting of hands-on experiences shall be offered to technicians.

2.1.5 Overview of the first Japan training (for engineers and technicians)

(1) For engineers

Table 2.1.5.1 Overview of the first Engineer Training in Japan

Item	Description
Training period	From November 25, 2017 to December 23, 2017 (from arrival in Japan to departure from Japan)
No. of days	29 days
Training programs	• Job report presentation, preparation/presentation of action plan • Technological issues GTCC (GT/ST/HRSG/high-temperature components/GTCC maintenance/power generator/control) Non-destructive inspection (MT/PT/UT/SUMP/RT)/supply water treatment/thermal efficiency control/vibration • Safety/quality issues Safety experience/lessons learned in the past/ quality control/human resource development • Tour of power plants/manufactures' factories Kansai Electric Power, Himeji No.2 Thermal Power Plant Ishikawajima-Harima Heavy Industries (IHI), Aioi Factory Mitsubishi Hitachi Power Systems (MHPS) Kawasaki Heavy Industries (KHI), Akashi Factory
Training location	JICA Kansai/Kansai Electric Power Headquarters/Kansai Electric Power, Training Center/power plants/manufacturers' factories
No. of participants	10 (see Attachment 2.1.5.2)

- For more information on the route and participants for the training, refer to Attachment 2.1.5.3.
- For conditions of each trainee during the training, refer to Chapter 4.

(2) For technicians

Table 2.1.5.2 Overview of the first Technician Training in Japan

Item	Description
Training period	From November 25, 2017 to December 16, 2017 (from arrival in Japan to departure from Japan)
No. of days	22 days
Training programs	• Job report presentation, preparation/presentation of action plan • Technological issues Handling of metallic materials/performing welding/high-temperature piping maintenance/valve overhaul/overhaul & NDT of motors/instrumentation maintenance) • Safety/quality issues Prevention of accidents & hazards/safety experience drill/quality experience drill) • Tour of power plants/manufactures' factories Kansai Electric Power, Himeji No.2 Thermal Power Plant Ishikawajima-Harima Heavy Industries (IHI), Aioi Factory Mitsubishi Hitachi Power Systems (MHPS), Takasago Factory
Training location	JICA Kansai/Kansai Electric Power Headquarters/Kanden Plant Training Center/power plants/manufacturers' factories
No. of participants	11 (see Attachment 2.1.5.5)

- For more information on the route and participants for the training, refer to Attachment 2.1.5.6.
- For conditions of each trainee during the training, refer to Chapter 4.

2.1.6 Approaches for the first Japan training

(1) Job report

For each trainee, a request was made to prepare a report on the works he performs at the power plant and issues related to them before coming to Japan. By presenting the report to JICA Expert Team (Kansai Electric Power) on their own works, roles and related issues on the first day of training, it was intended to have the trainees recognize the problems they have. It was also useful for the JICA Expert Team (Kansai Electric Power) to understand the problems trainees are facing and use the knowledge for the preparation of training materials for the programs provided during the training to resolve the problems.

(2) PCM (Project Cycle Management) method

The term PCM refers to a technique used to operate and manage the PDCA cycle of development support project using an outline table called Project Design Matrix (PDM). By performing "problem analysis," which is one of the components of PDM, during the training, it was intended to clarify the problems faced by the trainees. The problem analyses performed in the training are as follows.

- ✓ Problematic tasks: Visualize the O&M problems present in power plants using analysis charts by summarizing them using the cause-effect relationship to make them easy to understand.
- ✓ Goal analysis: Clarify the method-goal relationships for the desired conditions after solving the problems and the methods used to derive such conditions and visualize them using analysis charts like the ones used for problem analysis.

By performing these two analyses first in early in the training and performing following two processes the end of training, specific actions to be implemented after returning to Egypt were determined.

- ✓ Selection of methods: Select specific methods for issues, in which it is possible to solve problems and those which would receive significant benefits by solving problems, among the goals and methods listed in the goal analysis.
- ✓ Preparation of action plans (AP): Prepare specific plans to implement each method used to solve problems systematically.

(3) Technical training

In each training program, lectures were given by using textbooks and demonstrations. In classes involving skills training, a theoretical lecture was provided before the skills training to make it easier to understand.

(For engineers)

- ✓ GTCC (GT/ST/HRSG/high-temperature components/GTCC maintenance/power generator/control)

  Knowledge was provided by focusing on the structure and mechanism of GTCC. Besides providing lectures on key points in the maintenance of each facility, information was also given on past troubles experienced by the JICA Expert Team (Kansai Electric Power) and actions used for identifying causes.

- ✓ Non-destructive inspection (PT/UT/MT/SUMP/RT)

  Knowledge was provided on the reasons to perform NDTs and principle of each technique. Also, trainees were encouraged to learn notes on performing the test, recording data and key quality control issues through a skills training.

- ✓ Supply water treatment

  Supply water treatment is always important in operating and maintaining power plants. Along with the provision of knowledge on how to treat and manage the supply water, a lecture was given on how to address problems.

- ✓ Thermal efficiency control

  Knowledge was provided on how to control the thermal efficiency, which is the most important indicator of current status of power plant. The lecture was focused on providing practical skills related directly to actual tasks at power plants, such as

making calculations and analyzing the cause of drop in the thermal efficiency.

- ✓ Vibration analysis
  Knowledge was provided on the types of vibration, analysis methods and actions to address problems. In addition, using a rotor demonstrator, simulations of various vibration troubles were presented to let trainees see the data observed and learn available actions using visual representations.

(For technicians)

- ✓ Handling metallic materials
  A lecture was giving on metallic materials, which is fundamental in designing high-temperature and high-pressure piping and applying procedures used for welding.

- ✓ Performing welding
  Knowledge was provided on the control points and things to be noted by actually performing various welding techniques.

- ✓ High-temperature and high-pressure piping maintenance
  A multitude of high-temperature piping is employed in a thermal power plant. Knowledge was provided on the material properties of piping, methods to select proper piping and things to be noted for its proper use.

- ✓ Valve/motor overhaul
  We had trainers learn proper use of tools and measuring instruments, how to read and record data properly, safe working procedure and efficient installation method by actually performing valve and motor overhaul.

- ✓ Non-destructive inspection
  Lessons were given on the principles and features of various NDT techniques, note on performing tests and how to keep records through lectures and skills training.

- ✓ Instrumentation maintenance
  Lectures were given on the principles and characteristics of pressure gauges and thermometers. After the lectures, trainees were encouraged to learn how to perform overhaul, things to be noted during the overhaul and recording and keeping records.

(4) Safety/quality lectures

(For engineers)

- ✓ Safety experience/lessons learned in the past/quality control
  With the objective to enhance awareness on the safety, we had trainees experience close calls on minor hazards to let them learn the importance of safety devices and safe working practices to prevent them.
  Also, a presentation was given on accidents experienced by the JICA Expert Team (Kansai Electric Power) in the past caused by human errors and machine failures, along with their causes and actions taken to prevent their recurrence. At the same

time, through such an archive of data, experiences would be shared with future generations and had the trainees understand the importance of schemes to prevent similar problems in a lecture.

On the other hand, in order to maintain power plants, it is important to perform operation and maintenance by keeping a certain level of quality, instead of simply performing woks one after another. For that purpose, it is necessary to keep implementing *kaizen* activities (PDCA) at all times and, therefore, we had the trainees learn the necessity and approaches used in a lecture.

- ✓ Human resource development

  An introduction was made to the human resource development actions taken by the JICA Expert Team (Kansai Electric Power) and, at the same time, a lecture was given for the purpose of providing reference information useful for their programs in Egypt.

(For technicians)

- ✓ Prevention of accidents & hazards/safety experience drill/quality experience drill)

  For the purpose of minimizing casualties, we had the trainees learn the importance of safety devices and safe practices by letting them experience close calls of minor hazards, along with providing lectures on required safety measures.

  Also, trainees had a hands-on experience to understand that the withstand pressure and other properties may differ depending on the material, even for materials of same shape, to learn the importance of quality control on materials purchased.

(5) Training through tours of power plants/manufactures' factories

(For engineers/technicians)

Through tours of power plants operated by the JICA Expert Team (Kansai Electric Power), we had the trainees learn how the operation can be done effectively. Since there is no factories of equipment manufacturers in Egypt, trainees were invited to tour manufacturing plants in Japan to learn their manufacturing capacities and quality control methods.

(For engineers/technicians)

Kansai Electric Power, Himeji No.2 Thermal Power Plant
Ishikawajima-Harima Heavy Industries (IHI), Aioi Factory
Mitsubishi Hitachi Power Systems (MHPS)

(For engineers)

Kawasaki Heavy Industries (KHI) Akashi Factory

(6) Preparation and presentation of action plan

Each trainee had prepared an action plan on how to solve issues determined through the problem and goal analyses performed in the former half of the training using knowledge and experiences gained in the above programs and presented it.

Specifically, following action plans were prepared.

- ✓ Review of issues determined by the use of PCM method

  Reviewed and reconfirmed issues on the operation and maintenance of power plants listed in the former half of the training.

- ✓ Review of knowledge, experience and lessons learned in the Japan training.
  Reviewed the knowledge and experiences gained in the Japan training subject by subject.
- ✓ Selection of issues
  For each issue, trainees pondered how to utilize the knowledge learned in the training to solve it. There are many issues in the operation and maintenance of power plants. However, for a problem like "shortage of spares due to insufficient budget," measures available to on-site engineers and technicians are limited and the areas to which this Japan training can contribute is also limited. In preparing an action plan, it was noted to give priority on issues that can be "solved within the areas attended by the trainees" and "solved by the use of technical methods."
- ✓ Planning actions to solve issues (summarizing them as an action plan)
  After selecting issues in the operation and maintenance of power plants, how to solve them was summarized in an action plan.
  In principle, an action plan is made to lead colleagues in the power plant to solve technical issues by providing them knowledge and improving their technical skills. In an action plan, goals are made specific by stating when the knowledge (training) shall be provided.
  Action plans prepared by the trainees (examples) are listed in Attachment 2.1.6.1.
  Also, the progress of trainees' action plans shall be checked during our first on-site work to be performed in the future.

2.1.7 Review of the first Japan training and things to be reflected to the next training

(1) Feedbacks from the trainees

Following comments were received from trainees participated in the training and will be used as inputs to future trainings.

(From engineers/technicians)

- While fundamental trainings are important, more practical training and higher level technical knowledge are also required.

(From engineers)

- It is requested to offer more practical programs in addition to theories.
- It is requested to continue to offer following lectures as they were especially effective.
  Fundamentals of vibration (balancing), non-destructive inspection, introduction of latest GTCC technologies, GT and high-temperature components/maintenance
- It is requested to add following programs to the next training as welding problems and HRSG tube leaks are often encountered on site.
  Control of welding quality, HRSG maintenance technique

(From technicians)

- The training was useful but it was too short. It is requested to extend the period and include more subjects.
- Following lectures were found to be especially useful and it is requested to continue offering them in the future.
  Metallic materials, safety experience, welding control, fundamentals of non-

destructive inspection

- Because vibration problems on rotating devices are often encountered on site, it is requested to add following subject to the next training.
  Practical training on rotating devices (alignment and balancing)

(2) Feedbacks to the next training

Engineers were fluent in English and asked questions to the instructors proactively. Their attitude was good. Through questionnaires and evaluation meetings after receiving lectures, it was found that the trainees were more interested in advanced or latest information and skills rather than fundamental lectures. While we will try to expand the skills training, as for the fundamental lectures, we will consider the information required for engineers in Egypt by analyzing the O&M level in Egypt through our on-site work.

As for the technicians, few were fluent in English and the literacy in PC operation was considered to be low. On the other hand, their attitude in class attendance was good as evidenced in many questions being asked through an interpreter. Questionnaires and evaluation meetings after the lecture showed that many of them wanted more practical information and longer training period. While we will try to expand the skills training, extending the training period needs to be considered further. In the future, the training programs required for Egyptian technicians shall be considered by analyzing the O&M level in Egypt through our on-site work.

2.2 First on-site work

2.2.1 Overview of our first on-site work

(1) Personnel involved in the work

Table 2.2.1.1 Personnel involved in the work

No.	Name	Responsibility	Affiliated organization in Japan
1	Hiroki Hirahata	Overall project management	Kansai Electric Power Co., Inc.
2	Shigeru Yoshitake	Thermal power generation (Machine maintenance)	
3	Yoshihiro Doi		
4	Haruaki Furukawa	Thermal power generation (Electrical maintenance)	
5	Yuuki Obe	Thermal power generation (Control maintenance)	

(2) Period

From June 29 to July 14, 2018 (from the departure from Japan to the return)
For more information on the itinerary, refer to Attachment 2.2.1.2. For information on the activity conditions during our on-site work, refer to Chapter 4.

(3) Preliminary analysis by the JICA Expert Team (Kansai Electric Power)

Prior to the Japan training, following information was obtained from the analysis of annual report.

- In Egypt, the shortage of supply they had several years ago has been overcome by aggressive construction of new power sources in recent years and the supply capacity is significantly above the demand. Since more renewable energy, coal-fired thermal and nuclear power plants are planned in the future, the role of thermal power plants will change drastically.
- To be more specific, in the thermal power plants which are highly adjustable to the varying demand, adjustment of output power is done very frequently during the operation leading to severer use of the equipment compared to the past and the speed of deterioration will also be faster. Because power plants are relatively new in Egypt, many are running stably. On the other hand, drop in the power output, including stoppage, and drop in the efficiency are observed among aging power plants. Considering future operation, secure daily O&M will be more important to delay future aging and be the cornerstone for economic operation.

(4) Purpose of first on-site work

Following are the purposes of this on-site work.

- To check if the above analyses matches the recognition of people concerned and the current situation in Egypt and verify the appropriateness of training programs.
- In order to use the information as inputs to the next Japan training, investigate and

confirm the operational status of local power plants and status of human resource development.

- To check the progress of trainees' action plans and provide necessary guidance.
- To request the management class to cooperate with the execution of trainees' action plans.
- To investigate the needs of people concerned in Egypt concerning training programs and requirements for the application for next Japan training and try to reach an agreement after performing an analysis as JICA Expert Team (Kansai Electric Power).

(5) Visits made in our first on-site work

In selecting companies to visit, it is necessary to perform investigations on the awareness of current problems, operational capability, training capability and training needs at respective electrical utility companies. Therefore, power plants of trainees' affiliation, head offices, power plants, training centers of respective utility companies and EEHC, which oversees them, were picked for our first on-site work.

Table 2.2.1.3 Destinations on the first survey

No.	Electric utility companies	Locations observed	Purposes
1	EEHC	EEHC Office	Explanation of project and collecting information Sharing requirements for the application of next trainees
2		EEHC Training Center	Checking training facilities and utilization of them
3	CEPC	CEPC Office	Explanation of project and collecting information
4		Cairo North power plant	Checking the operational status and progress of action plans
5		Cairo North Training Center	Checking training facilities and utilization of them
6	MDEPC	MDEPC Office	Explanation of project and collecting information
7		Nubaria power plant	Checking the operational status and progress of action plans
8		Talkha Training Center	Checking training facilities and utilization of them
9	WDEPC	WDEPC Office	Explanation of project and collecting information
10		Sidi Krir power plant	Checking the operational status and progress of action plans
11		Abu Qir Training Center	Checking training facilities and utilization of them
12	UEEPC	UEEPC Office	Explanation of project and collecting information
14		Kriemat power plant	Checking the operational status and progress of action plans
15		Kriemat Training Center	Checking training facilities and utilization of them

(6) Map of companies visited

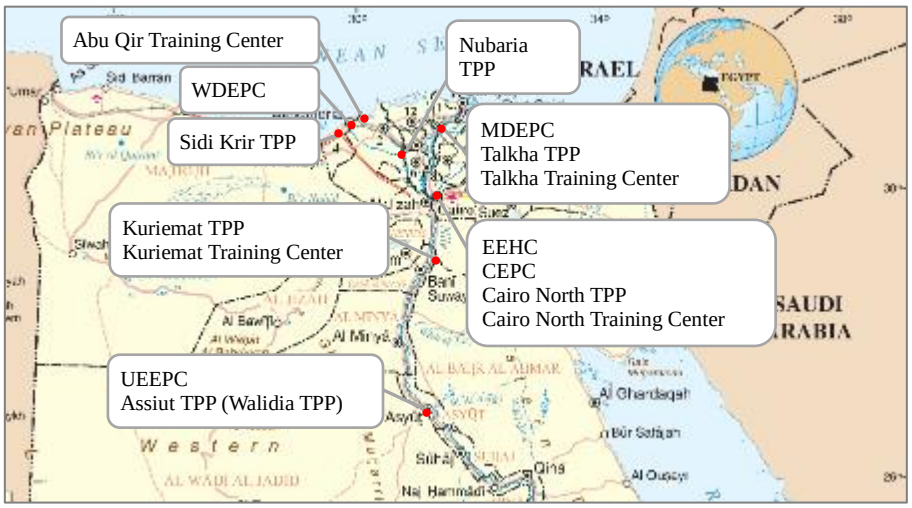


Figure 2.2.1.4 Location of companies visited

2.2.2 Observation of electric utility companies, power plants and training centers during our first on-site work

2.2.2.1 EEHC (Egyptian Electricity Holding Company)

EEHC was established by reorganizing the Egyptian Electricity Authority as a result of regulation enacted in 2000. EEHC not only oversees the service and operation of public power utilities (six power generation companies, one power transmission company and nine power distribution companies), but also play an important role in making plans.

(1) Objectives of EEHC

Following objectives are set for EEHC and it is run in accordance with them.

- Producing, transmitting and distributing electrical energy for all uses on the various voltages with high efficiency at affordable prices.
- Carrying out planning, studies and designs in the field of competence of the Company, its subsidiaries and other companies working in the field of electrical energy.
- Implementing thermal power plant projects for electrical energy production.
- Implementing electrical energy transmission and distribution projects.
- Managing the National Control Center for optimum operation of electric energy production, transmission and distribution.
- Purchasing the electrical energy produced at power plants constructed by authorized local and foreign investors and selling it on the various voltage networks.
- Managing, operating and maintaining electricity transmission and distribution networks at the various voltage levels, selling electrical energy on the various voltages throughout the country and making the optimal utilization of these networks.
- Implementing electricity interconnection projects, exchanging electrical energy with other countries, and selling and buying it according to the needs of electrical grids

interconnected with the Unified National Grid in Egypt.

- Conducting researches and tests of electric equipment at the various voltage levels.
- Carrying out consultancy and service works in the field of electrical energy production, transmission and distribution locally and internationally.
- Producing electrical energy from all sources except nuclear energy.
- Producing and selling desalinated water.

(EEHC annual report 2016/2017)

(2) Organizational chart

The organizational chart for EEHC, from the power generation to transmission and distribution of power is provided below. As described earlier, there are five utility companies that run thermal power plants.

Figure2.2.2.1 Organization structure of EEHC

(EEHC annual report 2016/2017)

(3) Interview with EEHC (HQ)

Followings are the results of interview with EEHC.

- EEHC also had the same recognition that the operation of thermal power plants will change drastically in the future as analyzed by the JICA Expert Team (Kansai Electric Power) prior to the Japan training. Because inefficient and old power plants will be decommissioned gradually, EEHC considers it important to share the technology and know-how obtained through OJT and Trainers of Training within Egypt. The JICA Expert Team (Kansai Electric Power) was requested to provide training focusing on excellent safety management and quality control techniques of Japan including the know-how on the training itself in view of sustainability.
- They said that the Siemens project had come to the final stage and a new O&M company would be established and a contract would be signed within a month. Ordinarily, EEHC is not directly involved in the performance of O&M but it is the responsibility of respective utility companies. While EEHC does not usually intervene with each project and it is left to each utility company, the Siemens project is an exception in which EEHC is involved.
- In terms of the types of power sources, EEHC expects to increase the share of renewable energy to 38% in 2035 and considers that the share of hydropower will drop by 4 to 5% every year. Also, since the water resource cannot be controlled by Egypt alone as other countries are involved, pumped hydropower is also considered as a source of adjustment for the supply and demand.

(4) Observation results of Leadership Development Center

It has been determined that the center has little to do with this project because followings became clear.

- The center provides classroom lectures for the management class, such as leadership training, of power generation companies and does not offer technical training.
- Their training programs range from PC skills, such as Excel and PowerPoint, business skills like exchanging business e-mails, and how to establish good relationship with people.
- They accept trainees from other countries including Arabic countries (Syria, Iraq, Sudan, Palestine, etc.) and APUA (African Power Utility Association).

2.2.2.2 CEPC (Cairo Electricity Production Company)

This is an electric utility company that owns the total installed capacity of 8,900 MW (power production capacity of 8,830 MW) and produces approximately 24% of total power supply in Egypt. It runs power plants with steam, GT and GTCC generation systems, along with two training facilities. (At the time of visit in 2018)

(1) CEPC organization chart

The organization chart of CEPC is provided below. It is considered a common structure for a power plant organization.

Figure2.2.2.1 Organization structure of CEPC

(Referenced from: CEPC HP)

(2) Interview with CEPC (HQ)

Followings are the information obtained on site in Egypt in association with the questions sent in advance.

- Each power plant has an organization consisting of 350 to 950 workers. It has experienced people working for them. It also employs new employees every time a new power plant is built.
- It is especially interested in how to address troubles without being upset and working hard to come up with specific measures.
  (JICA Expert Team has conveyed that it is important to assume problems and prepare actions to address such events as a routine practice to take appropriate measures without being upset.)
- The problem of FAC (Flow Accelerated Corrosion), which had been pointed out by trainees in the first Japan training, was not observed in this company.
- As the electric power companies run their power plants using the latest technology in recent years, experiences in each field of expertise are especially considered important. On the other hand, they wish to give higher priority on human aspects other than expertise, such as safety and spirit, in the future.
- They would like to learn from Japan as workers are trained on how to respond to natural hazards, such as earthquakes. In trainings in Japan, they hope that the focus would be on programs for the safety and human errors.
- They have a concern in securing human resources with technical expertise.
- They also have a concern in the shortage of spare parts. To be more specific, although they have relatively rich assortment of spares at the time of construction, partly thanks to aides from other countries, they have a concern in the supply of spare parts after the start of operation, partly due to the shortage in foreign currencies and long lead time, although the problem has not become apparent at the moment. They are trying to solve this problem by promoting sharing of spare parts with other power plants.

(3) Observation results of Cairo North Power Plant

This is a power plant having a combined cycle power generation of 1,500 MW. The start of operation, fuel, power output of power generating unit and manufacturer of major facilities they own are listed in Table 2.2.2.4.

Followings are the information obtained on site in Egypt in association with the questions sent in advance.

- They have signed LTSAs with MHPS and GE concerning gas turbines. The contract period is five years and, because the one with MHPS will expire this year, they plan to renew the contract (during our first on-site work). Also, they have requested to MHPS (2 to 3 persons) and GE (1 person) to send engineers (SV) when they have combustion chambers inspection and regular inspection.
- The problem of FAC being faced by other power plants is not a problem at Cairo North Power Plant.

- Improper installation at the time of manufacturing by GE was the only large trouble since the start of operation.
- After checking it in the control room of Module 1, the operators consist of four teams in two-shift system with five engineers and six technicians.

(4) Cairo North Training Center

Followings are the information obtained in Egypt in association with the questions sent in advance.

- There were plenty of practical training equipment including mechanical training equipment like welding equipment and drilling machines and electrical equipment like power cable termination device.
- The training center seemed to be utilized well with its equipment well serviced, well organized and thoroughly cleaned in comparison with other training centers.
- It offers a range of training programs including those for newcomers and has a certain level of functions as a training system including evaluation of trainees.
- With a limitation of time for the visit and investigation, it was not possible to check specific training programs and trainee evaluation method. The information was obtained only by interviewing the training center staff. In the future, further interviews shall be done as necessary at the next training or on-site work.

2.2.2.3 MDEPC (Middle Delta Electricity Production Company)

This is an electric utility company with the installed capacity of 5,836 MW (power production capacity of 5,760 MW) which produces approximately 18% of total power generation in Egypt. It runs power plants with steam, GT and GTCC power generation systems and one training facility. (At the time of investigation in 2018)

(1) MDEPC organization chart

Given below is the organization chart of MDEPC. It is considered a common structure for a power plant.

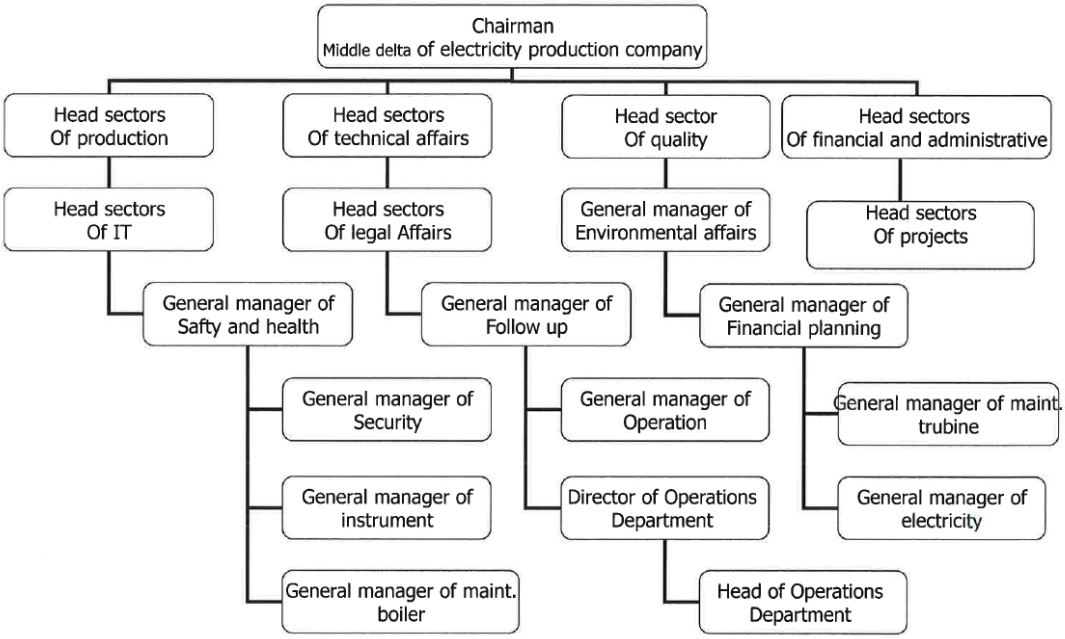


Figure 2.2.2.3 Organization structure of MDEPC

(Source: Documents collected from MDEPC)

(2) Interview with MDEPC (HQ)

Followings are the information obtained in Egypt in association with the questions sent in advance.

- At each power plant, an LTSA contract exclusively for GT is signed with the device manufacturer (Siemens, GE and MHPS) and the contract term is five to seven years on the EOH base.
- Like other electric utility companies, they have a concern in securing manpower with technical expertise.
- Like other electric utility companies, they also have a concern in the shortage of spare parts. Specifically, while relatively rich assortment of spares are available at the time of construction thanks to aides from other countries, they have a concern in the supply of spare parts after the start of operation, partly due to the shortage in foreign currencies

and long lead time, although the problem has not become apparent. They say they are trying to solve this problem by sharing spare parts among the power plants.

(3) Observation results of Nubaria Power Plant

This is a power plant having a combined cycle power generation of 2,250 MW total power output. The commencement date of operation, fuel, power output and manufacturer of power plants they own are listed in Table 2.2.2.4.

Followings are the information obtained in Egypt in association with the questions sent in advance.

- The Nubaria power plant has a number of plants referred to as Module 1, Module 2 and Module 3, which are 2on1 combined cycle power generation plants.
- Employees' awareness of safety seemed to be high based on the use of helmets by on-site workers and the high level of organization in work places. In addition, many safety promotion posters (use of helmets and earmuffs, off limits to unauthorized personnel, ban on the use of fire, etc.) are found on the walls and pillars and they gave us the impression that the power plant is run at a high level.
- The operation department consists of four teams for the three-shift system and each team has fifteen technicians and twenty engineers. In the central control room, there was a note on operations to be performed (the heat soak time in the startup mode) which was prepared by themselves and we got an impression that they are running the plant independently from the OEM.
- In the plant manager's office, there was an environment in which the operational status can be monitored using the same screens as the central control room and it gave us an impression that the operation of the power plant is done at a high level.
- Spare parts for generators are kept in areas that are color-coded in accordance with the manufacturers and controlled by the use of barcode system. They are also organized on shelves that are classified and addressed by the equipment and the storage condition is good. Instruments are kept in an air-conditioned room, which means that they are also aware of quality control.
- Spare parts for the GT rotor are kept not only for this power plant, but as common spares shared by other plants as well.
- Concerning issues in the maintenance of Nubaria power plant, there was an opinion mentioning problems related to HRSG. It is consistent with the information provided by a trainee in 2017 and the cause is assumed to be the internal surface corrosion on the boiler piping due to FAC.

(4) Observation results of Talkha Power Plant

This is a power plant that generates power using a relatively old gas turbine and having the total power output of 290 MW. The commencement date of operation, fuel, power output and manufacturer of power plants they own are listed in Table 2.2.2.4.

Followings are the information obtained in Egypt in association with the questions sent in advance.

- Talkha Power Plant is located next to MDEPC Headquarters and has a training center.
- It has plants of 2on11 (Siemens) and 4on12 (GE) combined cycle power generation. What is special about their plants is that they were constructed by ordering major facilities independently instead of making it an EPC turn-key project.
- Their operation department consists of four teams for the three-shift system (eight hours for a shift) and each team consists of 13 workers.
- Although there was an apparent shortage of gas three to four years ago, it has been resolved at the moment.
- There is a workshop within the premises of power plant, where machine tools like a large lathe are installed.
- Concerning maintenance, there is no operational problem like FAC at the Sidi Krir power plant at the moment.

(5) Talkha Training Center

This is a training center annexed to the Talkha power plant. Followings are the information obtained in Egypt in association with the questions sent in advance.

- While there is no instructor assigned exclusively to the training center, technical trainings are provided by the workers at the adjacent power plant (approximately 60 people).
- The level of understanding is checked by a test provided after the training and the evaluation done by the instructor.
- The instructor is subjected to an evaluation by the trainees.
- Although there were workshops for welding, steam turbines and machining, along with an operation simulator, they are suspended at the moment. Note that the operation simulator is expected to be replaced by a Siemens CCGT, according to their words.
- There are a multitude of training programs offered, including those for the safety, leadership, loyalty, honesty and human resource development, in addition to engineer courses, technician courses, general training courses, instructor training courses and orientation courses for newcomers and we got the impression that their programs are complete.
- In the future, they say that they plan to offer trainings on their company rules.
- Their training facility is not sufficient and it is assumed that their training rely on classroom lectures. We got the impression that they need to introduce more equipment and expand the range of skills training.
- Training programs for workers including newcomers are complete and are considered to be at a certain level required for a training system, as evidenced in their bi-directional evaluation between trainees and instructors.
- With a limitation of time for the visit and investigation, it was not possible to check specific training programs and trainee evaluation method. The information was obtained only by interviewing the training center staff. In the future, further interviews shall be done as necessary at the next training or on-site work.

2.2.2.4 WDEPC (West Delta Electricity Production Company)

This is an electric utility company with the total installed capacity of 4,639 MW (power generation capacity of 4,367 MW) and it produces approximately 12% of total power supply in Egypt. It runs power plants with steam, GT and GTCC generation systems, along with a training facility. (At the time of investigation in 2018)

(1) WDEPC organization chart

We were unable to obtain the organization chart.

(2) Interview with WDEPC (HQ)

Followings are the information obtained in Egypt in association with the questions sent in advance.

- Concerning maintenance issues at Sidi Krir power plant, there was an opinion that they were problems related to HRSG. It is consistent with the information provided by a trainee in 2017 and the cause is assumed to be the internal surface corrosion on the boiler piping due to FAC. There was an interest in reflecting the problem to the program of Japan training including the water supply management.

- For the power plants with CCGT, LTSA contracts only for GT was signed with respective equipment manufacturer.
- They said that the regular inspection of CCGT is planned in winter, when the demand is off the peak, by avoiding the peak in the summertime whenever possible. Because enough supply capacity has been attained in recent years, the freedom in selecting the time of regular inspection is high.
- The management mentioned that they work hard in providing trainings to their employees including newcomers and that their training programs are explained on their HP (details are unknown because it is written in Arabic) and we got the impression that they are enthusiastic in offering training.
- Because old and new power plants are present in this company, they have a strong interest in the aging of equipment.
- They have a strong concern in the availability (budget and lead time) of spare parts and consumables.

(3) Sidi Krir power plant

This is a power plant with the total power output of 1,390 MW and having two 320 MW conventional power plants and a 770 MW combined cycle power plant. The commencement date of operation, fuel, power output and manufacturer of power plants owned by them are listed in Table 2.2.2.4.

Followings are the information obtained in Egypt in association with the questions sent in advance.

- GT high-temperature parts are controlled based on the operation of 12,000 hours

considering the recommendation of the supplier.

- A general explanation on resolving problems (FAC) was given by Sidi Krir TPP. They are learning and implementing actions to solve problems and prevent their recurrences for past troubles they had experiences with a support from the manufacturer. In addition, they are also taking actions required to check the equipment condition (wall thickness test).
- Their operation department has a three-shift system with a team consisting of 12 workers, among which 7 are involved in the operation and 5 are technicians.
- There is no influence of gas shortage to their power generation.
- There is a plan to introduce MHPS GTCC in the JICA project in 2021 or 2022.
- The power plant premises are well organized and we got the impression that their awareness of safety was at a high level.

(4) Abu Qir Training Center

Followings are the information obtained in Egypt in association with the questions sent in advance.

- For the technical training for the power generation equipment, engineers dispatched from respective power plants are serving as instructors.
- The results of newcomer training course (3 months) are used to make the pass/fail determination of newcomers.
- A workshop of machining with lathes, welding machines and small machine tools are provided and utilized in trainings. There is also motor and PLC training facilities for electrical and instrumentation programs.
- A GTCC simulator is provided and is utilized for the training.
- There are total of 35 training courses for general subjects and technical subjects.
- They also prepare their original textbooks and use them in their training.
- This training center offers training programs in and out of the company, including high schools, universities and vocational schools. (in July and August)
- As stated above, the center offers full range of training programs for engineers and technicians including mechanical and electrical subjects and in the forms of classroom lectures and skills training. We consider they offer relatively high level of training.

2.2.2.5 UEEPC (Upper Delta Electricity Production Company)

This is an electrical utility company with total installed capacity of 4,954 MW (power generation capacity of 4,954 MW) and produces approximately 9% of total power supply in Egypt. It runs power plants with steam, GT and GTCC generation systems, along with a training facility. (At the time of investigation in 2018)

(1) UEEPC organization chart

We were unable to obtain the organization chart.

(2) Interview with UEEPC (HQ)

Followings are the information obtained in Egypt in association with the questions sent in advance.

- The number of employees is 3,000 (4.5 MW/person) and employee housings (in the scale of 300 employees) are provided in the premises of Kuriemat power plant.
- As a measure to improve the thermal efficiency, they hired ATD (Advanced Technology Development) and they pay them 50% return on the improvement made on the thermal efficiency.
- U1 was supplied by Toshiba and U2 was supplied by ANSALDO. For both plants, there are LTSAs concerning regular inspections in addition to ST.
- Major troubles in the UEEPC power plants are leaks from the boiler tube due to scales (water cooled walls, SH, RH) and attachment of ashes. Boiler tube leaks have been observed once or twice every month in the past and, because there were extensive damages on other boiler tubes, all tubes have been replaced with new ones recently. According to them, the frequency of the same problem has been stable at about once in six months after the modification, which included the improvement from straight tubes to spiral tubes.
  (However, the frequency is still high based on the experience in Japan and it is assumed that there is a room for improvement in the water treatment and combustion control.)
- In terms of sharing information on troubles experienced, they say they don't share the information although it is possible to share the information with EPC and power plants within Egypt.
- Concerning spare parts, they keep a stock of parts that are not available immediately including imported parts. As for packing and O-rings, which are not suited for long term storage, purchases are made whenever necessary.
- While they wanted the subjects of welding, quality control and vibration analysis to be focused on in the Japan training, they expressed their satisfaction and appreciation as those have already been covered in the existing training programs.
- Concerning their training, they do not invite outside instructors but lectures are given by UEEPC engineers. While the training offered by UEEPC accepts participants from universities, they say there is no participant from other companies such as IPP.

(3) Assiut Power Plant (Walidia Power Plant)

This is a power plant with two 300 MW conventional power generation units with the total power output of 600 MW. The commencement date of operation, fuel, power output and manufacturer of main facilities they own are listed in Table 2.2.2.4.

Followings are the information obtained in Egypt in association with the questions sent in advance.

- The crude oil used as the fuel is transferred through a pipeline. Also, there were two types of crude oil tanks provided (called Monthly and Daily). However, there is no environmental measures (EP, de-nitration and de-sulfurization) provided and we observed colored smoke being emitted from the smokestack during power generation.
- Although signs for reminding safety are provided, there were no workers wearing

protective gear (safety belt, safety boots, and helmet) and it seemed that the awareness of safety was not high.

- They said that Unit1 was in the regular inspection at the time of visit, the suspension of operation lasted for about nine months since October 2017. The regular inspection cycle is five years, which is set based on the steam turbine, and boilers are serviced in association with the regular inspection, they said.
- Similar to the Sidi Krir power plant, the spare parts warehouse was organized in accordance with the suppliers. Control boards were kept in an air-conditioned warehouse and the management condition was good.
- They were constructing a new plant within the power plant premises and they said that the work was progressing as planned. (Power output: 650 MW, Fuel: crude oil and NG, Type: subcritical pressure through flow boiler)

(4) Kuriemat Power Plant

This is a power plant having two 627 MW conventional power generation units and two 750 MW combined cycle generation units, which produces the total power of 2,754 MW. The commencement date of operation, fuel, power output and manufacturer of main facilities they own are listed in Table 2.2.2.4.

Followings are the information obtained in Egypt in association with the questions sent in advance.

- Because there is no environmental measures (EP, de-nitration and desulfurization) provided and we observed colored smoke being emitted from the smokestack during power generation. The exhaust gas temperature is controlled to 140 degrees C at the entrance of smokestack for the purpose of preventing low-temperature corrosion and, while the effective height of smokestack will increase and the environmental impact would drop, the thermal efficiency is considered to be poor in comparison with power plants in Japan.
- The fuel used is NG and crude oil, which are switched in response to the command. They said that they inject an additive in burning crude oil.
- Vibration monitors were installed for large accessories (such as boiler fans).
- Operators were divided into four teams for the 2-shift system and there were 18 workers (eight engineers and ten technicians) in a team. The collected operational data on equipment every four hours and kept a record.
- At the Kuriemat power plant, they said there has been no big trouble resulted in the suspension of power generation, including leaks from the boiler tube.
- They perform a full-fledged regular inspection every six to seven years following the advice of OEM.
- Similar to the Sidi Krir power plant, the spare parts warehouse was organized in accordance with the suppliers. Control boards were kept in an air-conditioned warehouse and the management condition was good.

(5) Kuriemat Training Center

Followings are the information obtained in Egypt in association with the questions sent in advance.

- Trainings concerning the operation are offered by inviting instructors from the power plant.
- Safety training are offered by inviting outside instructors.
- Besides there are tests to check the level of understanding, questionnaires to the trainees are collected before and after each training session and another questionnaire is sent to their superiors three months after the training to evaluate them.
- Questionnaire are passed around the trainees to evaluate the instructors.
- There are workshops with lathes, drilling machines, grinders, welding machines, refrigerators and air conditioners.
- There is a skills training room with half-cut models of valves and boiler piping models, which are necessary for mechanical training, and PLCs and control valves, which are necessary for electrical and instrumental training.
- A Siemens operation simulator is provided.
- The newcomer orientation (basic knowledge on the power plant, safety and social rules are taught) is targeted not only for engineers, but also for technicians.
- During the summer, public training is offered on electrical issued aimed at university students.
- In general, we got the impression that they offer high-level training programs with the provision of both mechanical and electrical training facilities, while considering the safety.

2.2.2.6 Summary of on-site investigation of electrical utility companies

(1) Facilities and operation of power plants

(Overview)

With old and new power generation systems are present, there were instances in which the power generation capacity had dropped below the design power especially in relatively old power plants. Also, there are power plants of which employees' age was not evenly distributed and, considering the future, it cannot be said that O&M is performed properly.

(Spare parts/consumable management)

Many power plants are managing spare parts properly and, especially with the color-coded organization by the manufacturer and systematized registration book, the management condition was good. In addition, the operation was appropriate by sharing parts that are difficult to obtain among power plants.

(Sharing trouble information)

It was said that information on troubles are kept within respective power plants and not shared with other plants. It is very inefficient and uneconomical that information on troubles experienced in the past are utilized only in a limited range.

(Safety)

It seemed that the awareness on the safety varied significantly between power plants. As each power plant has a concern in securing excellent workers, the safety is an important issue in securing and retaining such manpower.

(2) Facilities and operation of training centers

There were gaps in the provision and utilization of training facilities among the training centers. There are training centers offering training programs by having both mechanical and electrical facilities and, on the other hand, there are training centers that are not well organized and well furnished. The gap seemed significant.

The facilities are made by using workshops or reducing their scales and the training programs offered to engineers and technicians are considered effective.

On the other hand, while many lectures are focused on existing thermal power plant facilities, we consider that there is still a room to enhance the training on GTCC. Also, concerning the ability (analysis capability) required for troubleshooting, there is no sign that training is offered in the power plants or training centers and it is an area that needs to be expanded in the future.

It is admirable that training programs are open to local students, in addition to the electrical utility companies in the perspective of making contributions to the local community.

2.2.3 Checking the progress of action plans prepared by trainees for the first Japan training

For the trainees who participated in the first Japan training in 2017, the progress check on action plans was carried out as follows.

(1) Participation to the hearing of action plan progress

Participation to the hearing was as follows. Further information on the participation is given in Table 2.2.3.2.

Table 2.2.3.1 Hearing participants of first batched JICA-Trained participants

(Engineers)

Power plants	No. of participants in the first Japan Training	No. of participants in the hearing	Others
Cairo North power plant	3	2	One person was absent due to a conflict of work
Nubaria power plant	2	2	
Sidi Krir power plant	3	3	
Assiut power plant (Walidia power plant)	2	2	
Total	10	9	

(Technicians)

Power plants	No. of participants in the first Japan Training	No. of participants in the hearing	Others
Cairo North power plant	3	3	
Nubaria power plant	2	2	
Sidi Krir power plant	3	0	Three person was absent due to a conflict of work
Kuriemat power plant	3	3	
Total	11	8	

(2) Description of action plan progress hearing

Followings are the information obtained in Egypt in association with the questions sent in advance.

✓ Action plan progress

- In general, action plans are implemented without any problem by the engineers and technicians.
  (Although there are differences depending on the trainee, it seems that actions are taken constantly one to three times a month.)
- Actions are taken at different times by lecturing, before the work or during the working hours depending on the responsibility.
- Newcomers and people who do not have any experience in the training subject in question had been selected as trainees and had been provided training efficiently.
- If materials and equipment appropriate for the training were not available, the training may be offered at other power plant or training center.
- Persons who receive the training gather without a concern with their ages or number of years in their work.
- One of the trainees was awarded a prize by a vendor for the safety activity using the knowledge acquired in the Japan training.
- After the Japan training, people became aware of organizing parts and tools.

(3) Evaluation of action plan progress

In general, knowledge are transferred in various forms but we found that the trainees were using different ideas in implementing their action plans. Also, when engineers and technicians implement their action plans, it seemed that there is no critical hindrance except for minor ones like some shortages in materials and equipment.

However, because the check ended with the hearing only, we plan to have the trainees submit photos showing scenes of training in the next on-site work.

2.2.4 Reflection to the second Japan training

Through the visit to various electrical utility companies (head office, power plants and training centers) and hearing of trainees to the first training, checks were made on the training needs for the next Japan training and requirements for the selection of participants.

As a result, the training programs and the selection criteria for the second Japan training were proposed to EEHC as a table shown below during the wrap up meeting.

Table 2.2.4.1 Second training curriculum in Japan (draft)

Engineers	Technicians
Introduction of the latest technology in TPP	Introduction of the latest technology in TPP
Experience-based Safety Training	Experiential Safety Training
Human Resource Development	Welding Procedure Management
Quality Management	Experiential Quality Training
Thermal Efficiency Management	Metal Material
Basic Training of Vibration (Balancing)	**Overhauling Rotary Pumps**
Non-Destructive Inspection	Basics of Non-Destructive Inspection Skills
GT & High Temperature Parts / Maintenance of GTCC (inc. **HRSG**/Generator)	Maintenance of High Temperature and High Pressure Piping
Remaining Life Assessment (**advanced**)	**Occupational HSE (especially Safety)**
Feed Water Treatment	**General System and Outline of GTCC**
Site Visit on TPP and Manufacture's factory	Site Visit on TPP and Manufacture's factory
Lessons Learned from Accidents	Prevention of Accidents and Disasters
Participation in GTCC Overhaul	**Participation in GTCC Overhaul**
Human Error Prevention	Methodology to Formulate Action Plan
Welding Quality Management in Japan	
Effective Maintenance for Quality Electric Power Infrastructure	
Methodology to Formulate Action Plan	

*** New training subjects as shown in blue underlined & boldfaced type**

Table2.2.4.1 Selection criteria of second training participant

Items	Qualification (Engineers)	Qualification (Technicians)
Number	10 persons per annual	10 persons per annual
Training Term	About 1 month	About 3 weeks
Current Duties	Be a leading engineer working on thermal power plants, and has expertise related to **mechanical engineering in GTCC**, who are capable to be instructors to train other engineers.	Be a leading technician working on thermal power plants, and has expertise related to **mechanical work in GTCC**, who are capable to be instructors to train other technicians.
Experience in the relevant field	Have **from 5 to 10 years' experience in the field O&M of GTCC** including GT, ST and HRSG.	
Educational Background	Be a graduate of university	Be a diploma of technical high school or college, or higher
Language	Have a competent command of spoken and written English.	None[*1]
Health	Must be in good health, both physically and mentally, to participate in the program in Japan.	

1: Lecture will be made in Japanese and translated to English or Arabic. Course materials will be prepared in English, and participants are expected to prepare job reports and action plans in English.

Note that followings points shall be enhanced in the second Japan training compared to the first training in order to overcome various weak points found through the on-site investigation.

(For engineers)

- In order to respond to different technical levels of trainees, the purpose of training shall be clearly communicated to maintain and further enhance the motivation of each participant.
- Although lectures will be given mainly for mechanical subject like the first Japan training, they will contain more advanced technical information.
- The subjects of “welding management” and “boiler tube leak (HRSG),” which were requested by the trainees of first Japan training and also during the on-site investigation, shall be added.
- Because there are many vibration problems, a lecture on the alignment will be included in addition to vibration analysis.
- Because many power plants do not consider prevention of recurrence of problems, the subject of troubleshooting using FTA (fault tree analysis) shall be included as a skills training in each lecture.
- Further expansion of safety-related lectures, such as human errors, shall be considered.

(For technicians)

- In order to respond to different technical levels of trainees, the purpose of training shall be clearly communicated to maintain and further enhance the motivation of each participant.
- Because there are many vibration problems, overhaul of rotating devices shall be added and lectures will be given on points to be noted during the actual overhaul.
- Because the knowledge on power generation systems is limited, a lecture on the outline of CCGT shall be added.
- Lectures on the safety-related issues, such as human errors, shall be expanded further.

2.3 Second Japan training

2.3.1 Training programs

Based on the information obtained in the first Japan training, first on-site work and trainings in other countries offered in this program, following additions and improvements shall be made in the second Japan training.

(For engineers)

- Although lectures will be given mainly for mechanical subject like the first Japan training, more advanced technical information shall be included.
- The subjects of "welding management" and "boiler tube leak (HRSG)," which were requested by the trainees of first Japan training and also during the on-site investigation, shall be added.
- Because there are many vibration problems, a lecture on the alignment will be included in addition to vibration analysis.
- The subject of troubleshooting using FTA (fault tree analysis) shall be included as a skills training in each lecture. In addition, introduction of case studies for troubles experienced in Japan shall be expanded.
- Further expansion of safety-related lectures, such as human errors, shall be done.
- In preparing action plans, the format uses shall be improved to make the plan more specific. (Describing 5W1H clearly.)
- By experiencing Japanese culture, understanding of fundamental spirit underlying Japan's high-quality products shall be promoted.
- As the training programs are expanded and more practical ones will be added, the training period will be extended by one week, from approximately four weeks for the first training to five weeks.

(For technicians)

- Because there are many vibration problems, overhaul of rotating devices shall be added.
- Because the knowledge on power generation systems is limited, a lecture on the outline of CCGT shall be added.
- Lectures on the safety-related issues, such as human errors, shall be expanded further.
- The introduction of troubles experienced in Japan in the past shall be expanded.
- In preparing action plans, the format uses shall be improved to make the plan more specific. Also, because the proficiency in English and the literacy in the use of PC are relatively low, the instructor organization shall be strengthened. (Describing 5W1H clearly.)
- By experiencing Japanese culture, understanding of fundamental spirit underlying Japan's high-quality products shall be promoted.

2.3.2 Overview of the second Japan training (for engineers and technicians)

(1) For engineers

Table 2.3.2.1 Overview of the second Engineer Training in Japan

Item	Description
Training period	From October 8, 2018, to November 10, 2018 (from arrival in Japan to departure from Japan)
No. of days	34 days
Training programs	• Job report presentation, preparation and presentation of action plans • Technical lectures GTCC (GT/ST/HRSG/high-temperature components/control) Thermal efficiency control, supply water treatment, non-destructive inspection (MT/PT/UT/SUMP/RT) Diagnosis of remaining service life, vibration analysis, pump alignment (centering) • Lectures on the safety/quality Lessons learned in the past, human errors, safety experience, O&M, quality infrastructure, human resource development, quality control, welding control • Tour of power plants and manufacturers' factories Ishikawajima-Harima Heavy Industries (IHI), Aioi Factory Mitsubishi Hitachi Power Systems (MHPS), Takasago Factory Kansai Electric Power, Central Load Dispatching Center/RMC tour Kansai Electric Power, Himeji No.2 Thermal Power Plant (observation of regular inspection site) Kawasaki Electric Power, Himeji No.1 Thermal Power Plant • Experiencing Japanese culture Tour of historic monuments in Kyoto (*Kinkakuji* Temple), lecture on the Japanese language
Training location	JICA Kansai/Kansai Electric Power Headquarters/Kanden Plant Training Center/power plants/manufacturers' factories
No. of participants	10 (see Attachment 2.3.2.2)

- For more information on the route and participants for the training, refer to Attachment 2.3.2.3.
- For conditions of each trainee during the training, refer to Chapter 4.

(2) For technicians

Table 2.3.2. Overview of the second Technician Training in Japan

Item	Description
Training period	From October 8, 2018, to October 27, 2018 (from arrival in Japan to departure from Japan)
No. of days	20 days
Training programs	• Job report presentation, preparation and presentation of action plans • Technical lectures Overview and structure of GT/ST/HRSG, handling metallic materials Performing welding, pump overhaul, high-temperature and high-pressure piping maintenance Non-destructive inspection • Safety/quality-related issues Prevention of accidents and hazards, quality experience training, labor safety Safety experience training • Tour of power plants and manufacturers' factories Ishikawajima-Harima Heavy Industries (IHI), Aioi Factory Mitsubishi Hitachi Power Systems (MHPS), Takasago Factory Kansai Electric Power, Central Load Dispatching Center/RMC tour Kansai Electric Power, Himeji No.2 Thermal Power Plant (observation of regular inspection site) • Experiencing Japanese culture Tour of historic monuments in Nara (*Kasuga Taisha* Shrine), lecture on the Japanese language
Training location	JICA Kansai/Kansai Electric Power Headquarters/Kanden Plant Training Center/power plants/manufacturers' factories
No. of participants	10 (see Attachment 2.3.2.5)

- For more information on the route and participants for the training, refer to Attachment 2.3.2.6.
- For conditions of each trainee during the training, refer to Chapter 4.

2.3.3 Approach to the second Japan training

In the second Japan training, we tried to maximize the understanding of training subjects by an effective combination of practical skills training with theoretical information. Also, an attempt was made to maintain and further enhance the motivation to the training by presenting the objective of training, a summary of each subject of lecture and the relationships between them at the very beginning of the training.

(1) Orientation

The objectives of training were input on the very first day of the training. In this training, workers from different power plants and training centers in Egypt have been selected using predefined selection criteria. However, since people of different ages have been invited from different power plants in Egypt, there are differences in the technical levels between

individuals. For this reason, some trainees may be familiar with the subject depending on the contents of lectures and, if that happens, it will affect the motivation of such trainees. Therefore, we emphasized the fact that the purpose of this training is to "maintain and enhance the level of O&M" and each trainee has been sent as TOT (training of trainers) and is expected to play the role of a "teacher" after the return to his country. It was also instructed to learn how the information is communicated since "how to teach" is also important even if the contents of lecture was already known.

(2) Job report

Similar to the first Japan training, each trainee was requested to prepare a report on the work he is responsible at the power plant and problems surrounding them before the arrival in Japan. By presenting the tasks, roles and problems to the JICA Expert Team (Kansai Electric Power) on the first day of the training, trainees were asked to renew their recognition of issues held by them. It is also useful for the JICA Expert Team (Kansai Electric Power) to understand the issues recognized by the trainees as the information was used to prepare lecture materials to solve problems in later training programs.

(3) PCM (Project Cycle Management) method

Similar to the first training, the PCM method was used to clarify the problems associated with the maintenance and operation of thermal power plants in Egypt. Tasks to be performed in the PCM method are as follows.

- ✓ Problematic tasks: By summarizing problems present in O&M of power plants using the relationship of "cause and consequence," represent the problems visually to facilitate better understanding. Note that an analysis of people involved was performed to extract more specific problems compared to the first training and to limit the target to routine responsibilities and works of each trainee. The analysis of people involved performed in the training was to clarify everybody involved with trainees' works and defining their relationships with problems clearly by clearly stating their roles and responsibilities. By performing this problem analysis, it became possible for the trainees to restrict the problems in the area where they can be solved solely by themselves in succeeding steps.
- ✓ Goal analysis: Clarify the relationship of "means and goals" for the desirable condition after the problem has been solved and the means used to bring such a condition using a system chart similar to the one in the problem analysis.

First, above two steps were performed in the former half of the training and, by performing following two steps at the completion of training, specific actions to be implemented after the return to their countries were set.

- ✓ Selection of means: Select specific means based on the goals and means listed in the goal analysis mainly for issues, in which it is possible to solve problems and those which would receive significant benefits by solving problems. Especially, select means based on the knowledge and experiences gained during the training.
- ✓ Preparation of action plans (AP): Prepare specific plans to implement each means

used to solve problems. Note that the format used has been reviewed to make it possible to prepare and record more specific actions compared to the first training. To be more specific, the form was revised to enable planning and recording when and how action plans shall be implemented to communicate the experiences and knowledge gained in the training to the colleagues in the power plant.

(4) Technical training

In each training program, the lecture was given by using textbooks and demonstrations. In lectures involving skills training, a classroom lecture was given before the skills training to facilitate better understanding.

(For engineers)

- ✓ GTCC (GT/ST/HRSG/high-temperature components/control)

  Knowledge was provided for the construction and mechanism of GTCC. In addition, as pointed out in our first on-site work, there was an information that many boiler tube leaks are encountered frequently in Egypt, although the phenomenon is limited to some power plants, and, for this reason, a thorough explanation and practical training were provided on the troubleshooting method.

  Apart from this, past troubles experienced by the JICA Expert Team (Kansai Electric Power) and how to identify the cause were lectured in relation to things to be noted in the maintenance of facilities.

- ✓ Thermal efficiency control

  Knowledge on the thermal efficiency control, which is the most important task in understanding the current condition of power plant, was provided. While the thermal efficiency control is performed in Egypt, it is focused more on recording data and the trend control and troubleshooting for drops in the efficiency were not usually performed. Hence, lectures were designed to improve actual works by performing calculations to analyze factors causing the drop in the thermal efficiency.

- ✓ Supply water treatment

  The treatment of supplied water is always important in maintaining and operating the power plant. In Egypt, it is reported that boiler tube leaks are frequently observed although the phenomenon is limited to some power plants. Because the cause of this problem was assumed to be internal surface corrosion, a thorough explanation and practical training were offered concerning troubleshooting of the problem.

- ✓ Non-destructive inspection (MT/PT/UT/SUMP/RT)

  Knowledge was offered on the reasons for performing NDT and its principle. Also, because there was a request for the provision of more practical information, the priority was placed on practical training, rather than theories, and had the trainees learn things to be noted in the performance, how to record data and key points in the quality control.

- ✓ Vibration analysis/pump alignment (centering)
  In Egypt, troubles caused by vibration were observed here and there regardless of the main generator or auxiliary machine. That is why the technique of vibration analysis was lectured in this training. In addition, by using a demonstrator, troubleshooting method for vibration was demonstrated visually. By practicing the alignment in assembling pumps, trainees were prompted to learn the calculation methods used, machine behaviors and things to be noted. Through the same skills training, it was encouraged to learn how to organize tools and record data.

- ✓ Diagnosis of remaining service life
  It is very important to check the limit of use for the facility and perform maintenance in accordance with the limit of use in running the plant economically. In this lecture, information was provided on how to determine the phenomenon of deterioration and estimate the level of deterioration focusing on the creep damage on high-temperature components by utilizing electron microscopy photos taken in actual cases.

(For technicians)

- ✓ Overview and structure of GT/ST/HRSG
  Because it was assumed that technicians in Egypt have few opportunities to acquire theoretical information while technical knowledge is gained through the practice, lectures were provided on the configuration of power plant equipment and outline structure of each equipment. In addition, the most important aspects to be noted in overhauling equipment were lectured whenever there was an opportunity.

- ✓ Handling metallic materials
  Lectures were provided on metallic materials, of which the knowledge would be the basis for designing high-temperature and high-pressure piping and performing welding.

- ✓ Performing welding
  By actually performing various types of welding, knowledge was provided on the control points and things to be noted.

- ✓ High-temperature and high-pressure piping maintenance
  As a multitude of high-temperature piping are used in a thermal power plant, knowledge on the material properties, how to select the material and things to be noted was provided.

- ✓ Valve/motor overhaul
  By actually performing the overhaul procedures of valves and motors, trainees were encouraged to learn proper use of tools and measuring instruments, how to record and keep data, safe working practice and how to perform overhauls efficiently.

- ✓ Non-destructive inspection
  We have the trainees learn the principles and features of different NDT techniques,

notes in inspection and how to record data through lectures and skills training.

(5) Safety/quality-related lectures

(For engineers)

- ✓ Safety experience/lessons learned in the past/quality control/welding control

  With the objective of enhancing the awareness of safety, we had the trainees learn the importance of safety devices and safe practices by experiencing close calls on minor hazards.

  Accidents experienced by the JICA Expert Team (Kansai Electric Power) in the past and caused by human errors and machinery failures were introduced together with the causes and actions to prevent recurrences. At the same time, through such an archive of data, experiences would be shared with future generations and had the trainees understand the importance of schemes to prevent similar problems in a lecture. Especially regarding welding, it is reported that problems related to welded parts are often observed in Egypt. Therefore, lectures were given concerning the maintenance points on welded parts.

  On the other hand, in order to maintain power plants, it is important to perform operation and maintenance by keeping a certain level of quality, instead of simply performing woks one after another. For that purpose, it is necessary to keep implementing *kaizen* activities (PDCA) at all times and, therefore, we had the trainees learn the necessity and approaches used in a lecture. Especially regarding welding, it is reported that some problems related to welding are often observed in Egypt. Hence, a lecture was given concerning the maintenance points in welding.

- ✓ Quality electric power infrastructures/development of human resources

  For the "high-quality electric power infrastructures" organized by APEC, lectures were given on the requirements for the supply of high-quality power. Electric power utility companies in Japan generally satisfy these requirements. Therefore, an introduction was made to schemes to develop human resources and mechanism of *kaizen* activities taken by the JICA Expert Team (Kansai Electric Power) and, at the same time, a lecture was given for the purpose of providing reference information useful for their human resource development in Egypt.

(For technicians)

- ✓ Prevention of accidents and hazards/safety experience training/quality experience training

  For the purpose of minimizing casualties, we had the trainees learn the importance of safety devices and safe practices by letting them experience close calls of minor hazards, along with providing lectures on required safety measures.

  Also, trainees had a hands-on experience to understand that the withstand pressure and other properties may differ depending on the material, even for materials of same shape, to learn the importance of quality control on materials purchased.

(6) Tour of power plants/manufactures' factories

(For engineers/technicians)

Through tours of power plants operated by the JICA Expert Team (Kansai Electric Power), we had the trainees learn how the operation can be done efficiently. Because regular inspection was underway at the Himeji No.2 Thermal Power Plant at the time when the second Japan training was offered, we let the trainees observe overhauls of large machines at the same time.

In addition, since there is no factories of equipment manufacturers in Egypt, trainees were invited to tour manufacturing plants in Japan to learn their manufacturing capacities and quality control methods.

(For engineers/technicians)

Ishikawajima-Harima Heavy Industries (IHI), Aioi Factory

Mitsubishi Hitachi Power Systems (MHPS), Takasago Factory

Kansai Electric Power, Central Load Dispatching Center/RMS tour

Kansai Electric Power, Himeji No.2 Thermal Power Plant (observation of regular inspection site)

Kansai Electric Power, Himeji No.1 Thermal Power Plant

(For engineers)

Kansai Electric Power, Himeji No.1 Thermal Power Plant

(7) Experiencing Japanese culture

In order to deepen the understanding of historical and cultural backgrounds of Japan, tours of historical structures in Kyoto and Nara were offered. First, the concept of "Japanese-like features" was explained in a lecture, real historic remnants were observed in the historic locations and the trainees experienced Japanese culture including tea ceremony.

In addition, we had the trainees experience the culture unique to Japan, such as keeping time and organizing surroundings, through daily life by travelling from the hotel to the training center using public transportation and visiting a nearby high school to make the training more effective.

(8) Preparation and presentation of action plans

Each trainee had prepared an action plan on how to solve issues determined through the problem and goal analyses performed in the former half of the training using knowledge and experiences gained in the above programs and presented it.

Specifically, following action plans were prepared.

- ✓ Review of issues determined by the use of PCM method
  Reviewed and confirmed issues in the operation and maintenance of power plants listed in the former half of the training.
- ✓ Review of knowledge, experience and lessons learned in the Japan training.
  Reviewed the knowledge and experiences gained in the Japan training subject by subject.
- ✓ Selection of issues
  For each issue, trainees pondered how to utilize the knowledge learned in the training

to solve it. There are many issues in the operation and maintenance of power plants. However, for a problem like "shortage of spares due to insufficient budget," measures available to on-site engineers and technicians are limited and the areas to which this Japan training can contribute is also limited. In preparing an action plan, it was noted to give priority on issues that can be "solved within the areas attended by the trainees" and "solved by the use of technical methods."

- ✓ Planning actions to solve issues (summarizing them as an action plan)
  After selecting issues in the operation and maintenance of power plants, how to solve them was summarized in an action plan.
  In principle, an action plan is made to lead colleagues in the power plant to solve technical issues by providing them knowledge and improving their technical skills. In an action plan, goals are made specific by stating when the knowledge (training) shall be provided. In addition, compared to the first Japan training, considerations were given to limit the targets more consistent with trainees' responsibilities and make the plan more specific.
  Action plans prepared by the trainees (examples) are listed in Attachment 2.3.3.1.

2.3.4 Review of second Japan training

Although it has been decided to terminate the training offered in Japan in this project after the second one that took place at this time, things that have been reflected in the training shall be used as inputs to training of other countries within the same program.

- ✓ Review on the training programs
  There is a tendency to forget the original objective of ToT (Training of Trainers) during the extended period of training and, if the subject of lecture was already familiar to the trainees, the level of concentration tended to drop no matter how. On the other hand, since it is not practical to match the subject of lecture with individual levels in a situation where there are gaps in the technical levels between trainees, we will try to maintain and enhance the motivation of trainees by performing simple reviews on the purposes of lectures and subjects regularly in the next training.
- ✓ PCM method
  The PCM method is effective in determining the goals in the project and making action plans and is especially useful in rough decision making like deciding on policies. On the other hand, trainees who are the main target of this project are performing works at respective power plants and the use of this technique has a tendency to set vague goals and actions plans. While it was the responsibility of instructors of JICA Expert Team (Kansai Electric Power) to provide guidance to make the goals and action plans more specific, there was a limit due to the limitation in time.

  Therefore, for the next training in Japan offered to other countries, we decided to introduce issue analysis to overcome this problem. Specifically, goals are predefined by the JICA Expert Team (Kansai Electric Power) and, at the same time, requirements to achieve such goals shall be set (this is referred to as "the ideal condition"). Also, for these requirements, considerations shall be given in the three areas of "human requirements", "material

requirements" and "schematic requirements" to cover every area. For the requirements predetermined by the JICA Expert Team (Kansai Electric Power), trainees are requested to clarify the current situation and prepare a plan for actions required based on the gap between the ideal condition and actual situation. By doing this, it is expected that the action plan would be more specific and reasonable.

On the other hand, because this approach is not used by the Egyptian trainees, we will check the appropriateness and reasonableness of action plans prepared by them using this method during our second on-site work and, at the same time, it will be checked if their action plans cover all areas of improvement.

2.4 Second on-site work

2.4.1 Overview of the second on-site work

(1) Personnel involved in the activities

Table 2.4.1.1 Personnel involved in the activities

No.	Name	Responsibility	Affiliated organization in Japan
1	Hiroki Hirahata	Overall project management	Kansai Electric Power Co., Inc.
2	Akira Kozakai	Thermal power generation (Operation)	
3	Yoshihiro Doi	Thermal power generation (Machine maintenance)	
4	Haruaki Furukawa	Thermal power generation (Electrical maintenance)	
5	Yuuki Obe	Thermal power generation (Control maintenance)	

(2) Period

From June 22 to July 4, 2019 (from the departure from Japan to the return)

For more information on the itinerary, refer to Attachment 2.4.1.2. For information on our on-site work, refer to Chapter 4.

(3) Purposes of second on-site work

In our second on-site work, followings are considered as its purposes.

- To reconfirm the current situation and future concerns in Egypt (confirmation of steady O&M).
- To check the progress of trainees' action plans and provide advices.
  In addition, a request was made to each trainee to take photos of training scenes so that their activities can be made easy to understand.
- To explain the details of second Japan training to the management level to facilitate better understanding on the action plans.

- To request for cooperation from the management level for the implementation of action plans by the trainees.

(4) Visits made during our second on-site work

In selecting the companies to be visited, it is necessary to carry out hearing of trainees and explanation to the management level of electric utility companies involved. Also, because it is necessary to perform on-site work efficiently within the limited time, followings have been decided.

- In this project, the cooperation of management level of each electric utility company is indispensable. Therefore, an explanation on the significance of this project shall be made to the management level at the head office of each electric utility company.
- Trainees are requested to gather at the head office of each company to carry out the hearing efficiently.
- Explanation to the management and hearing of engineers/technicians shall be carried out at the same time for efficient use of time.

Table 2.4.1.3 Destinations on the second survey

No.	Electric utility companies	Locations observed	Purposes
1	EEHC	EEHC Office	(For management personnel) Explain outline of the project. Propose actions to enhance O&M of thermal power plants in Egypt. (For engineers/technicians) Analysis of current problems (increasing the depth of current investigation) Check the progress of action plans
2	CEPC	CEPC Office	
3		Cairo North power plant	
4	MDEPC	MDEPC Office	
5	WDEPC	WDEPC Office	
6	UEEPC	UEEPC Office	

(5) Locations of companies visited

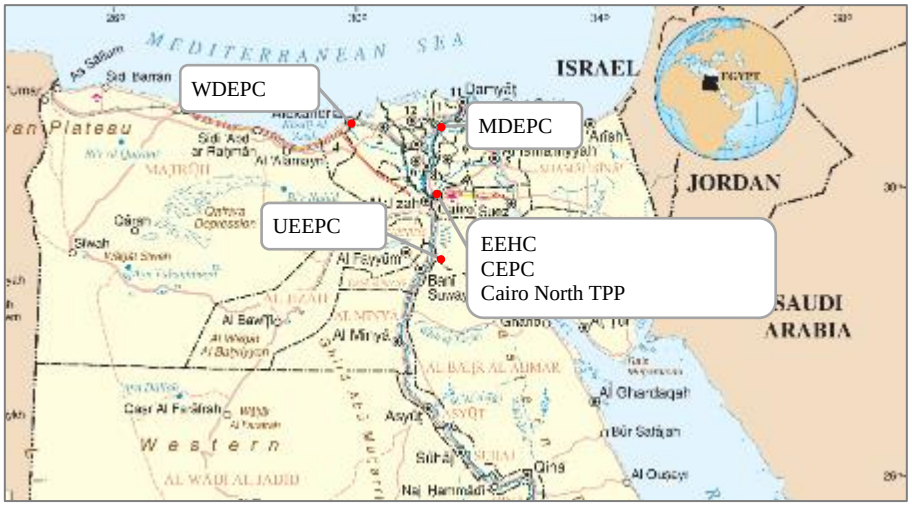


Figure 2.4.1.4 Location of companies visited

2.4.2 Explanation of project outline to the management level

During our second on-site work, explanations were provided to the management level of each electric utility company (CEPC, MDEPC, WDEPC and UEEPC) on the past undertakings in the project. Major items reported are listed below. For the reports made, no particular objection was raised and the management agreed on them. In addition, explanation was made that the support of management level is indispensable for the continued implementation of action plans made by engineers and technicians and it was understood and agreed upon by the management.

(1) Backgrounds

Based on the supply and demand for electrical power in Egypt, it is considered that the operation of thermal power plants in Egypt will shift drastically from the basic and middle operation to peak operation in the future, which will have an influence on the equipment and efficiency of thermal power plants. Therefore, it was explained that proper O&M will be even more important in the future.

(2) Project outline

Explanations were provided on the purposes, outputs and overall schedule of this project, as well as processes of second on-site work.

(3) Japan training

Outline of the second Japan training was explained. Especially, in addition to passive lectures and tours, it was explained that the combination of active training programs to facilitate proactive participation to workshops and skills training by the trainees has enhanced the effectiveness of training.

(4) Analysis of issues

An explanation was provided on the results of analysis carried out on the ideal condition of O&M of thermal power plants assumed in advance by the JICA Expert Team (Kansai Electric Power) *, the gap between the ideal condition and current situation, and possible actions to be taken using the information obtained in past training and on-site work.

* It was also explained that the assumptions made by the JICA Expert Team (Kansai Electric Power) are being checked with engineers and technicians at the same time explanations to the management level at each power plant are made.

2.4.3 Analyses of current issues faced by the trainees of first and second Japan training

As analyzed in 2.3.4, there was a problem in the preparation of action plans using the PCM method that it is difficult to establish a direct causal relationship between the goals and actions. Therefore, it was decided to use the issue analysis method, which was found to be effective in the trainings provided to other countries in the same program after the completion of second Japan training for Egyptian engineers and technicians to check the current situation in Egypt and the appropriateness of action plans through on-site work.

Issue analysis is a method used to analyze the ideal condition of O&M of thermal power plants extracted comprehensively by the JICA Expert Team (Kansai Electric Power) in advance and the gap between the ideal condition and the current status and to consider effective actions based on the analysis results. The JICA Expert Team (Kansai Electric Power) has made some assumptions on the current status of Egypt and made a comparison with the ideal condition using the information obtained in the first and second Japan trainings and our first on-site work. While hearing sessions were held for trainees on the correctness of assumptions during our second on-site work, there was no particular objections and, especially, it was established as a common understanding that continued implementation of Japan training programs and trainees' action plans is effective in filling the gaps.

2.4.4 Checking the progress of action plans prepared by trainees of first and second Japan trainings

The participation to the hearing is explained below. For further information on the participation, refer to Attachment 2.4.4.2.

Table 2.4.4.1 Hearing participants of first & second batched JICA-Trained participants

(Engineers)

Power companies	No. of participants in the first and second Japan training	No. of participants in the hearing	Others
EEHC	1	1	Explanations provided in the wrap-up meeting
CEPC	4	3	One person was absent due to a conflict of work
MDEPC	4	4	
WDEPC	6	4	One person was absent due to a conflict of work On person was absent because or retirement.
UEEPC	4	2	Two persons were absent due to a conflict of work
Total	19	14	

(Technicians)

Power companies	No. of participants in the first and second Japan training	No. of participants in the hearing	Others
CEPC	6	5	One person was absent due to a conflict of work
MDEPC	4	4	
WDEPC	6	6	
UEEPC	5	4	One person was absent due to a conflict of work
Total	21	19	

(1) Description of action plan progress hearing

Followings are the information obtained in Egypt in association with the questions sent in advance.

✓ Action plan progress

- In general, action plans are implemented without any problem by the engineers and technicians.
  (Although there are differences depending on the trainee, it seems that actions are taken constantly one to three times a month.)
- Actions are taken at different times by lecturing, before the work or during the working hours depending on the responsibility.
- There was a trend that practical trainings were provided for small groups of people.

- Newcomers and people who do not have any experience in the training subject in question had been selected as trainees and had been provided training efficiently.
- If materials and equipment appropriate for the training were not available, the training may be offered at other power plant or training center.
- Persons who receive the training gather without a concern with their ages or number of years in their work.
- After the Japan training, people became aware of organizing parts and tools.
- Regular meetings are being held to share the information on the operational status of power plants and equipment conditions between the operation department and the maintenance department. Thanks to this, the amount of knowledge has increased and the safety level has been enhanced, they said.
- The awareness of safety has been increased constantly (although it is still not complete).

(2) Evaluation of action plan progress

In general, while knowledge is communicated in various forms, we were able to get the condition in which everybody was using his own ideas to implement the action plan. Opinions obtained in our on-site work are as follows.

- Both engineers and technician were trying hard to find time for implementing their action plans by obtaining supports of their superiors and colleagues although they were busy.
- There was a request from the trainees to install facilities exclusively used for the purpose of training (e.g. half-cut models) to make the training more effective.
- Many of the officers in the management level of power plants showed their understanding and enthusiastic support for trainees' action plans.
- On the other hand, while training programs offered by individual members of power plants were performed proactively together with the reform of awareness, there were differences in the organization of training systems between individual electric utility companies.

2.4.5 Final meeting with EEHC

As a summary of this project, a report was made to EEHC on the information provided to the management level as described above and the progress of action plans prepared by the trainees and a general approval has been obtained.

(1) Backgrounds

Based on the supply and demand for electricity in Egypt, it is considered that the operation of thermal power plants in Egypt will shift drastically from the basic and middle operation to the peak operation in the future, which will have an influence on the equipment and efficiency of thermal power plants. Therefore, it was explained that proper O&M will be even more important in the future.

(2) Project outline

Explanations were provided on the purposes, outputs and overall schedule of this project, as well as processes of second on-site work.

(3) Japan training

Outline of the second Japan training was explained. Especially, in addition to passive lectures and tours, it was explained that the combination of active training programs to facilitate proactive participation to workshops and skills training by the trainees has enhanced the effectiveness of training.

(4) Progress of action plans

It was explained that engineers and technicians were providing the knowledge they have gained to their colleagues by using materials and OEM manuals kept in each power plant. Also, a request was made that EEHC would provide their support for the execution of action plans by the trainees, provide recommendations and, where necessary, in arranging training equipment. For further information on the progress of action plans implemented by each trainee is described in 2.4.4.

(5) Issue analysis

An explanation was provided on the results of analysis carried out on the ideal condition of O&M of thermal power plants assumed in advance by the JICA Expert Team (Kansai Electric Power), the gap between the ideal condition and current situation, and possible actions to be taken using the information obtained in past training and on-site work.

It was also explained that, as a result of carrying out hearing of trainees, it was confirmed that their action plans are consistent with current problems and it was requested that they would provide continued supports on trainees' activities in the future.

(6) Future directions

As stated earlier, this project was planned for two year period and training programs and on-site work are complete with what have been done at this occasion. With the activities undertaken in past two years, the awareness of technical capabilities and safety in Egypt

has been enhanced continuously. On the other hand, this achievement has overcome only one of the technical issues being faced in workplaces concerning the O&M of thermal power plants and many other issues still remain to be solved.
Therefore, the JICA Expert Team (Kansai Electric Power) has made following requests concerning the O&M of thermal power plants and technical capabilities in the workplaces for the further development of Egyptian technical capabilities.

- It is desired that further efforts shall be made continuously by the trainees after the completion of this project without being complacent with the achievements made so far in the project.
- By avoiding excessive reliance on the vendors, try to run power plants autonomously.
- Have interest in the latest technologies and, with the help of vendors and other parties, make efforts to build a better O&M environment.

In addition, the JICA Expert Team (Kansai Electric Power) has expressed that it is prepared to offer continuous support not only for these issues, but also for general subjects.

3 Summary of the project and prospects in the future

Although the period for the project was two years, which was rather short, we could continue to make improvements by running a series of cycles to understand the current conditions of Egypt, consider appropriate training programs and offer them. Also, because improvement activities were implemented by including other projects within the same program, the speed of improvement in the project was evaluated to be relatively faster than other single programs.

As stated in Chapter 1, the environment surrounding Egyptian thermal power plants is changing rapidly. Especially, after overcoming the shortage in the supply experienced several years ago by the construction of new sources of power, now is “the time for accumulating power” with the sufficient power supply capability secured. Even the new sources of power will age and their deterioration will be apparent in ten or twenty years from now. How such aging and deterioration may be held in check is the question that must be dealt with in several years from now. If power plants continue to age and deteriorate in the same manner as in the past, repeating the condition where drops in the power production and efficiency cannot be prevented, the anxiety on the power supply will resurface in the future. With many new power supply sources installed, now is the time to improve the technical capabilities to resist the deterioration due to aging and contribute to the stable development in the future.

To achieve it, it is also necessary to install a mechanism to enhance technical capabilities by an organized effort, not to mention the enhancement of technical levels of individual engineers and technicians. While the project just completed was focused on the enhancement of individual technical levels, an organization is required (scheme) to make it possible to maintain and further enhance individual technical levels. For that purpose, it is sometimes considered effective to coordinate the efforts of respective electric utility companies, in addition to the coordination of power plants and training centers owned by various electrical utility companies.

It is also considered necessary to improve the operation method of power plants in addition to the provision of training. For example, a scheme to prevent recurrences of human and mechanical troubles occurring at different power plants is also required. In addition to the causal investigation, sharing information on recurrence prevention measures among the power plants is essential in improving the ability to run power plants in the future.

Since such elements necessary for the operation are described in details in “Guideline for Quality Electrical Power Infrastructure” published by APEC, it is desired to use it as a reference.

As for the specific operation method, intellectual properties held by the JICA Expert Team (Kansai Electric Power) can be used to materialize it. In the future, the JICA Expert Team (Kansai Electric Power) is prepared to offer supports not only for the hardware, but also for the software including the establishment of operational method and schemes.

4 Scenes from activities in the project

4.1 JICA Expert Team (Kansai Electric Power)

4.1.1 First Japan training

(1) Engineers

Safety experience training

Skills training for vibration technology

Tour of Himeji No.2 Thermal Power Plant

Skills training for non-destructive inspection

GTCC lecture

Action plan presentation

Closing ceremony

(2) Technicians

Safety experience training

Skills training for valve overhaul

Skills training for motor overhaul

Skills training for non-destructive inspection

Lecture

Action plan presentation

Closing ceremony

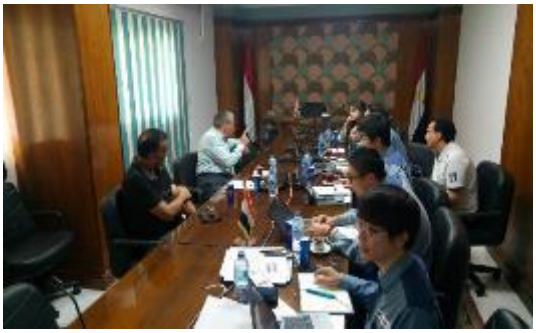
4.1.2 First on-site work

Kick-off meeting with EEHC

Investigation on the EEHC training center

Investigation on the Sidi Krir power plant

Hearing of WDEPC



Investigation on the WDEPC training center

Investigation on the Nubaria power plant

Investigation on the Talkha power plant

Hearing of MDEPC

Investigation on the MDEPC training center

Hearing of UEEPC

Investigation on the Assiut power plant

Investigation on the UEEPC training center

Investigation on the Kuriemat power plant

Hearing of CEPC

Investigation on the CEPC training center

Investigation on the Cairo North power plant

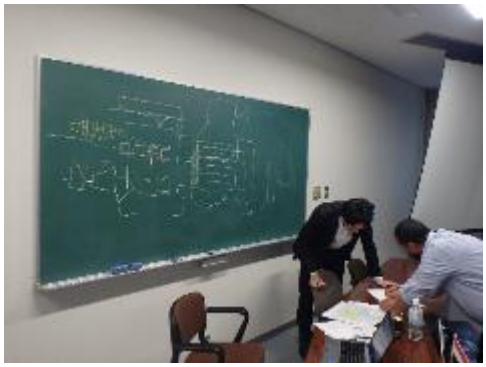
Wrap up meeting with EEHC

4.1.3 Second Japan training

(1) Engineers

Quality control/efficiency control

GTCC (GT/ST/HRSG)



Tour of IHI Aioi Factory

Tour of MHPS Takasago Factory

Tour of Himeji No.2 Thermal Power Plant

Tour of Himeji No.1 Thermal Power Plant

Welding control

Non-destructive inspection

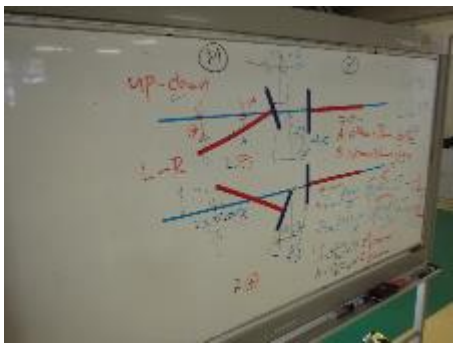
Diagnosis of remaining service life

Lessons learned in the past

GTCC control

Fundamental technology of vibration

Pump alignment



Safety experiencee

Closing ceremony

(2) Technicians

Tour of Himeji No.2 Thermal Power Plant

Quality experience training

Pump overhaul

Action plan presentation

Evaluation meeting

Closing ceremony

4.1.4 Second on-site work

Explanation to the management (WDEPC)

Hearing of engineers (WDEPC)

Hearing of technicians (WDEPC)

Participants to the hearing (WDEPC)

Explanation to the management (MDEPC)

Hearing of engineers (MDEPC)

Hearing of technicians (MDEPC)

Participants to the hearing (MDEPC)

Explanation to the management (UEEPC)

Hearing of engineers (UEEPC)

Hearing of technicians (UEEPC)

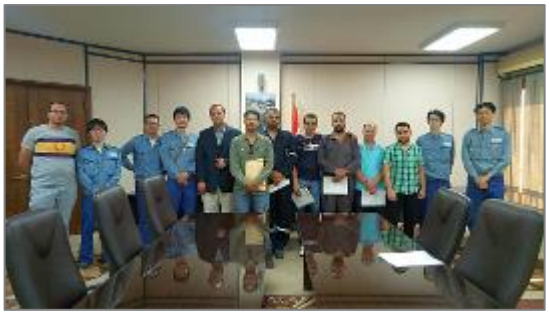
Participants to the hearing (UEEPC)

Explanation to the management (CEPC)

Hearing of engineers (Cairo North TPP)

Hearing of technicians (Cairo North TPP)

Participants to the hearing (Cairo North TPP)



Wrap up meeting (EEHC)

Participants to the wrap up meeting (EEHC)

4.2 JICA-trained participants (scenes from the local training)

WDEPC

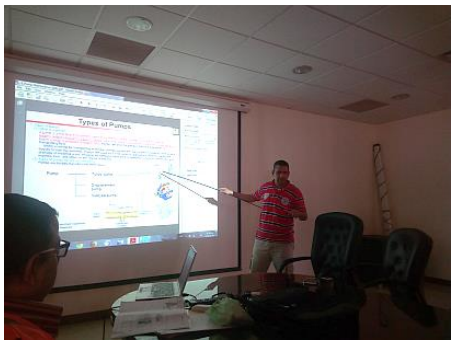


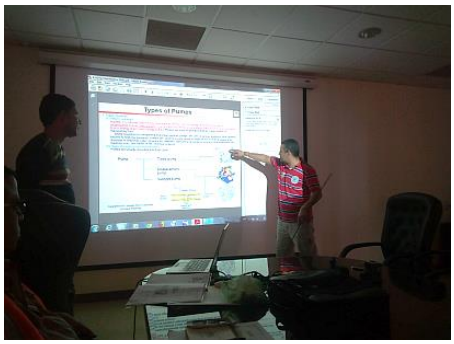

MDEPC




UEEPC

CEPC





Attachments

Attachment 2.1.5.2 The first batched training participants list (engineer)

Attachment 2.1.5.3 The first training curriculum in Japan for Engineer

Attachment 2.1.5.5 The first batched training participants list (technician)

Attachment 2.1.5.6 The first training curriculum in Japan for Technician

Attachment 2.1.6.1 Sample of Action Plan of first batched engineer

Attachment 2.2.1.2 The first survey itinerary

Attachment 2.2.2.4 Outline of thermal power plants in the first site survey

Attachment 2.2.3.2 Attendance list in the first survey hearing on Action Plan

Attachment 2.2.4.3 Minutes of Wrap-up meeting in the first survey

Attachment 2.3.2.2 The second batched training participants list (engineer)

Attachment 2.3.2.3 The second training curriculum in Japan for Engineer

Attachment 2.3.2.5 The second batched training participants list (technician)

Attachment 2.3.2.6 The second training curriculum in Japan for Technician

Attachment 2.3.3.1 Attendance list in the first survey hearing on Action Plan

Attachment 2.4.1.2 The second survey itinerary

Attachment 2.4.4.2 Attendance list in the second survey hearing on Action Plan

Attachment 2.4.5.1 Minutes of Wrap-up meeting in the second survey

The first batched training participants list (engineer)

1	Mr.BADERELDINE Moustafa Esmat Ahmed	Senior Engineer,Gas Turbine Maint./Cairo North Power Station,Egyptian Electricity Holding Company (EEHC)
2	Mr.IBRAHEM Ayman Ibrahem Mohamed	Senior Engineer,Turbine Maint./Cairo Power Station,Egyptian Electricity Holding Company (EEHC)
3	Mr.MEWAFY Abdelrahman Saad Abdelrahman	Senior Engineer,Turbine Maint./Cairo North Power Station,Egyptian Electricity Holding Company (EEHC)
4	Mr.SAAD Ayman Saad Azer	Operation Supervisor,Operation Management./Nubaria Power Station,Middle Delta Electricity Company / (EEHC)
5	Mr.ELSAEIDY Ibrahim Ahmed Osman	Team Leader,Mechanical Maintenance Dept.,Middle Delta Electrical Production Company/(EEHC)
6	Mr.ELSHEKH Mohamed Hamdy Ibrahim Abdelmak	Head section engineer,Turbine Maint.Dept/Sidi Krir Combined cycle pow.stat.,West Delta For Electricity Production Company / (EEHC)
7	Mr.ABDELHAMID Tarek Moustafa Mohamed	Shift Charge Engineer,Operation Dept./Sidi Krir Power Station,West Delta For Electricity Production Company / (EEHC)
8	Mr.AWAD Abdelmoneim Ali Ahmed Mohamed	Head /Dept.Mech.Maint.Eng.,Sidi Krir Power Station,West Delta For Electricity Production Company / (EEHC)
9	Mr.KAOUD Mekhaimer Abozeid Mekhaimer	Maintenance Eng,Maint.Dept.of Water Treat./Assiut Power Plant,Upper Egypt Electricity Production Company / (EEHC)
10	Mr.TAWFIK Mohamed Aboueleyoun Hassan Oraby	Maintenance Eng,Maint.Dept.of Boiler/Assiut Power Plant,Upper Egypt Electricity Production Company / (EEHC)

The first training curriculum in Japan for Engineer

Date	Time	Course	Lecturer	Venue
11/25/2017(Sat)	－	Arrival in Japan		
11/26/2017(Sun)	－	Holiday		
11/27/2017(Mon)	10:00～11:30	Briefing		JICA Kansai
	13:00～14:30	Course orientation	Taieo Fujii	
	14:30～16:00	Program orientation	Yoshiko Oi	
11/28/2017(Tue)	14:00～17:00	Job report presentation	Takeko Fujii	JICA Kansai
11/29/2017(Wed)	9:15～12:00	Overall of Kansai EPCO/ Fuel supply chaine	Yoshiyuki Sugita	Kansai EPCO
			Eiichi Ito	
	13:00～16:00	Overall of Thermal power plant(GTCC/coal)	Yoshiya Okagaki	
			Syohei Watanabe	
11/30/2017(Thu)	9:00～12:00	Orientation of Training Center	Toshio Hagiwara	Kansai EPCO
	13:00～15:15	Action plan making prosedure	Toru Kawai	
			Shigeru Yoshitake	
			Yoshihiro DOI	
			Akiko Tahara	
12/1/2017(Fri)	9:00～11:30	Action plan making prosedure	Toru Kawai	Kansai EPCO
			Yoshihiro DOI	
			Akiko Tahara	
	13:00～15:45	Safety through experience	Shinji Fujio	
12/2/2017(Sat)	－	Holiday		
12/3/2017(Sun)	－	Holiday		
12/4/2017(Mon)	9:00～12:00	Human Resource Development/Heat efficiency management	Takeko Fujii	Kansai EPCO
			Susumu Hiratsuka	
	13:00～16:00	Quality management/Vibration	Toshio Hagiwara	
			Teruaki Kodera	
12/5/2017(Tue)	9:00～12:00	Vibration	Teruaki Kodera	Kansai EPCO
	13:00～15:30	Vibration/Lesson learned	Teruaki Kodera	
			Kazumoto Fukumoto	
12/6/2017(Wed)	9:00～16:00	Vibration	Teruaki Kodera	Kansai EPCO
12/7/2017(Thu)	9:00～14:30	Vibration	Teruaki Kodera	Kansai EPCO
12/8/2017(Fri)	13:10～16:30	Site visit at IHI Aioi Factory	Takeko Fujii	IHI Aioi Factory
12/9/2017(Sat)	－	Holiday		
12/10/2017(Sun)	－	Holiday		
12/11/2017(Mon)	10:00～12:00	Site visit at Himeji No.2 TPP(GTCC)	Takeko Fujii	Himeji No.2 TPP
	13:30～16:45	Site visit at MHPS Takasago Factory		MHPS Takasago Factory
12/12/2017(Tue)	9:00～12:00	NDI(MT)	Toshiyuki Morishita	Kansai EPCO
			Yoshitane Konishi	
	13:00～15:00	NDI(PT)	Shinoda Kunihiko	
12/13/2017(Wed)	9:00～12:00	NDI(UT/SUMP)	Toshiyuki Morishita	Kansai EPCO
			Yoshitane Konishi	
	13:00～16:00	NDI(RT/SUMP)	Shinoda Kunihiko	

Date	Time	Course	Lecturer	Venue
12/14/2017(Thu)	9:00～12:00	GTCC(ST/HRSG)	Toru Yamane	Kansai EPCO
	13:00～15:30	GTCC(Hot parts)	Shigeru Yoshitake	
12/15/2017(Fri)	9:00～12:00	Maintenance of GTCC	Toru Yamane	Kansai EPCO
			Shigeru Yoshitake	
	13:00～14:00	GTCC(Generator)	Teruaki Kodera	
12/16/2017(Sat)	－	Holiday		
12/17/2017(Sun)	－	Holiday		
12/18/2017(Mon)	9:00～12:00	GTCC(Control)	Fumitaka Miyahara	Kansai EPCO
	13:00～15:00	Feed water Treatment	Shinji Fujio	
12/19/2017(Tue)	10:00～16:00	Making Action Plan	Yoshihiro DOI	JICA Kansai
12/20/2017(Wed)	10:00～12:00	Making Action Plan	Yoshihiro DOI	JICA Kansai
	14:00～16:30	Action Plan presentation	Yoshihiro DOI	
			Yoshiya Okagaki	
12/21/2017(Thu)	13:30～16:45	Site visit at KHI Akashi actory	Takeko Fujii	KHI Akashi Factory
12/22/2017(Fri)	10:00～11:00	Evaluation meeting	Yoshiko Oi	JICA Kansai
	11:00～11:30	Closing ceremony	Hiroki Hirahata	
	11:30～12:30	Exchange opinion meeting	Takeko Fujii	
12/23/2017(Sat)	－	Departure from Japan		

別紙 2.1.5.5

The first batched training participants list (technician)

1	Mr.MOHAMED Emad Abdelrahim Rashidy	Technician,Turbine Mainten./Cairo Power Station,Egyptian Electricity Holding Company (EEHC)
2	Mr.IBRAHEM Khtab Ragab	Technician,Turbine Mainten./Cairo Power Station,Egyptian Electricity Holding Company (EEHC)
3	Mr.SHAHIN Mohamed Said Elsayed	Technician,Turbine Mainten./Cairo Power Station,Egyptian Electricity Holding Company (EEHC)
4	Mr.KALIFA Mohamed Helal	Chief of Turbine Workshop,Turbine Mainten.Dept/Bubaria Power Plant,Middle Delta Electricity Production Co./EEHC
5	Mr.ABDELHAFEZ Elshahat Abdalla	Mechanical Supervisor,Nubaria Power Station,Middle Delta Electrical Production Company (EEHC)
6	Mr.ABDELAAL Omar Mohamedyoussef	Technical Supervisor,Turbine Mainten./Sidi Krir Combined cycle pow.stat.,West Delta For Electricity Production Company / (EEHC)
7	Mr.BASHA Ashraf Abdelaziz	Technical Supervisor,Turbine Mainten./Sidi Krir Combined cycle pow.stat.,West Delta For Electricity Production Company / (EEHC)
8	Mr.ELTAHAN Mohamed Abdallah	Technical Supervisor,Turbine Mainten./Sidi Krir Combined cycle pow.stat.,West Delta For Electricity Production Company / (EEHC)
9	Mr.ABBAS Amir Kamal Abdellatif	Supervisor,Turbines Mech. Mainten./Cairo Power Station,Upper Egypt Electricity Production Co./ (EEHC)
10	Mr.ELIAN Samir Ayesh Abdelazim	Supervisor,Mech. Mainten./Elkurimat Power Station,Upper Egypt Electricity Production Co./ (EEHC)
11	Mr.MOHAMED Sayed Ali Mahmoud	Supervisor,Mech. Mainten./Thermal Power Plant,Upper Egypt Electricity Production Co./ (EEHC)

The first training curriculum in Japan for Technician

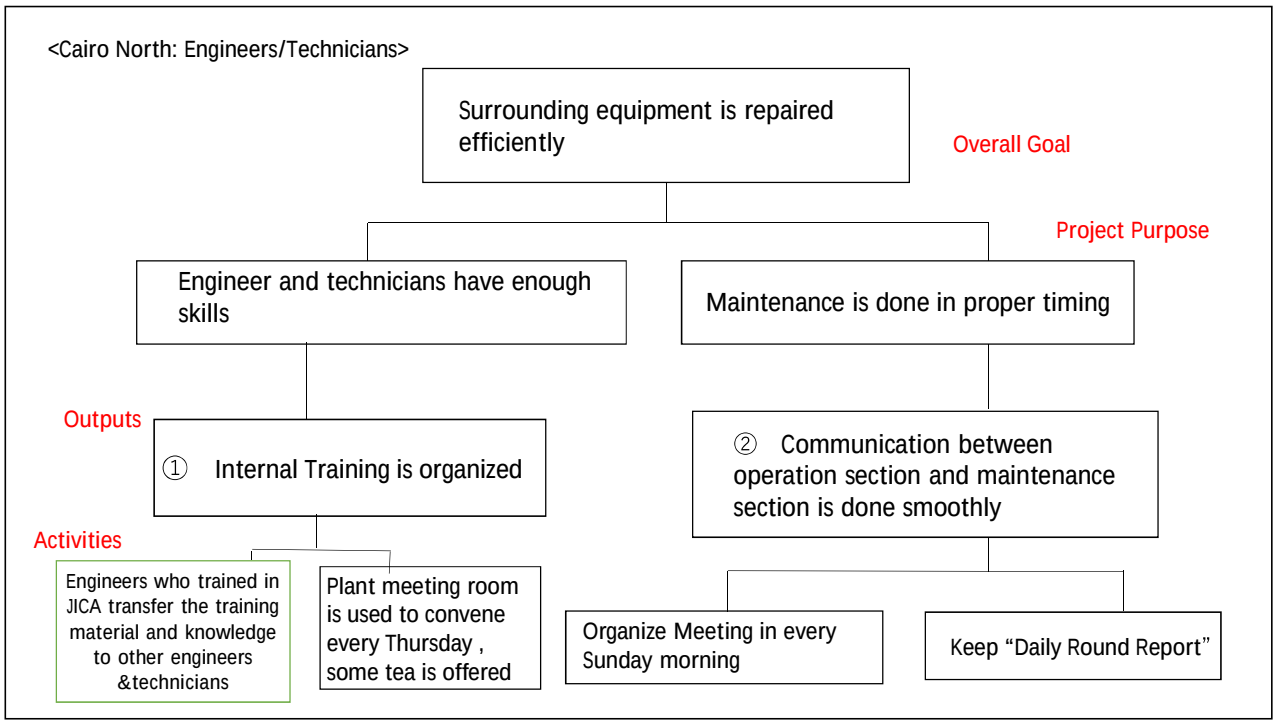
Date	Time	Course	Lecturer	Venue
11/25/2017(Sat)	－	Arrival in Japan		
11/26/2017(Sun)	－	Holiday		
11/27/2017(Mon)	10:00～11:30	Briefing		JICA Kansai
	13:00～14:30	Program orientation	Yoshiko Oi	
	14:40～16:00	Course orientation	Takeo Fujii	
11/28/2017(Tue)	10:00～12:10	Jpb Report Presentation	Takeo Fujii	JICA Kansai
11/29/2017(Wed)	9:00～12:00	Overall of Kansai EPCO/ Fuel supply chaine	Yoshiyuki Sugita	Kansai EPCO
			Eiichi Ito	
	14:00～16:15	Overall of thermal power pant(GTCC/coal)	Yoshiya Okagaki	
			Shohei Watanabe	
11/30/2017(Thu)	9:00～12:00	Training center orientation	Shigemi Zyosho	Kanden Plant
	13:00～17:00	Action Plan making procedure	Kenji Morimoto	
12/1/2017(Fri)	9:00～12:00	Mertaric material	Koji Yamada	Kanden Plant
	13:00～15:50	Safety training through experience	Takumi Kudo	
12/2/2017(Sat)	－	Holiday		
12/3/2017(Sun)	－	Holiday		
12/4/2017(Mon)	9:00～12:00	Welding	Takayuki Kita	Kanden Plant
	13:00～16:00	Quality training	Yuzi Inagaki	
12/5/2017(Tue)	9:00～11:30	High temperature & pressure piping maintenance/Valve maintenance	Koji Yamada	Kanden Plant
			Yuzi Inagaki	
	13:00～15:50	Valve maintenance	Yuzi Inagaki	
12/6/2017(Wed)	9:00～12:00	High temperature & pressure piping maintenance/High voltage motor maintenance	Koji Yamada	Kanden Plant
			Masashi Ashida	
	13:00～16:00	motor maintenance	Masashi Ashida	
12/7/2017(Thu)	9:00～16:10	NDI	Koji Yamada	Kanden Plant
12/8/2017(Fri)	13:10～16:25	Site visit at IHI Aioi Factory	Kenji Morimoto	IHI Aioi Factory
12/9/2017(Sat)	－	Holiday		
12/10/2017(Sun)	－	Holiday		
12/11/2017(Mon)	10:00～12:00	Site visit at Himeji No.2 TPP(GTCC)	Kenji Morimoto	Himeji No.2 TPP
	13:30～16:40	Site visit at MHPS Takasago Factory		
12/12/2017(Tue)	9:00～11:45	I&C maintenance	Hiroyuki Sumitomo	Kanden Plant
	13:00～16:45	Preventing accidents and disasters	Masashi Ashida	
12/13/2017(Wed)	9:00～19:45	Making Action Plan	Kenji Morimoto	Kanden Plant
12/14/2017(Thu)	10:30～11:45	Making Action Plan	Kenji Morimoto	JICA Kansai
	13:00～16:00	Action Plan presentation	Kenji Morimoto	

Date	Time	Course	Lecturer	Venue
12/15/2017(Fri)	10:00～11:00	Evaluation meeting	Yoshiko Oi	JICA Kansai
			Shigemi Zyosyo	
	11:00～11:40	Closing ceremony	Kenji Morimoto	
	11:50～12:30	Exchanging opinions meeting	Hiroki Hirahata	
	13:30～14:45	Internal evaluation meeting	Takeo Fujii	
12/16/2017(Sat)	－	Departure from Japan		

Capacity Development for Operation & Maintenance of Thermal Power Stations, Egypt 2017 (Engineers/Technicians)

Cairo North

Action Plan



Capacity Development for Operation & Maintenance of Thermal Power Stations
Egypt 2017
Action Plan (Engineers/Technicians)

Name of the Power Company: Cairo North Power Station
Name of the member: Engineers (Moustafa Esmat Ahmed, Ayman Ibrahim Mohamed Ibrahim, Abdel Rahman Saad Abdel Rahman) and Technicians (Mohamed Emad Abdelrahim, Ibrahim Khatab Ragab Khatab, Shahin Mohamed Said Elsayed)

Overall Goal (Core Objective)	Surrounding Equipment is repaired efficiently
Project Purpose	1. Engineer and technicians have enough skills 2. Maintenance is done in proper timing
Outputs (Positive effects by implementing the Activities)	1. Internal Training is organized 2. Communication between operation section and maintenance section is done smoothly
Activities	1. See separate document “Detailed Plan of Training” for details. 2-1 Invite operation engineers/technicians for bilateral meeting with maintenance engineers/technicians every Sunday morning to increase cooperation and share information, experience and lessons learned. 2-2 Make “Daily Monitoring Round Report” by maintenance team members every day.
Person & Section in charge	Maintenance department (60 technicians & 6 engineers) and Operation department (40 technicians & 6 engineers)
Financial Source	(Just some tea money through contributions from Engineers and Management)
Risk (Possible Obstacles)	A-Outages that need continuous work for maintenance we may divide in three shifts to maintain the turbine in minimum time. B- Some sister plants may borrow some technicians to help them in their outages.

Detailed Plan of Training

Name of the Power Plant: **Cairo North Power Station** E.E.H.C (Engineers/Technicians)

<table>
<tr><td colspan="2">Title of the Training</td></tr>
<tr><td colspan="2">Internal Training</td></tr>
<tr><td colspan="2">Person/Section in charge</td></tr>
<tr><td colspan="2">Maintenance Engineers</td></tr>
<tr><td colspan="2">Things that have to be considered in implementing the Training</td></tr>
<tr><td colspan="2">- Venue: Power Station meeting room
- Facilities, equipment etc.: TBD
- Lecturers: Engineers & Technicians who joined JICA training, Experienced personnel within PS
- Financial source: Just some tea money through contributions from Engineers and management)
Risks (possible obstacles): A-Outages that need continuous work for maintenance we may divide in three shifts to maintain the turbine in minimum time.
- B- Some sister plants may borrow some technicians to help them in their outages.</td></tr>
<tr><td colspan="2">Target Group of the Training
Technicians and Engineers</td></tr>
<tr><td>Syllabus

1) Work safety and disaster avoidance

2) Vibration balancing

3) Pump operation and maintenance

4) Welding procedures

5) Valve maintenance

6) NDI

7) Quality Control & Efficiency management</td><td>Timeframe
2 hours every Thursday</td></tr>
</table>

The first survey itinerary

Date	Time	Venue/aim	Counterpart	Accomodation
29/06/2018(Fri)	23:45-04:50	Move (KIX - DXB)	–	Night Flight
30/06/2018(Sat)	08:15-10:05	Move (DXB - CAI)	–	Cairo
01/07/2018(Sun)	11:00-12:00	[Destination] JICA Egypt Office [Purpose] Kick - off meeting with each counterpart, explanation of the project	JICA	Cairo
02/07/2018(Mon)	10:00-12:00	[Destination] EEHC Office [Purpose] Explanation of the project and information gathering	EEHC	Alexandria
	13:00-15:00	[Destination] EEHC Training Center [Purpose] Explanation of the project, information gatheringand site visit at T/C	EEHC	
03/07/2018(Tue)	09:30-15:00	[Destination] Sidi Krir TPP [Purpose] Explanation of the project, information gathering (O&M situation) and interviews with JICA-trained participants	WDEPC (Sidi Krir TPP)	Alexandria
04/07/2018(Wed)	8:30-10:00	[Destination] WDEPC Office [Purpose] Explanation of the project and information gathering	WDEPC	Talkha
	11:00-12:00	[Destination] WDEPC Training Center (Abu Qir Training Center) [Purpose] Explanation of the project, information gathering (T/C situation) and interviews with JICA-trained participants	WDEPC (Abu Qir Training Center)	
	14:00-16:00	[Destination] Nubaria TPP [Purpose] Explanation of the project, information gathering (O&M situation) and interviews with JICA-trained participants	MDEPC (Nubaria TPP)	
05/07/2018(Thu)	9:00-10:30	[Destination] MDEPC Office [Purpose] Explanation of the project and information gathering	MDEPC	Cairo
	10:30-11:00	[Destination] MDEPC Training Center (Talkha Training Center) [Purpose] Explanation of the project and information gathering (T/C situation)	MDEPC (Talkha Training Center)	
	11:00-12:00	[Destination] Talkha TPP [Purpose] Information gathering (O&M situation)	MDEPC (Talkha TPP)	
06/07/2018(Fri)	All	Document Preparation	–	Cairo
07/07/2018(Sat)	All	Document Preparation	–	Assiut
08/07/2018(Sun)	9:30-11:00	[Destination] UEEPC Office [Purpose] Explanation of the project and information gathering (O&M situation)	UEEPC	Assiut
	11:00-15:00	[Destination] AssiutTPP (Walidia TPP) [Purpose] Explanation of the project, information gathering (T/C situation) and interviews with JICA-trained participants	UEEPC (Assiut TPP)	
09/07/2018(Mon)	9:30-11:00	[Destination] UEEPC Training Center [Purpose] Explanation of the project and information gathering (O&M situation)	UEEPC (Kriemat Training Center)	Cairo
	11:00-15:00	[Destination] KuriematTPP [Purpose] Explanation of the project, information gathering (T/C situation) and interviews with JICA-trained participants	UEEPC (Kriemat TPP)	

Date	Time	Venue/aim	Counterpart	Accomodation
10/07/2018(Tue)	9:00-10:00	[Destination] CEPC Office [Purpose] Explanation of the project and information gathering	CEPC	Cairo
	11:00-12:00 14:00-16:00	[Destination] Cairo NorthTPP [Purpose] Explanation of the project, information gathering (T/C situation) and interviews with JICA-trained participants	CEPC (Cairo North TPP)	
	16:30-17:30	[Destination] CEPC Training Center [Purpose] Explanation of the project and information gathering	CEPC (Cairo North Training Center)	
11/07/2018(Wed)	15:00-16:00	[Destination] JICA Egypt office [Purpose] Pre - meetin for Wrap up meeting	JICA	Cairo
12/07/2018(Thu)	10:00-12:00	[Destination] EEHC Office [Purpose] Wrap up meeting and Signing MoM	EEHC	Cairo
13/07/2018(Fri)	18:40-0:25	Move (CAI - DXB)	–	Night Flight
14/07/2018(Sat)	3:40-17:50	Move (DXB - KIX)	–	–

Outline of thermal power plants in the first site survey

Company	Power Plant	Unit		COD	Fuel	Output	GT	ST	HRSG	GEN
CEPC	Cairo North	Module1	Unit-1	Jul-04	NG	250MW	MHI	—	NEM	Melco
			Unit-2	Jul-04	NG	250MW	MHI	—	NEM	Melco
			Unit-3	Jan-06	—	250MW	—	Hitachi	—	Melco
		Module2	Unit-4	Jun-06	NG	250MW	GE	—	NEM	GE
			Unit-5	Apr-06	NG	250MW	GE	—	NEM	GE
			Unit-6	Jul-08	—	250MW	—	ALSTOM	—	ALSTOM
MDEPC	Nubaria	#1 & #2	Unit-1	Jul-05	N.G	250MW	Siemens	—	ALSTOM	Siemens
			Unit-2	Aug-05	N.G	250MW	Siemens	—	ALSTOM	Siemens
			Unit-3	Sep-05	N.G	250MW	Siemens	—	ALSTOM	Siemens
			Unit-4	Sep-05	N.G	250MW	Siemens	—	ALSTOM	Siemens
			Unit-5	Aug-06	—	250MW	—	MHI	—	MHI
			Unit-6	Sep-06	—	250MW	—	MHI	—	MHI
		#3	Unit-1	May-09	N.G	250MW	GE	—	STF ITALY	GE
			Unit-2	Jul-09	N.G	250MW	GE	—	STF ITALY	GE
			Unit-3	Oct-10	—	276MW	—	ALSTOM	—	ALSTOM
	Talkha	Unit-1		Aug-06	N.G	250MW	Siemens	—	ALSTOM	Siemens
		Unit-2		Aug-06	N.G	250MW	Siemens	—	ALSTOM	Siemens
		Unit-3		Feb-10	—	250MW	—		—	ALSTOM
WDEPC	Sidi Krir	Conventional	Unit-1	Jan-00		320MW	—			
			Unit-2	Mar-00		320MW	—			
		Combined Cycle	CTG1	Aug-09	N.G	250MW	MHI	—	NEM	Melco
			CTG2	Sep-09	N.G	250MW	MHI	—	NEM	Melco
			STG	Aug-10	—	270MW	—	ANSALDO		ANSALDO
UEEPC	Assiut (Walidia)	Unit-1		Mar-92	N.G	300MW	—			
		Unit-2		Feb-97	N.G	300MW	—			
	Kuriemat	#1	Unit-1	Nov-97	N.G	627MW	—	GE	Babcock	
			Unit-2	Aug-98	N.G	627MW	—	GE	Babcok	
		#2	Unit-1	Feb-07	N.G	250MW	Siemens	—	CMI	Siemens
			Unit-2	Oct-07	N.G	250MW	Siemens	—	CMI	Siemens
			Unit-3	Jun-09	—	250MW	—	ALSTOM	—	ALSTOM
		#3	Unit-1	Jan-09	N.G	250MW	GE	—	CMI	GE
			Unit-2	Jul-09	N.G	250MW	GE	—	CMI	GE
			Unit-3	Oct-11	—	250MW	—	ALSTOM	—	ALSTOM

Attendance list in the first survey hearing on Action Plan

Venue	Name	Responsible field	Title	Attendance
Cairo North発電所	Mr.BADERELDINE Moustafa Esmat Ahmed	Gas Turbine Maintenance	Engineer	✓
	Mr.IBRAHEM Ayman Ibrahem Mohamed	Turbine Maintenance	Engineer	✓
	Mr.MEWAFY Abdelrahman Saad Abdelrahman	Turbine Maintenance	Engineer	Due to another business
	Mr.MOHAMED Emad Abdelrahim Rashidy	Turbine Maintenance	Technician	✓
	Mr.IBRAHEM Khtab Ragab	Turbine Maintenance	Technician	✓
	Mr.SHAHIN Mohamed Said Elsayed	Turbine Maintenance	Technician	✓
Nubaria発電所	Mr.SAAD Ayman Saad Azer	Operation Management.	Engineer	✓
	Mr.ELSAEIDY Ibrahim Ahmed Osman	Mechanical Maintenance	Engineer	✓
	Mr.KALIFA Mohamed Helal	Turbine Maintenance	Technician	✓
	Mr.ABDELHAFEZ Elshahat Abdalla	Mechanical	Technician	✓
Sidi Krir発電所	Mr.ELSHEKH Mohamed Hamdy Ibrahim Abdelmak	Turbine Maintenance	Engineer	✓
	Mr.ABDELHAMID Tarek Moustafa Mohamed	Operation Dept.	Engineer	✓
	Mr.AWAD Abdelmoneim Ali Ahmed Mohamed	Mechanical Maintenance	Engineer	✓
	Mr.ABDELAAL Omar Mohamedyoussef	Turbine Maintenance	Technician	Due to another business
	Mr.BASHA Ashraf Abdelaziz	Turbine Maintenance	Technician	Due to another business
	Mr.ELTAHAN Mohamed Abdallah	Turbine Maintenance	Technician	Due to another business
Assiut発電所 （Walidia発電所）	Mr.KAOUD Mekhaimer Abozeid Mekhaimer	Maint.Dept.of Water Treat.	Engineer	✓
	Mr.TAWFIK Mohamed Aboueleyoun Hassan Oraby	Maint.Dept.of Boiler	Engineer	✓
Kuriemat発電所	Mr.ABBAS Amir Kamal Abdellatif	Turbine Maintenance	Technician	✓
	Mr.ELIAN Samir Ayesh Abdelazim	Mechanical Maintenance	Technician	✓
	Mr.MOHAMED Sayed Ali Mahmoud	Mechanical Maintenance	Technician	✓

Minutes Of Meeting
for
The First Wrap-Up Meeting
on
The Project for Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance
between
Japan International Cooperation Agency
and
The Government Of Arab Republic Of Egypt

Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the follow-up mission (hereinafter referred to as "the Mission") for "The Project for Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance" (hereinafter referred to as "the Project") to discuss the detail of the Project with the officials of Egyptian Electricity Holding Company (hereinafter referred to as "EEHC") for the effective and successful implementation.

The JICA Mission and the officials of EEHC hereby confirmed the result of discussions in the wrap up meeting (hereinafter referred to as "the Meeting") on 12th July 2018, at EEHC Head Office, chaired by Eng. Gaber Desouki Moustafa, the chairman of EEHC.

As a result of discussions in the Meeting, the Japanese side and Egyptian side have confirmed the main items described in the Annex.

Cairo, 12th July 2018

田所 博	Gaber
Mr. Hiroshi Tadokoro Mission Leader Senior Advisor, Industrial development and Public Policy Department, Japan International Cooperation Agency	Eng. Gaber Desouki Moustafa Chairman Egyptian Electricity Holding Company

平畑 弘樹

Mr. Hiroki Hirahata
JICA Expert / Chief Advisor

ANNEX

1. Project Outline
   (1) Confirmation of Project Outline
   The JICA Mission has explained the scope of works, overall schedule and the activities to be conducted in the Project. The JICA Mission requested further close collaboration to the Egyptian side for the implementation of the Project activities as well as for organizing the Meeting.
   The Egyptian side acknowledged the contents of the explanation and the request from the JICA Mission, and agreed the plan in principle.
   The both sides confirmed the overall of the Project Summary and the second training in Japan as below.

2. Project Summary
   (1) Targeted Type of Power Generation
   Gas Turbine Combined Cycle (GTCC)
   (2) Project Sites
   Thermal Power Plants (TPPs) of EEHC and its affiliated production companies
   (3) Beneficiaries
   Engineers & technicians of production companies trained by JICA and their trainees
   (4) Counterparts
   Ministry of Electricity and Renewable Energy (MoERE)
   Egyptian Electricity Holding Company (EEHC)
   Cairo Electricity Production Company (CEPC)
   East Delta Electricity Production Company (EDEPC)
   Middle Delta Electricity Production Company (MDEPC)
   West Delta Electricity Production Company (WDEPC)
   Upper Egypt Electricity Production Company (UEEPC)
   (5) Duration
   October 2017 – September 2019(2 years)
   (6) Project Purpose
   ✓Overall Goal:
   Capacity of O&M of Thermal Power Plants (TPPs) is strengthened.
   ✓Project Goal:
   Training capacity on O&M of EEHC is strengthened.
   (7) Project Output
   ✓Output 1: Training needs are identified based on current situation of O&M.
   ✓Output 2: Capacity of instructors as well as engineers and technicians of EEHC and its affiliate production companies is enhanced.
   ✓Output 3: O&M training activity at TPPs is reviewed.

AJ.

(8) Project Work Flowchart
The Project will be planned according to the below schedule.

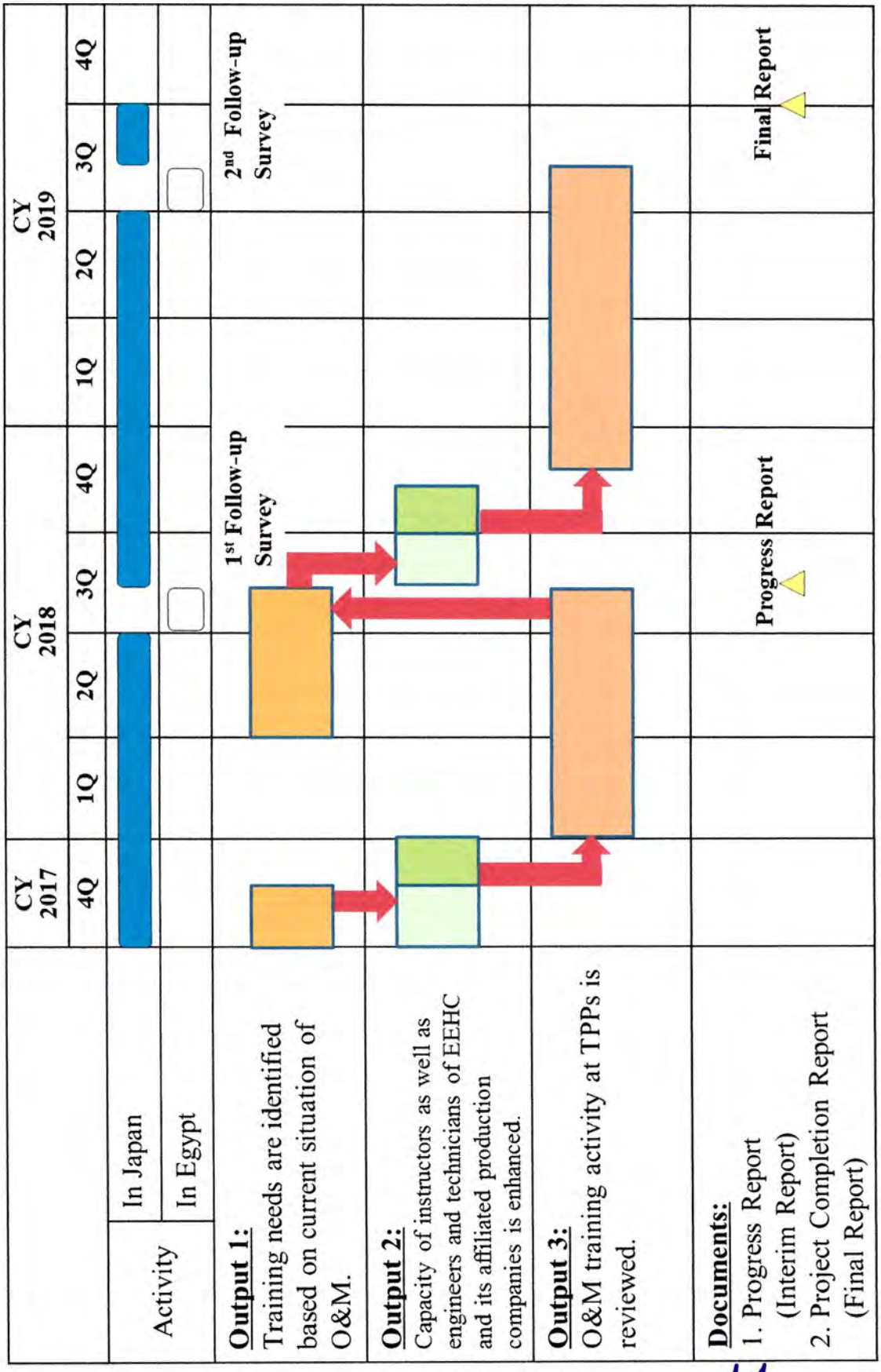


Fig1. Project Work Flowchart

AJ.

3. The Second Training in Japan

(1) Schedule

Counterpart Training in Japan is tentatively planned from 8th October to 10th November for engineers and from 8th to 27th October for technicians, 2018. (from arrival to departure)

(2) Goal

The goal of the second training in Japan is to develop capacity of instructors and O&M staff and conduct trainings at each thermal power station by the instructors. Based on the result of the first training, the second training will be focused on more practical and advanced curriculum such as "Participation on GTCC Overhaul", "Human Error Prevention." and "Overhauling the Rotary Pumps".

(3) Overall Contents

The both sides confirmed that the overall tentative contents of the second training in Japan shall be as follow;

Fig2. Overall training contents

(1) Egyptian Side will take necessary measures to:

a. select participants based on the selection criteria (by 15th AUG, 2018); and
b. secure other operational cost if necessary; and
c. report to Japanese side O&M training activities at TPPs implemented by JICA-trained engineers & technicians.

(2) Japanese Side will take necessary measures to:

a. conduct the O&M training in Japan for each 10 engineers/technicians as participants (OCT/NOV, 2018); and
b. review O&M training activities at TPPs implemented by JICA-trained engineers & technicians.

Attachment 1 Attendance List in the Wrap-Up Meeting
Attachment 2 Presentation Materials

A.J.

meeting title: _____

Capecity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

Wind up Meeting Attendance List

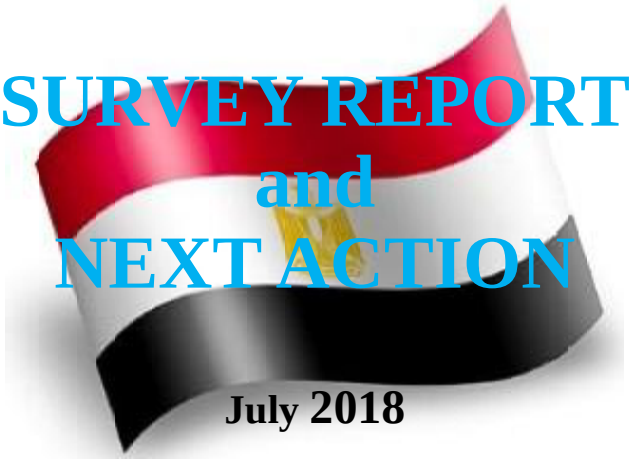
Date: 12th July 2018

Time: 14 : 30 - 15 : 00

Place: EEHC Office

Name	Position	Company	Signature

SURVEY REPORT and NEXT ACTION



July 2018

Japan International Cooperation Agency (JICA)

The Kansai Electric Power Co., Inc.

Contents

1. Project Summary

3

This JICA project aims to implement capacity building for O&M at Thermal Power Plants (TPPs), in order to make continuous technical support for EEHC.

Project Purpose

Overall Goal	Capacity of O&M of Thermal Power Plants (TPPs) is strengthened.
Project Goal	Training capacity on O&M of EEHC is strengthened.

Project Output

Output 1	Training needs are identified based on current situation of O&M.
Output 2	Capacity of instructors as well as engineers and technicians of EEHC and its affiliated production companies is enhanced.
Output 3	O&M training activity at TPPs is reviewed.

1. Project Summary

4

Targeted Type of Power Generation	Gas Turbine Combined Cycle (GTCC)
Project Sites	Thermal Power Plants (TPPs) of EEHC and its affiliated production companies
Counterpart	Ministry of Electricity and Renewable Energy (MoERE) Egyptian Electricity Holding Company (EEHC) Cairo Electricity Production Company (CEPC) East Delta Electricity Production Company (EDEPC) Middle Delta Electricity Production Company (MDEPC) West Delta Electricity Production Company (WDEPC) Upper Egypt Electricity Production Company (UEEPC)
Beneficiaries	Engineers & technicians trained by JICA and their trainees
Duration	October 2017 – September 2019 (2 years)

1. Project Summary: Work Flowchart

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		CY 2017	CY 2018				CY 2019			
		4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Activity	In Japan									
	In Egypt				1st Follow-up Survey				2nd Follow-up Survey	
Output 1: Training needs are identified based on current situation of O&M.										
Output 2: Capacity of instructors as well as engineers and technicians of EEHC and its affiliated production companies is enhanced.			Preparing the training program / Training of participants in Japan				Reviewing the activity that participants disseminate their knowledge and skills obtained in the training program in Japan to other colleagues at TPPs.			
Output 3: O&M training activity at TPPs is reviewed.										
Documents: 1. Progress Report (Interim Report) 2. Project Completion Report (Final Report)					Progress Report				Final Report	
			1st Year (Completed)				2nd Year (Plan)			

1. Project Summary: Actual Itinerary of Follow-up Survey

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Date		Activities			Contents
2.Jul.	Mon	Meeting	Cairo	EEHC	Briefing on the Interim Report
		SiteVisit		EEHC Training Center	Interview with each counterpart and Site Visit at the these TPPs/Training Centers.
3.Jul.	Tue	Meeting	Alexandria	Sidi Krir Power Station	
		Site Visit			
4.Jul.	Wed	Meeting	Alexandria	WDEPC	
		Site Visit		WDEPC Training Center	
			Nubaria	Nubaria Power Station	
5.Jul.	Thu	Meeting	Talkha	MDEPC	
		Site Visit		MDEPC Training Center	
				Talkha Power Station	
8.Jul.	Sun	Meeting	Assuit	UEEPC	
		Site Visit		Assuit Power Station	
9.Jul.	Mon	Site Visit	Kuriemat	UEEPC Training Center	
				Kuriemat Power Station	
10.Jul.	Tue	Meeting	Cairo	CEPC	
		Site Visit		CEPC Training Center	
				Cairo North Power Station	
11.Jul.	Wed	Pre-Meeting	Cairo	JICA Members	Preparation for the Wrap-up Meeting
12.Jul.	Thu	Wrap-up Meeting	Cairo	All Members	Briefing on the Survey Report

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1. Project Summary

2. **O&M Training in Japan: OCT/NOV, 2018**

3. Selection Criteria for Next Participants: Engineers & Technicians

4. Summary on the Mission for Next Step

2. O&M Training in Japan: Participant's Comments

8

	Main Suggestion	Especially Useful Subjects	Required Additional Subjects
Engineers	Ø We need **more practical training** (participation in turbine inspection) and **more technical-advanced training** (not beginner). Ø The program is theoretical but we need **practical a lot**. Ø **Practical application** should be more than theoretical lectures.	Ø Basic Training of Vibration (Balancing) Ø Non-Destructive Inspection Ø Introduction of the latest technology in GTCC Ø GT & High Temperature Parts / Maintenance of GTCC	Ø **Welding Quality Management in Japan** Ø Heat Recovery Steam Generator **(HRSG) Maintenance**
Technicians	Ø We need **more technical-advanced training.** Ø We need more time in comparison with training contents.	Ø Metal Material Ø Experiential Safety Training Ø Welding Procedure Management Ø Basics of Non-Destructive Inspection Skills	Ø **Practical Skill at Rotary Equipment** (Alignment and Balancing) Ø **Participation in GTCC Overhaul**

2. O&M Training in Japan: Important Assumption

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Finding of this Mission: Thermal Power Plants (TPPs)

- ü TPPs are so well operated and maintained that EEHC can attain high O&M quality of TPPs, despite of some technical issues.
- ü Aging GTCCs have concern of **Flow Accelerated Corrosion (FAC)** in Heat Recovery Steam Generator (HRSG) .
- ü Some TPPs require "energy management" followed by O&M cost reduction and higher availability factor: **major technical troubles** and **the latest maintenance technology** in case of Japanese GTCC etc.

Finding of this Mission: JICA-trained Engineers/Technicians

- ü JICA trained engineers & technicians are utilizing their knowledge and skills obtained in Japan, through **not only dissemination to other colleagues but also actual trouble-shooting** at TPPs.
- ü Engineers shall take **the responsibility of O&M work** implemented by technicians.

2. O&M Training in Japan: GTCC Line-up of EEHC

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Company	CCGT Station	No. of Units	Installed Capacity	Fuel	Commissioning Date
Cairo	Cairo South II	1x110L1x55	165	NG/LFO	1995
	Cairo North	4x250+2x250	1500	NG/LFO	2004-'06-'07-'08
	North Giza	6x250+3x250	2250	NG/LFO	2014-'15-'16
East Delta	Damietta	6x132+3x136	1200	NG/LFO	1989-1993
	Talkha	8x19.5+2x40	236	NG	'79-'80-1989
	Talkha 750	2x250+1x250	750	NG	2006-2010
	Nubaria 1,2	4x250+2x250	1500	NG/LFO	2005-2006
Middle Delta	Nubaria 3	2x250+1x250	750	NG/LFO	2009-2010
	Mahmoudia	8x21+2x50	268	NG/LFO	1983-1995
	El-Arf	2x250+1x250	750	NG/LFO	2009-2010
	Banha	2x250+1x250	750	NG/LFO	2014-2015
West Delta	Damanhour	4x25+1x58	158	NG/LFO	1985-1995
	Sidi Krir	**2x250+1x250**	**750**	**NG/LFO**	**2009-2010**
Upper Egypt	Kuriemat 1	2x250+1x250	750	NG	2007-2009
	Kuriemat 2	2x250+1x250	750	NG	2009-2011
Siemens	Burulls	6x400 (Gas Unit)	2400	NG/LFO	2017
	Beni Suef	6x400 (Gas Unit)	2400	NG/LFO	2017
	New Capital	2x400 (Gas Unit)	800	NG/LFO	2017

Concern of FAC in HRSG

Remarkable issue of FAC in HRSG

*Source: EEHC Annual Report 2016/2017

2. O&M Training in Japan: Important Assumption

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Finding of this Mission: Training Centers (T/Cs)

- EEHC has various training curriculum from management skill in Leaders Development Center (LDC) to technical expertise in T/Cs of each Electric Production Company (EPC).
- T/Cs have O&M training program including mechanical workshop, but there is still room for reinforcing **O&M training program (especially GTCC)**.
- While every T/C implements safety management, some TPPs are expected to enhance Health, Safety and Environment (HSE), **especially safety**.
- Some T/Cs have old-fashioned training facilities (under renovation), and have potential needs such as **non-destructive inspection** and **remaining life assessment** for aging main equipment of TPPs.

2. O&M Training in Japan: Training Program

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Engineers	Technicians
Introduction of the latest technology in TPP	Introduction of the latest technology in TPP
Experience-based Safety Training	Experiential Safety Training
Human Resource Development	Welding Procedure Management
Quality Management	Experiential Quality Training
Thermal Efficiency Management	Metal Material
Basic Training of Vibration (Balancing)	Overhauling Rotary Pumps
Non-Destructive Inspection	Basics of Non-Destructive Inspection Skills
GT & High Temperature Parts / Maintenance of GTCC (inc. HRSG/Generator)	Maintenance of High Temperature and High Pressure Piping
Remaining Life Assessment (advanced)	Occupational HSE (especially Safety)
Feed Water Treatment	General System and Outline of GTCC
Site Visit on TPP and Manufacture's factory	Site Visit on TPP and Manufacture's factory
Lessons Learned from Accidents	Prevention of Accidents and Disasters
Participation in GTCC Overhaul	Participation in GTCC Overhaul
Human Error Prevention	Methodology to Formulate Action Plan
Welding Quality Management in Japan	
Effective Maintenance for Quality Electric Power Infrastructure	
Methodology to Formulate Action Plan	

Practical Skill

Workshop

Action Plan

* New training subjects as shown in blue underlined & boldfaced type

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3. Selection Criteria: Important Assumption

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Finding of this Mission: TPPs and T/Cs

- ü Each EPC has its own T/C and implements its own training program for engineers and technician, but there is still room for reinforcing **O&M training program (especially GTCC)** in some T/Cs.
- ü **Mechanical participants** are preferable to electrical and C&I, considering foreseeable aging impact on O&M quality and cost in the near future.
- ü **There is no officer dedicated only for instructors.** At the request of T/Cs, leading officer of TPPs usually implements training course as instructor.

Suggestion from JICA Expert

- ü Target should be **leading engineers and technicians who are capable of disseminating their knowledge and skills obtained in O&M training in Japan to other colleagues** at TPPs.

3. Selection Criteria for Next Participants

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Items	Qualification (Engineers)	Qualification (Technicians)
Number	10 persons per annual	10 persons per annual
Training Term	About 1 month	About 3 weeks
Current Duties	Be a leading engineer working on thermal power plants, and has expertise related to **mechanical engineering in GTCC**, who are capable to be instructors to train other engineers.	Be a leading technician working on thermal power plants, and has expertise related to **mechanical work in GTCC**, who are capable to be instructors to train other technicians.
Experience in the relevant field	Have **from 5 to 10 years' experience in the field O&M of GTCC** including GT, ST and HRSG.	
Educational Background	Be a graduate of university	Be a diploma of technical high school or college, or higher
Language	Have a competent command of spoken and written English.	None*1
Health	Must be in good health, both physically and mentally, to participate in the program in Japan.	

*1:Lecture will be made in Japanese and translated to English or Arabic. Course materials will be prepared in English, and participants are expected to prepare job reports and action plans in English.

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4. Summary on the Mission for Next Step

ü **Request for Next Step:**

Giving us comments from Egyptian side for Minutes of Meeting (MoM) **by JUL 31, 2018**, if any, especially,

- Ø O&M training program in Japan, and
- Ø Selection criteria for next participants.

ü **Undertaking by Egyptian Side:**

- Ø Selecting participants based on the selection criteria **(by AUG 15, 2018),**
- Ø Securing other operational cost if necessary and
- Ø Reporting O&M training activity at TPPs implemented by JICA-trained engineers & technicians.

ü **Undertaking by Japanese Side:**

- Ø Conducting the O&M training in Japan for each 10 engineers/technicians as participants **(OCT/NOV, 2018),** and
- Ø Reviewing O&M training activity at TPPs implemented by JICA-trained engineers & technicians.

Hiroki HIRAHATA (Focal Point)
hirahata.hiroki@b5.kepco.co.jp
Thermal Power Division
The Kansai Electric Power Co.,Inc.

Current Situation: Power Supply and Demand

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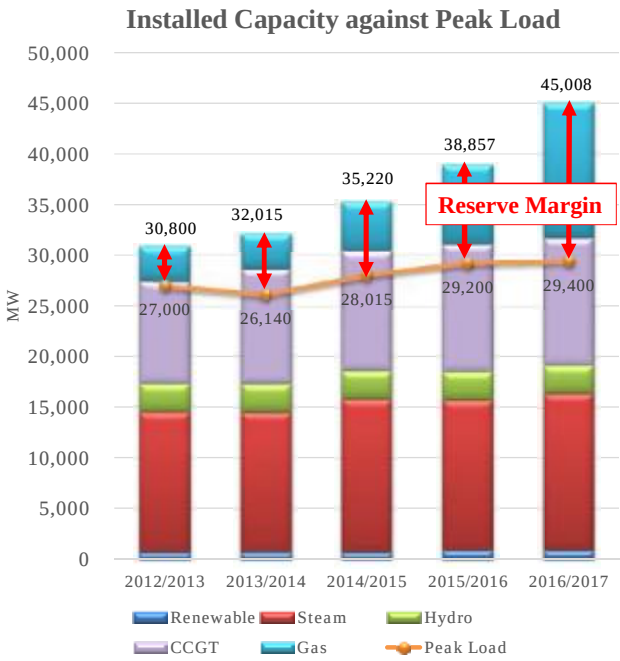
No additional thermal power plants are needed under the 8th Five-Year Plan (2017-2022), EEHC (2016/17*1)

Current Situation

- **Meeting the peak load** in 2016/2017 that reached 29,400MW without load shedding.
- **Increase of total installed capacity** to the unified national grid up to 45,008MW, including Fast Track Plan (3,636MW) and Siemens Project (5,600MW).
- Consequently, progressive **increase of reserve margin** relative to peak load.



*1: EEHC Annual Report 2016/2017

Current Situation: Diversifying Generation Capacity Mix

20

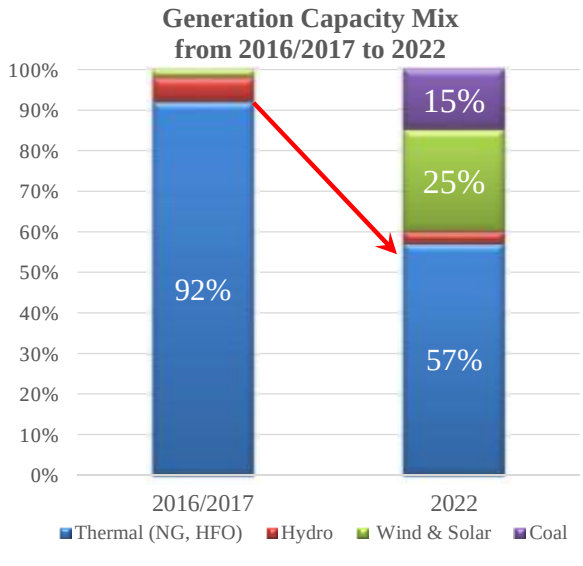
Current Situation*1

- **Excessive reliance on thermal assets** (90+% of installed capacity)
- Frequent power outages due to natural gas and fuel shortage

Various countermeasures to **overcome the undiversified power generation mix** taken by EEHC.

Recent Activity for Improving Energy Mix

- **The renewable energy** will generate over 20% of electricity.
- **Clean coal thermal power plant** will be installed.
- **Nuclear power plant** will be installed.



*1: MoERE Addressing Egypt's Electricity Vision 2015

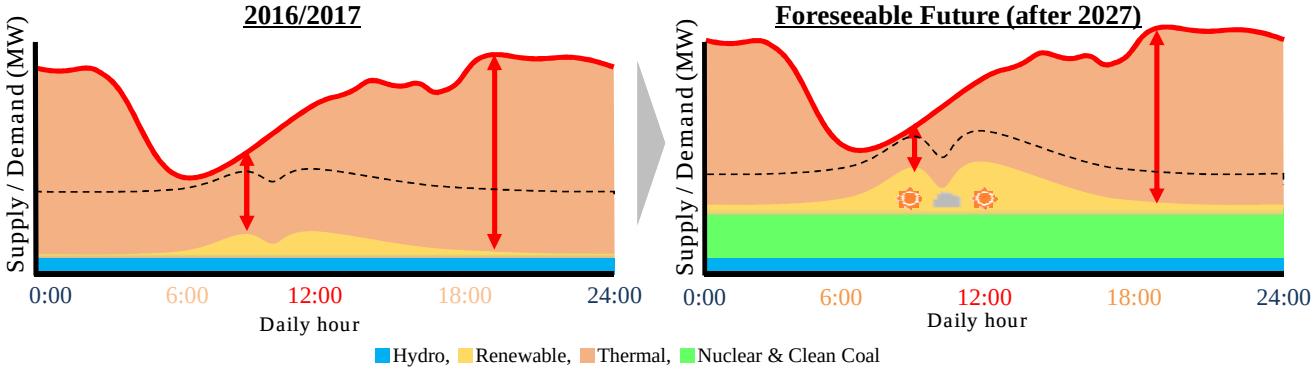
Current Situation: Drastic Change in role of TPPs

21

In the near future, many existing thermal power plants are increasingly required to **switch the operation from base & cyclic to peak (including standby reserve)**.

Main Dominant Factors;

- ü Recent peak load growth relatively stable.
  - ➡ **No more drastic change in demand growth expected in next decade.**
- ü Brand-new clean coal/nuclear power plant as base load operation.
- ü Positive installation of intermittent renewable energy sources.



Issue in O&M of Thermal Power Plants (TPPs)

22

Foreseeable Critical Issues (O&M needs)

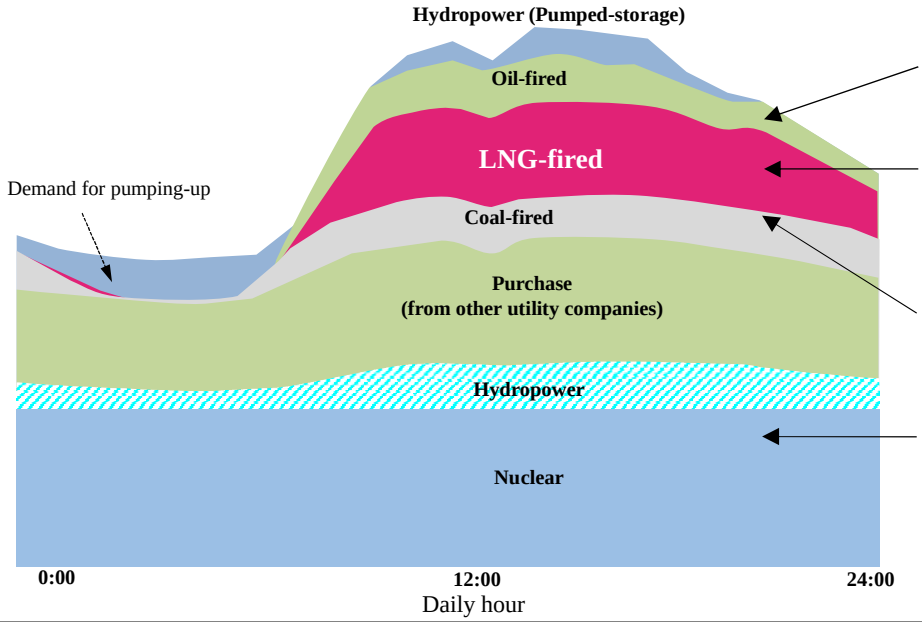
- ü Frequent Partial Load
  - ➡ **Thermal efficiency deteriorates at the partial load** because power plants are designed to attain the best performance at the rated output
- ü Frequent Start-up & Shut-down
  - ➡ TPPs suffer from not only creep damage at base & moderate cyclic operation but also **fatigue damage at intense cyclic & peak operation**.
- ü 1/3 installed capacity is over 20 years.
  - ➡ **Aging impact on O&M quality and cost** (especially major overhaul)
- ü Increase in Standby Reserve
  - ➡ Standby reserve TPPs require some amount of fixed O&M cost.

ü Considering the current situation, EEHC is expected to **improve plant performance** and **respond to peak demand fluctuation:** Thermal efficiency, availability factor and unplanned outage rate etc.

Kansai's Technical Solutions

Kansai Electric: Long history in Responding demand fluctuation

In Kansai's power generation portfolio, LNG and Oil thermal power plants have been responding to peak demand fluctuation and contribute to the consistent and stable supply of electricity.



Oil: **Peak ~ Standby Reserve**
- Cost: High
- Flexibility: High

LNG: **Cyclic ~ Peak Load**
- Cost: Middle ~ High
- Flexibility: Middle

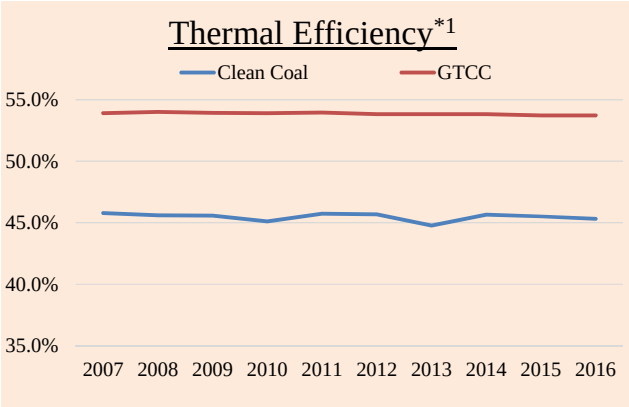
Coal: **Base Load**
- Cost: Low
- Flexibility: Low

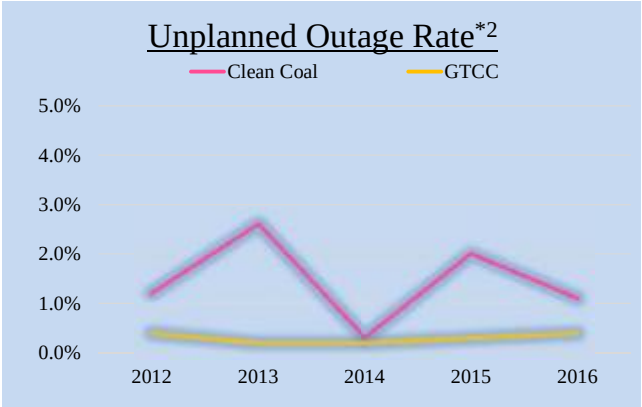
Nuclear: **Base Load**
- Cost: Low
- Flexibility: Low

Kansai's Technical Solutions

Kansai has accumulated precious experience and maintained technical knowledge and skill of high quality O&M for over 65 years.

The following know-how contributes to **low degradation of thermal efficiency** and **low unplanned outage rate**; for example,
"thermal efficiency management", "non-destructive inspection", "safety management", "quality management", and "remaining life assessment" etc.





*1: Gross, LHV basis

*2: Unplanned Outage Rate (%) =
No. of days of unplanned outage / (No. of days of operation + No. of days of unplanned outage)

General Information: Kansai Electric Power Co., Inc.

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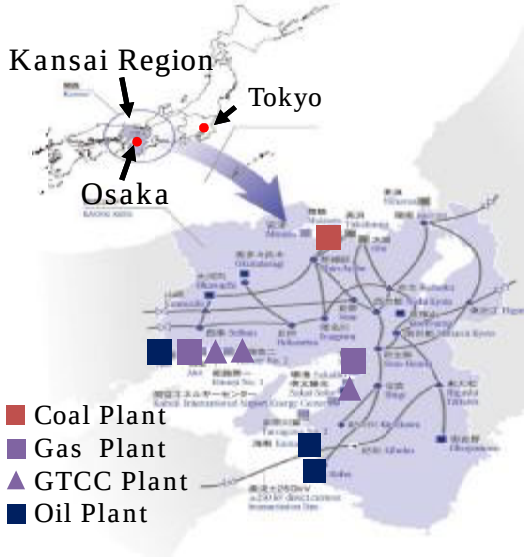
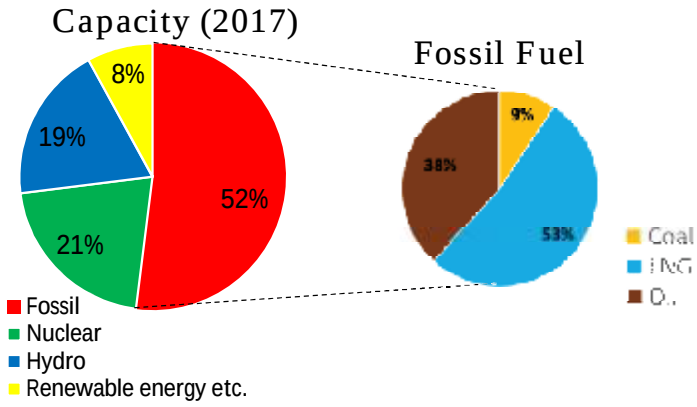
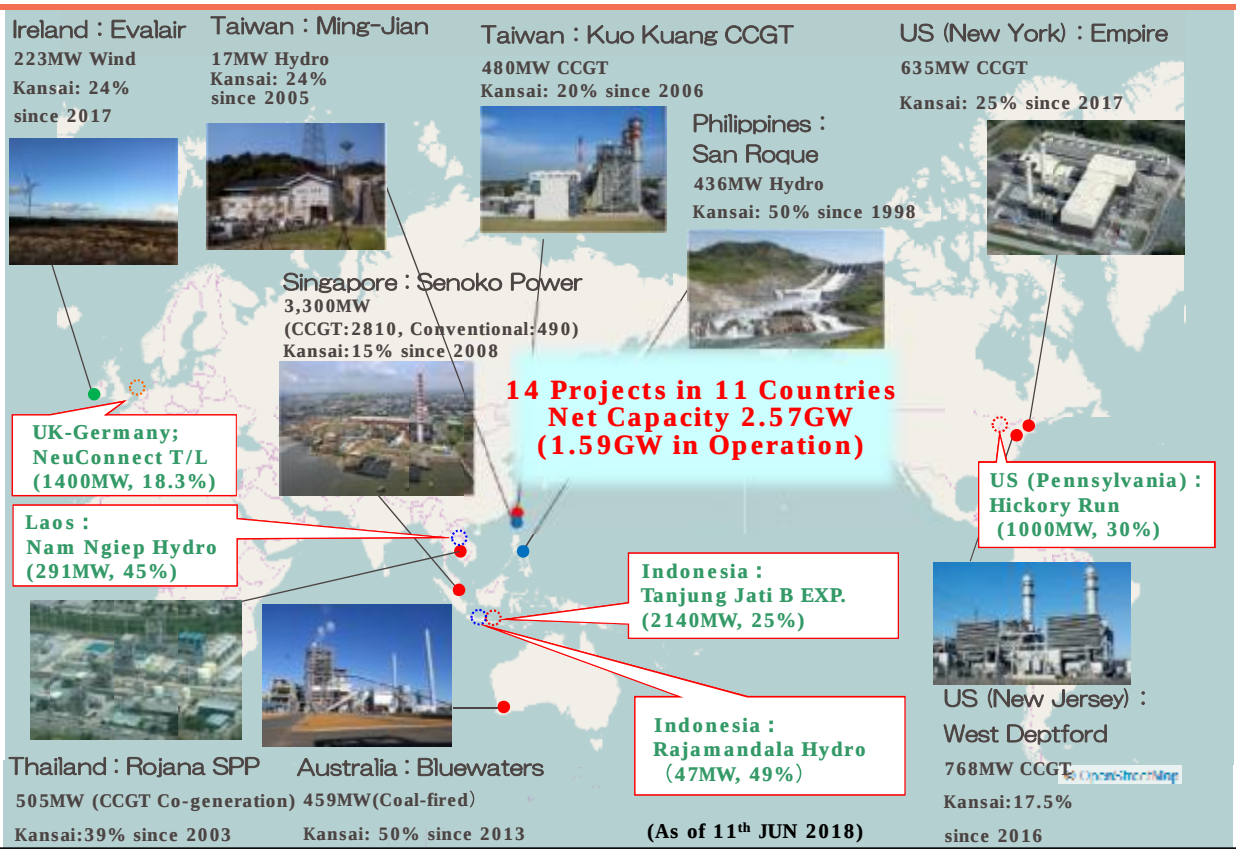


- Established in 1951
- Electricity Sales : 127,516 GWh
- The authorized Capacity : 36.6 GW



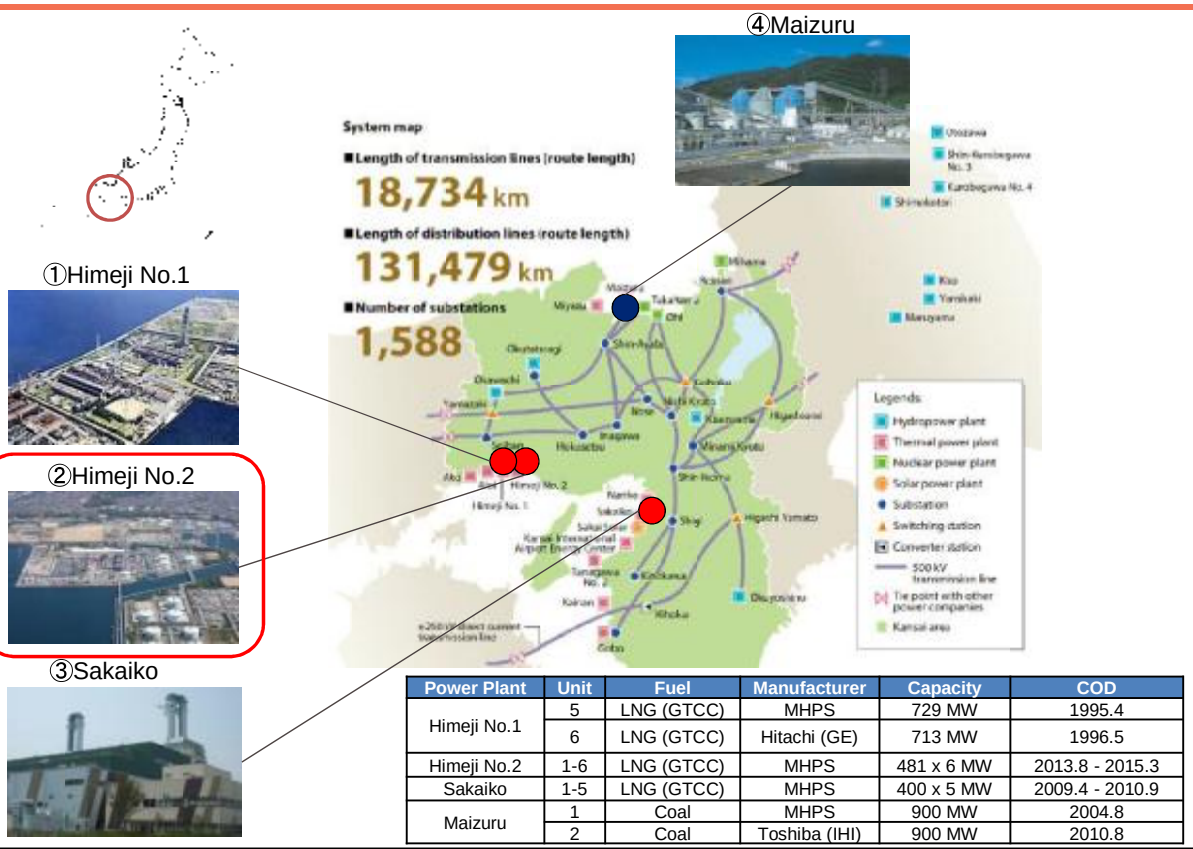
Kansai's Overseas Project

26



Kansai's GTCC and Coal Fired Power Plants

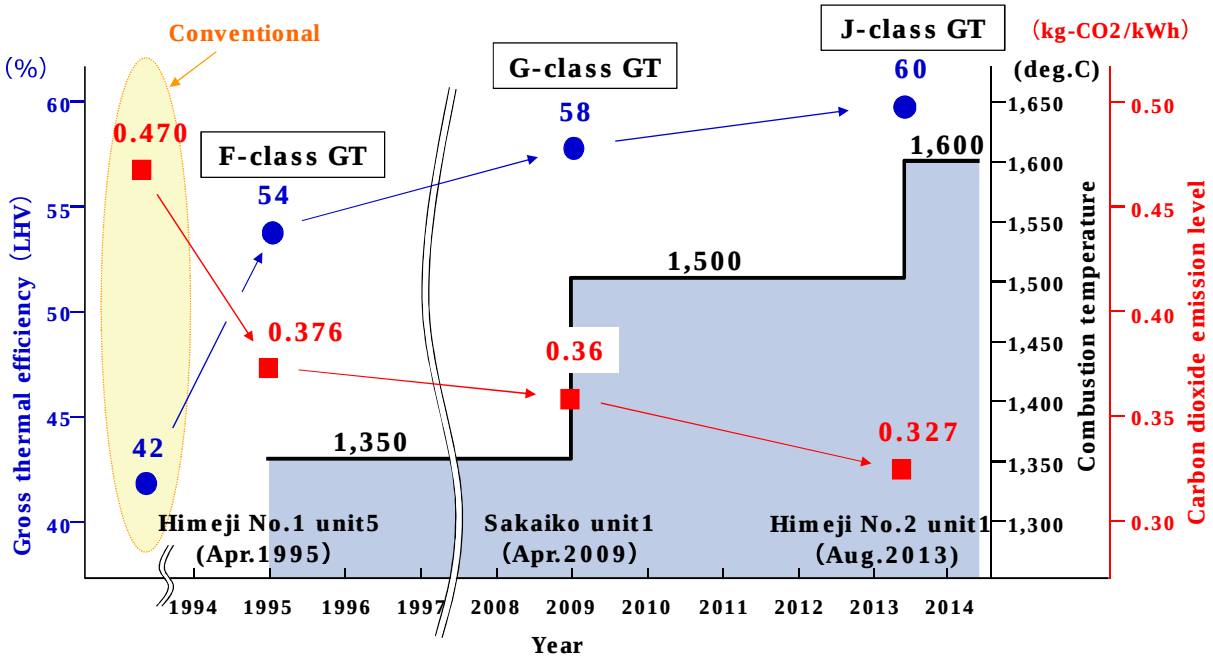
27



Power Plant	Unit	Fuel	Manufacturer	Capacity	COD
Himeji No.1	5	LNG (GTCC)	MHPS	729 MW	1995.4
	6	LNG (GTCC)	Hitachi (GE)	713 MW	1996.5
Himeji No.2	1-6	LNG (GTCC)	MHPS	481 x 6 MW	2013.8 - 2015.3
Sakaiko	1-5	LNG (GTCC)	MHPS	400 x 5 MW	2009.4 - 2010.9
Maizuru	1	Coal	MHPS	900 MW	2004.8
	2	Coal	Toshiba (IHI)	900 MW	2010.8

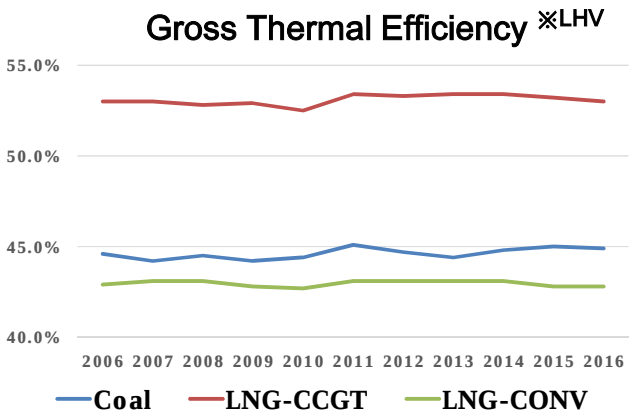
Kansai's GTCC Performance Improvement

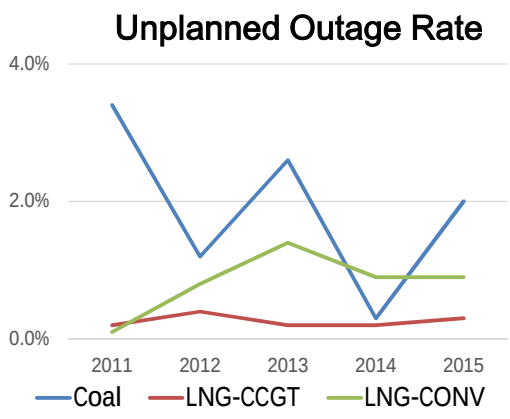
28



n 30% reduction of fuel consumption and carbon dioxide emission compared to conventional power plants.

Kansai's Operational Performance





※Gross Thermal Efficiency : electricity generated/energy input
※Unplanned Outage Rate :
unplanned outage days/(operation days+ unplanned outage days)

LNG-CONV: LNG Conventional

- Able to keep a high level of *Gross thermal Efficiency* and a low level of *Unplanned Outage Rate*
- Tackling various troubles and improving operational efficiency constantly.

Updated Business Environment in Japan

Before

- 10 Electric Power Companies dominated and controlled the market.

After

- Full liberalization of the electricity market in 2016
- Opening a new market
  - 200 billion USD market scale

Kansai's Technical Service Strategy

31

Know-How Experience

New Services & Products

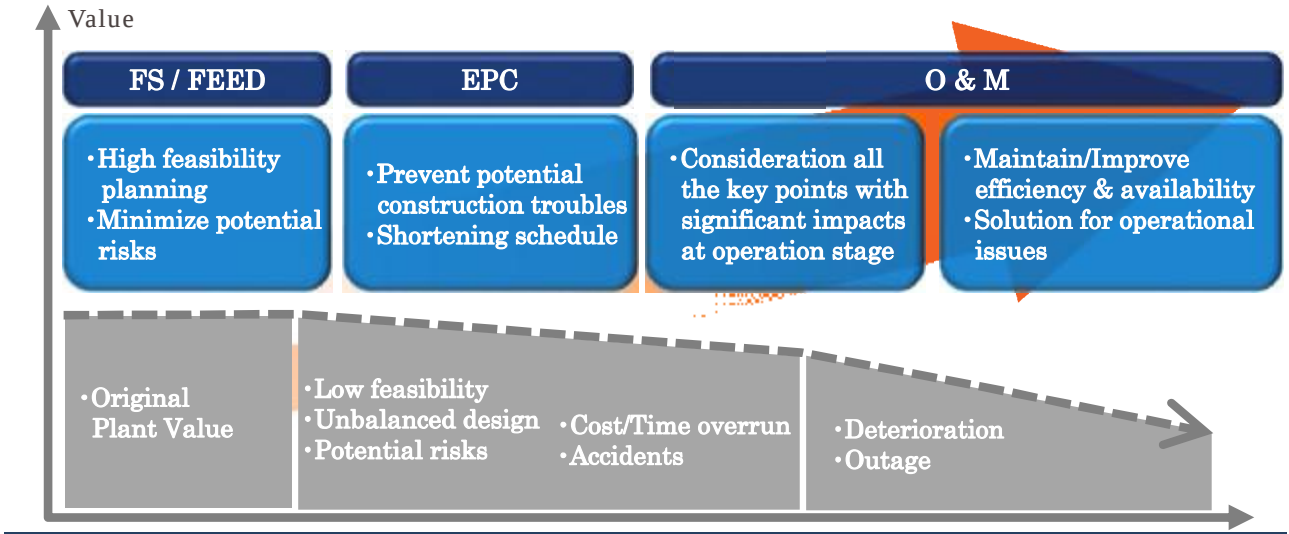
	Existing	New
Our existing Power Plants	**Enhance Existing Business Profits** p Reform Cost Structure • O&M Optimization • Fuel Conversion	**Develop New Services & Products** p Integrate our Know-How with Advanced Digital Technology • Operation Optimization using AI
New (Customer)	**Expand Business Domain** p Provide Solution Services • Engineering Services • O&M Support	**Challenges to New Field** p Provide New Services & Products to New Markets • Remote Monitoring Service

New Markets

Kansai Value Creation Service

K-VaCS

32



- Comprehensive solution for managing Power Plant
- Provide "Value Creation" service integrated with IoT / AI technology

Challenges in Optimizing O&M at Kansai

33

Operation Optimization

- Enhancing plant power output & efficiency
- Unplanned Down Time Reduction

→ Early Anomaly Detection

Maintenance Optimization

- Applying CBM instead of TBM
- Introducing advanced device & method

→ Drone

Operation

Maintenance

Ø Big Data Analysis System with AI

+

Ø IoT / ICT devices
Ø Advanced device

Data Management Infrastructure

Operating Data | Knowledge | Experience

Early Anomaly Detection System (Before Installation)

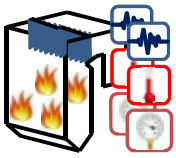
34

Operators are notified of alarm if any actual value of operating data is detected beyond limit, which is NOT adjusted according to various operating condition.

Controller

Alarm Set

Alarm: High Limit



Operating Data

Actual Value

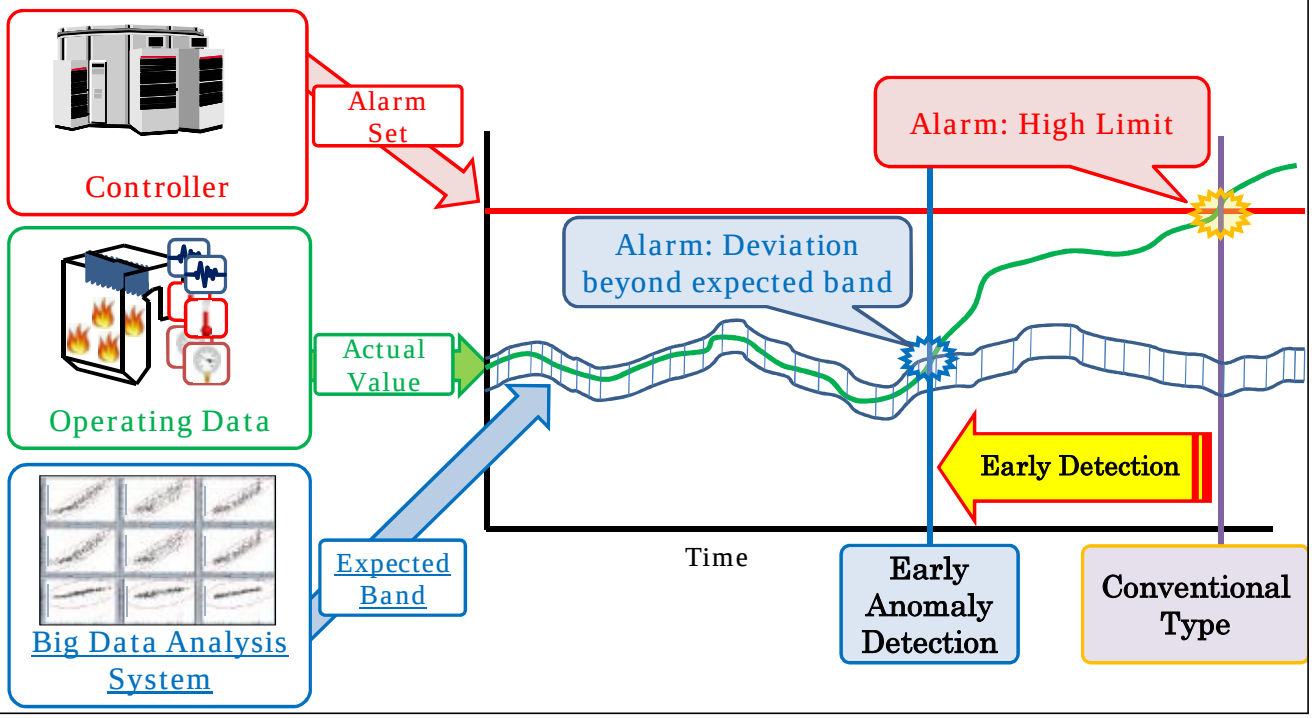
Time

Conventional Type

Early Anomaly Detection System (After Installation)

35

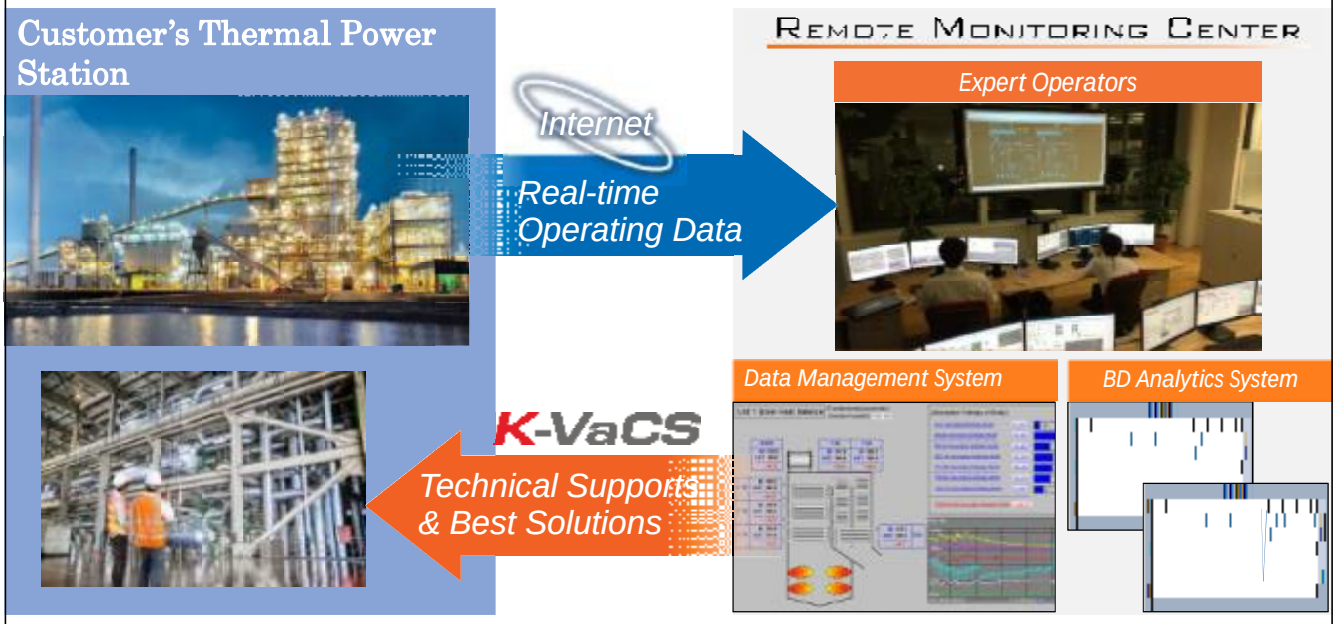
Early anomaly detection system helps operators to detect symptom of trouble earlier, by setting expected band through big data analysis system.



Kansai's Remote Monitoring Service

K-VaCS Kansai Value Creation Service

36



Together with real-time notification by the early anomaly detection system with AI, our experienced O&M expert provides total solution from user's point of view

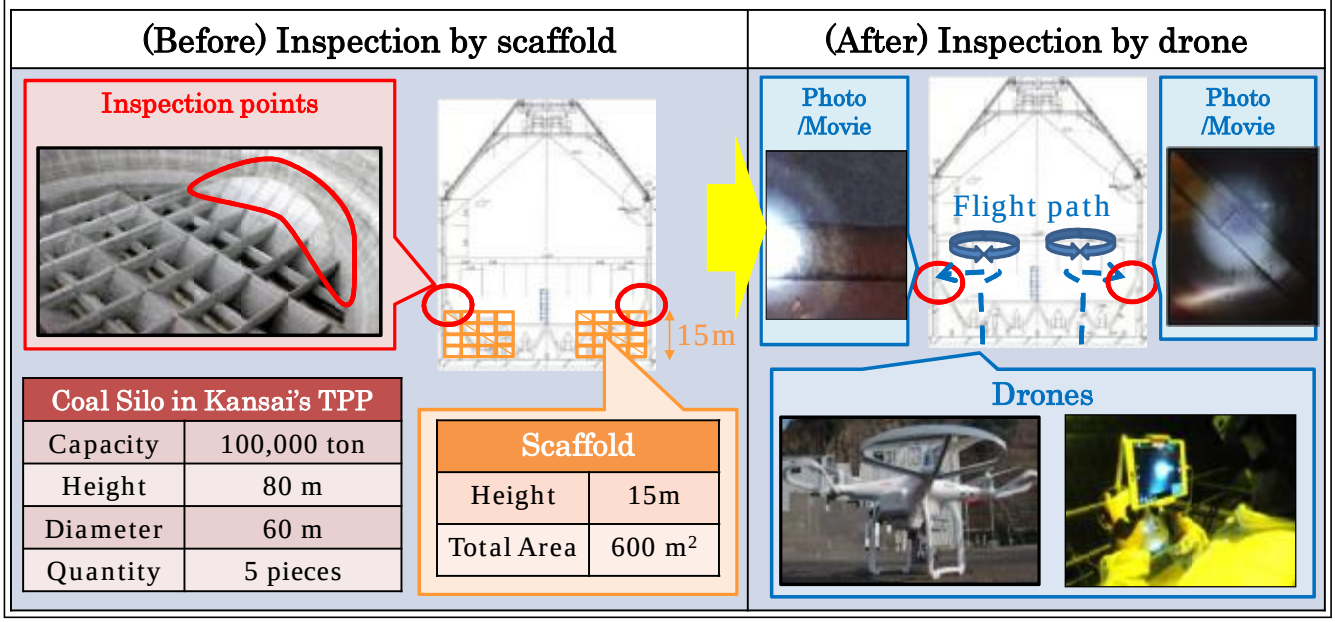
Introducing Advanced Device and Method: Drone

37

By using drone, it is possible to implement inspection work without assembly & disassembly of scaffold in Kansai's TPP.

➡ *More safety, Shorter maintenance period and Cost-saving !*

Example: Inspection work at coal silo



O&M Training Participants: Engineers (1st Year Completed: 2017)

38

	Participants	EHHC	Power Station	Title
1	Mr. BADERELDINE Moustafa Esmat Ahmed	CEPC	Cairo North	Senior Engineer (GT Maintenance)
2	Mr. MOHAMED Ayman Ibrahem	CEPC	Cairo North	Senior Engineer (Turbine Maintenance)
3	Mr. ABDULRAHMAN abdelrahman Saad	CEPC	Cairo North	Senior Engineer (Turbine Maintenance)
4	Mr. AZERQ Ayman Saad	MDEPC	Nubaria	Supervisor (Operation Manager)
5	Mr. ELSAEIDY Ibrahim Ahmed Osman	MDEPC	Nubaria	Team Leader (Mech. Maintenance)
6	Mr. ABDELMAKSOUD Mohamed Hamdy Ibrahim	WDEPC	Sidi Krir	Head Engineer (Turbine Maintenance)
7	Mr. ABDELHAMID Tarek Mousafa	WDEPC	Sidi Krir	Shift Charge Engineer (Operation)
8	Mr. MOHAMEDAWAD Abdelmoneim Aliahmed	WDEPC	Sidi Krir	Head Engineer (Mech. Maintenance)
9	Mr. MEKHAIMER Mekhaimer Abozeid	UEEPC	Assuit	Maint. Engineer (Water Treat)
10	Mr. ORABY Mohamed Aboueleyoun Hassan	UEEPC	Assuit	Maint. Eng. (Boiler)

O&M Training Participants: Technicians (1st Year Completed: 2017)

39

	Participants	EHHC	Power Station	Title
1	Mr. MOHAMED Emad Abdelrehem	CEPC	Cairo North	Technician (Turbine Maintenance)
2	Mr. IBRAHIM Khtab Ragab	CEPC	Cairo North	Technician (Turbine Maintenance)
3	Mr. SHAHEN Mohamed Saaed	CEPC	Cairo North	Technician (Turbine Maintenance)
4	Mr. KALIFA Mohamed Helal	MDEPC	Nubaria	Chief (Turbine Maintenance)
5	Mr. ABDELHAFEZ Elshahat Abdalla	MDEPC	Nubaria	Mechanical Supervisor
6	Mr. ABDELAAL Omal Mohamedyoussef	WDEPC	Sidi Krir	Technical SV (Turbine Maintenance)
7	Mr. BASHA Ashraf Abdelaziz	WDEPC	Sidi Krir	Technical SV (Turbine Maintenance)
8	Mr. ELTAHAN Mohamed Abdallah	WDEPC	Sidi Krir	Technical SV (Turbine Maintenance)
9	Mr. ABDULATIF Amir Kamal	UEEPC	Kuriemat	SV (Turbine Maintenance)
10	Mr. ABDELAZIEM Samir Ayesh	UEEPC	Kuriemat	SV (Mech. Maintenance)
11	Mr.MOHMOUD Sayed Aly	UEEPC	Kuriemat	SV (Mech. Maintenance)

O&M Training in Japan: Training Program (1st Year Completed: 2017)

40

Engineers (from 25th Nov. to 23rd Dec., 2017)	Technicians (from 25th Nov. to 16th Dec., 2017)
n **Develop Capacity of Instructors of TPP**	n **Develop Capacity of Instructors of TPP**
ü Introduction of the latest technology in TPP	ü Introduction of the latest technology in TPP
ü **Experience-based Safety Training**	ü **Experiential Safety Training**
ü Human Resource Development	ü Welding Procedure Management
ü **Quality Management**	ü **Experiential Quality Training**
ü Lesson Learned from Accidents	ü Metal Material
ü **Thermal Efficiency Management**	ü Valve Maintenance skills and Overhauling Motors
ü Basic Training of Vibration (Balancing)	ü Maintenance Technique of Industrial Instruments
ü **Non-Destructive Inspection**	ü **Basics of Non-Destructive Inspection Skills**
ü GT & High Temperature Parts / Maintenance of GTCC (inc. **Remaining Life Assessment**)	ü Maintenance of High Temperature and High Pressure Piping
ü Feed Water Treatment	ü Prevention of Accidents and Disasters
ü Site Visit on TPP and Manufacture's factory	ü Site Visit on TPP and Manufacture's factory
n **Conduct Trainings at each TPP by the Instructors**	n **Conduct Trainings at each TPP by the Instructors**
ü Job Report Presentation	ü Job Report Presentation
ü Methodology to Formulate Action Plan	ü Methodology to Formulate Action Plan
ü Presentation about Action Plan	ü Presentation about Action Plan

O&M Training in Japan: Photos (1st Year Completed: 2017)

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Engineers: Basic Training of Vibration (Balancing)

Technicians: Experiential Safety Training

Engineers: Presentation about Action Plan

Technicians: Basics of Non-Destructive Inspection Skills

Action Plan in Cairo North & West Delta (1st Year Completed: 2017)

42

【Cairo North (Engineers/Technicians)】

Overall Goal	Project Purpose	Outputs	Activities
Surrounding equipment is repaired efficiently.	Engineers and technicians have enough skills.	Internal training is organized.	ü JICA-trained engineers transfer the training material and knowledge to other engineers & technicians ü Plant meeting room is used to convene every Thursday, some tea is offered.
	Maintenance is done in proper timing.	Communication between operation section and maintenance section is done smoothly.	ü Organize Meeting in every Sunday morning. ü Keep “Daily Round Report”.

【West Delta (Engineers/Technicians)】

Overall Goal	Project Purpose	Outputs	Activities
Maintenance is done efficiency	Employees do their duties as planned.	There is an institution to praise those who work hard.	ü Provide an award competition to encourage those who work hard.
		Workers are skilled enough to know the importance of their duties.	ü Organized TBT (Tool Box Talk) among colleagues to share experience. ü Provide training opportunities for workers

Action Plan in Middle Delta (1st Year Completed: 2017)

43

【Middle Delta (Engineers)】

Overall Goal	Project Purpose	Outputs	Activities
Surrounding equipment is repaired efficiently.	Spare parts are available to do maintenance.	Right maintenance plan is made and followed	ü Improve maintenance planning skill. ü Organize training to brush up skills, in order to grasp current condition of the machines

【Middle Delta (Technicians)】

Overall Goal	Project Purpose	Outputs	Activities
Surrounding equipment is repaired efficiently.	Required maintenance is implemented in proper way.	Spare parts are purchased on time.	Prepare purchase order for required spare parts at specified intervals.
		Skilled human resource is enough.	Internal training is organized.

Action Plan in Upper Egypt (1st Year Completed: 2017)

44

【Upper Egypt (Engineers)】

Overall Goal	Project Purpose	Outputs	Activities
Surrounding equipment is repaired efficiently.	Spare parts are ready to use.	Spare parts are ordered on time.	ü Make a plan early enough. ü Begin to process the paperwork and make purchase order according to the plan.
		There is efficient workshop.	ü Organize training for engineers. ü Repair the old parts in workshop

【Upper Egypt (Technicians)】

Overall Goal	Project Purpose	Outputs	Activities
Surrounding equipment is repaired efficiently.	Required maintenance is implemented in proper way.	Monitoring tool is used for daily operation.	ü Inspection sheet and time table are developed.
		Technicians have enough skills.	ü Information and experience is exchanged among technicians at the weekly meeting. ü Training is provided to improve skills.

Activity Report on Action Plan (1st Year Completed: 2017)

45

Number of Trainees (Engineers : 10 , Technician : 11)

	Question	Cairo	MDEPC		WDEPC	UEEPC	
		Engineer(3)/ Technician(3)	Engineer(2)	Technician(2)	Engineer(3) /Technician(3)	Engineer(2)	Tech. (3)
General	Is training in Japan effective?	Yes	Yes		Yes	Yes	To be confirmed
General	What kind of Action Plan is effective for improving O&M?	Need to develop programs to fill the gap between expected and actual.	Spare parts are available to do maintenance.		To be confirmed	Following action plan with sector head– trainees	
Training in Egypt	Implementation status of the training program	Implemented	Implemented		Implemented	Implemented	
Training in Egypt	How many times a month?	2～3 times per month.	Every daily work permit.		Monthly	3 months	
Training in Egypt	How many people have participated in training so far?	20 person	The number of people participating in the training is not specified.		All colleagues in the department	60 person	
Training in Egypt	Feeling the effect of the training	Yes	Yes		Yes	Yes	

Targeted Scope of Capacity Building for O&M at TPPs

46

Training in Japan will focus on **maintenance knowledge and skill,** especially **mechanical field in GTCC**.

Operation Training: More Suitable Condition (especially advanced course)

- ü Collective training for **operators in shift team.**
- ü Using actual facilities or simulator which has **same specification** as current workplace.
- ü Learning operation knowledge and skill including **normal/urgent operation**.

➡ ***Manufacturer's support in the workplace seems more effective.***

Maintenance Training: More Suitable Condition

- ü Collective training for **engineers/technicians with equal competence**.
- ü Using main equipment which has **same type of power generation** as current workplace.
- ü Learning maintenance knowledge and skill including **updated trouble-shooting.**
- ü **Mechanical** preferable to electrical/C&I, considering foreseeable aging impact on O&M quality and cost in the near future.

➡ ***From utility's viewpoint, Kansai can contribute to EEHC more effectively.***

The second batched training participants list (engineer)

1	Mr.OTHMAN Medhat Sayed Mahmoud	Head of Tech.Affairs Technical Affairs Sector for Production Companies Egyptian Electricity Holding Company (EEHC) / MOERE(2016)
2	Mr.NAKHLA Essam Attia Nagib	Director of Boiler Dept West Delta Electricity Productoin Co. (WDEPCo.) Egyptian Electricity Holding Company (EEHC) / MOERE(2016)
3	Mr.KAMAR Tamer Farouk Aly Hassan	Shift Charge Engineer West Delta Electricity Productoin Co. (WDEPCo.) Egyptian Electricity Holding Company (EEHC) / MOERE(2017)
4	Mr.TELEB Farag Elsayed Ibrahim	Shift Charge Engineer West Delta Electricity Productoin Co. (WDEPCo.) Egyptian Electricity Holding Company (EEHC) / MOERE(2012)
5	Mr.EMARA Ahmed Elsayed Azzazi	Gas Turbine Mec.Maint.Eng. New Talkha Compined Cycle Power Plant Middle Delta fElectricity Productoin /(EEHC) / MOERE(2005)
6	Mr.YOUNIS Ibrahim Mohamed Shabana	Lead Operation Eng. Operation Dept/New Talkha Comp.Cycle P.Plant Middle Delta Electricity Productoin /(EEHC) / MOERE(2010)
7	Mr.HASSAN Ahmed Hassan Farag	Operation Engineer Mech. Mainten./Upper Egypt Elrect.Produc.Co. Egyptian Electricity Holding Company (EEHC) / MOERE(2014)
8	Mr.FAYED Mohamed Korany Mohamed	Maintenance Manager Eng Mech. Mainten./Upper Egypt Elrect.Produc.Co. Egyptian Electricity Holding Company (EEHC) / MOERE(2014)
9	Mr.MOHAMED Ahmed Mohamed Abdelmohsen	Mechanical Maint.Eng.(2nd Eng.) HRSG(Heat Ecov.Steam Generation) Maint.Dept Upper Egypt Electricity Production Company / (EEHC)(2017)
10		

The second training curriculum in Japan for Engineer

Date	Time	Course	Lecturer	Venue
10/8/2018(Mon)	－	Arrival in Japan		
10/9/2018(Tue)	10:00～11:30	Briefing	Ayaka Sawai	JICA Kansai
			Rie Matsushita	
	11:30～12:15	Program orientation	Yoshiko Oi	
	12:15～13:00	Course orientation	Yoshihiro DOI	
	14:00～17:00	Job report presentation		
	18:00～19:30	Japanese language	Reiko Ikkai	
10/10/2018(Wed)	9:00～12:00	Overall of Kansai EPCO/Fuel supply chaine	Yoshiyuki Sugita	JICA Kansai
			Shintaro Onishi	
	14:00～16:00	Kansai EPCO Central despatch center／RMC/K-VaCS	Takayuki Adachi	Kansai EPCO
			Tadahiro Nakazawa	
	18:00～19:30	Japanese language	Reiko Ikkai	JICA Kansai
10/11/2018(Thu)	9:00～12:00	Action plan making prosedure	Yoshiko Oi	JICA Kansai
	13:00～16:00	Action plan making prosedure	Akiko Tahara	
	18:00～19:30	Japanese language	Reiko Ikkai	
10/12/2018(Fri)	9:00～12:00	Action plan making prosedure	Akiko Tahara	JICA Kansai
	13:00～16:00	Overall of Thermal power plant(GTCC/coal)	Akihiro Matsuoka	
			Tomohiro Mouri	
10/13/2018(Sat)	－	Holiday		
10/14/2018(Sun)	－	Holiday		
10/15/2018(Mon)	9:00～12:00	Orientation of Training Center	Takeshi Mamori	Kansai EPCO
			Sadahito Sakurai	
	13:00～16:00	Quality management/Heat efficiency management	Tomohiro Takahata	
			Susumu Hiratsuka	
10/16/2018(Tue)	9:00～12:00	GTCC	Akira Kozakai	Kansai EPCO
	13:00～16:00	GT	Akira Kozakai	
10/17/2018(Wed)	9:00～12:00	ST	Akira Kozakai	Kansai EPCO
	13:00～16:00	HRSG	Akira Kozakai	
10/18/2018(Thu)	13:00～17:00	Site visit at IHI Aioi Factory	Kazuyo Kitagawa	IHI Aioi Factory
10/19/2018(Fri)	9:30～12:00	Site visit at Himeji No.2 TPP(GTCC)	Keisuke Takimoto	Himeji No.2 TPP
	13:30～17:00	Site visit at MHPS Takasago Factory	Shigeru Yoshitake	MHPS Takasago Factory
10/20/2018(Sat)	－	Holiday		
10/21/2018(Sun)	－	Holiday		
10/22/2018(Mon)	9:30～12:00	Site visit at Himeji No.2 TPP(GTCC)	Keisuke Takimoto	Himeji No.2 TPP
	14:00～16:30	Site visit at Himeji No.2 TPP(GTCC)	Ryosuke Onishi	Himeji No.1 TPP
10/23/2018(Tue)	9:00～12:00	GTCC(Hot parts)	Takeshi Arino	Kansai EPCO
	13:00～16:00	Feed water Treatment/welding management	Shinji Fujio	
			Toshiyuki Morishita	
10/24/2018(Wed)	9:00～12:00	NDI	Toshiyuki Morishita	Kansai EPCO
	13:00～16:00	NDI	Toshiyuki Morishita	
10/25/2018(Thu)	9:00～12:00	NDI	Toshiyuki Morishita	Kansai EPCO

Date	Time	Course	Lecturer	Venue
10/25/2018(Thu)	13:00～16:00	NDI	Toshiyuki Morishita	Kansai EPCO
10/26/2018(Fri)	9:00～12:00	Remaining life assessment	Takeshi Arino	Kansai EPCO
	13:00～16:00	Remaining life assessment	Takeshi Arino	
10/27/2018(Sat)	－	Holiday		
10/28/2018(Sun)	－	Holiday		
10/29/2018(Mon)	9:00～10:30	Human Resource Development	Yoshihiro DOI	Kansai EPCO
	10:30～12:00	Lesson learned	Kazumoto Fukumitsu	
	13:00～16:00	GTCC(control)/Quality management	Fumitaka Miyahara	
			Kazumoto Fukumitsu	
10/30/2018(Tue)	9:00～12:00	Vibration	Toru Yamane	Kansai EPCO
	13:00～16:00	Vibration	Toru Yamane	
10/31/2018(Wed)	9:00～12:00	Vibration	Toru Yamane	Kansai EPCO
	13:00～16:00	Vibration	Toru Yamane	
11/1/2018(Thu)	9:00～12:00	Vibration	Toru Yamane	Kansai EPCO
	13:00～16:00	Vibration	Toru Yamane	
11/2/2018(Fri)	9:00～12:00	Vibration	Toru Yamane	Kansai EPCO
	13:00～16:00	Vibration	Toru Yamane	
11/3/2018(Sat)	－	Holiday		
11/4/2018(Sun)	－	Holiday		
11/5/2018(Mon)	9:00～12:00	Pump alignment	Hiroyuki Chiba	Kansai EPCO
			Isao Inoue	
	13:00～16:00	Pump alignment	Hiroyuki Chiba	
			Isao Inoue	
11/6/2018(Tue)	9:00～12:00	Safety through experience	Shinji Fujio	Kansai EPCO
	13:00～16:00	O&M/ Quality Electric Power Infrastructure	Yoshihiro DOI	
			Kazuyo Kitagawa	
11/7/2018(Wed)	11:00～16:00	Making Action Plan		JICA Kansai
11/8/2018(Thu)	9:00～16:00	Making Action Plan		JICA Kansai
11/9/2018(Fri)	9:00～12:00	Action Plan presentation		JICA Kansai
	13:00～14:00	Evaluation meeting		
	14:00～14:30	Closing ceremony		
	14:30～15:30	Exchange opinion meeting		
11/10/2018(Sat)		Departure from Japan		

The second batched training participants list (technician)

1	Mr.GABALA Mohamed Ibrahim Abdelaziz	Technical Supervisor West Delta Electricity Productoin Co. (WDEPCo.) Egyptian Electricity Holding Company (EEHC)/MOERE(2011)
2	Mr.ASHERY Mohamed Abdelmotaleb Mohamed Mansour	Technical Supervisor West Delta Electricity Productoin Co. (WDEPCo.) Egyptian Electricity Holding Company (EEHC)/MOERE(2013)
3	Mr.ALY Mohamed Moustafa Mohamed	Technical Supervisor West Delta Electricity Productoin Co. (WDEPCo.) Egyptian Electricity Holding Company (EEHC) /MOERE(2016)
4	Mr.MOUSA Ali Abouzeid Mousa Abouzeid	Gas Turbine Mec.Maint.Eng. New Talkha Compined Cycle Power Middle Delta Electricity Productoin /(EEHC)/MOERE(2003)
5	Mr.BAYOUMI Ali Ghanem Ali	Comb.Cycl.Oper.Techn. New Talkha Compined Cycle Power Plant Middle Delta Electricity Productoin /(EEHC)/MOERE(2007)
6	Mr.SALEH Khaled Sayed Mohamed	Mechanic. Maint.Supervisor Mech. Mainten./Upper Egypt Elrect.Produc.Co. Egyptian Electricity Holding Company (EEHC)/MOERE(2014)
7	Mr.TAHA Walid Mohamed Mahmoud Mohamed	Operation Technician Operation Dept./Upper Egypt Elrect.Produc.Co. Egyptian Electricity Holding Company (EEHC)/MOERE(2016)
8	Mr.AWWAD Hassan Awwad Hassan	Operation Technician Operation Dept/Shobra El-khima Power Plant Cairo Elect.Produc.Co.(CRPC)/ (EEHC)/MOERE(2015)
9	Mr.FARAG Mahmoud Aly Abdellatif	Operation Technician Operation Dept/Shobra el-khima Power Plant Cairo Elect.Produc.Co.(CEPC)/ (EEHC)/MOERE(2015)
10	Mr.ELSAYYAD Amr Mohamed Hamdy Abdelazim	Technician Mech. Mainten./Giza North Station Cairo Elect.Produc.Co.(CEPC)/ (EEHC)/MOERE(2018)

The second training curriculum in Japan for Technician

Date	Time	Course	Lecturer	Venue
10/8/2018(Mon)		Arrival in Japan		
10/9/2018(Tue)	9:00～10:00	Overall briefing	Takeo Fujii	JICA Kansai
	10:00～11:30	Briefing		
	11:30～12:15	Program orientation		
	12:15～13:00	Course orientation	Yoshihiro Doi	
	14:00～17:00	Jpb Report Presentation		
	18:00～19:30	Japanese language	Harumi Shimizu	
10/10/2018(Wed)	9:00～12:00	Overall of Kansai EPCO/ Fuel supply chaine	Yoshiyuki Sugita	JICA Kansai
			Shintaro Onishi	
	14:00～16:00	Site visit at Central Dispatch Center	Takayuki Adachi	Kansai EPCO
			Tadahiko Nakazawa	
	18:00～19:30	Japanese language	Harumi Shimizu	JICA Kansai
10/11/2018(Thu)	9:00～12:00	Action plan lecture	Yoshiko Oi	JICA Kansai
	13:00～16:00	Action plan lecture	Yoshiko Oi	
	18:00～19:30	Japanese language	Harumi Shimizu	
10/12/2018(Fri)	9:00～10:30	Action plan lecture	Yoshiko Oi	JICA Kansai
	13:00～16:00	Overall of GTCC and Coal Fired Power Plant	Akihiro Matsuoka	
			毛利 友宙	
10/13/2018(Sat)	－	Holiday		
10/14/2018(Sun)	－	Holiday		
10/15/2018(Mon)	9:00～11:00	Training Center Orientation	Shigemi Zyosyo	Kanden Plant
	11:00～14:00	Overall of GT, ST, HRSG and each structure	Koji Yamada	
	14:00～16:00	Quality training	Masashi Ashida	
10/16/2018(Tue)	9:00～12:00	Metaric Material	Koji Yamada	Kanden Plant
	13:00～14:00	Welding	Noriaki Manabe	
	14:00～16:30	Welding	Noriaki Manabe	
10/17/2018(Wed)	9:00～11:00	Pump maintenance	Koji Yamada	Kanden Plant
	11:00～12:00	Pump maintenance	Koji Yamada	
	13:00～16:30	Pump maintenance	Koji Yamada	
10/18/2018(Thu)	13:00～17:00	Site visit at IHI Aioi Factory	Kazuyo Kitagawa	IHI Aioi Factory
10/19/2018(Fri)	9:30～12:00	Site visit at Himeji No.2 TPP(GTCC)	Keisuke Takimoto	Himeji No.2 TPP
	13:30～17:00	Site visit at MHPS Takasago Fatory	Shigeru Yoshitake	MHPS Takasago Factory
10/20/2018(Sat)	－	Holiday		
10/21/2018(Sun)	－	Holiday		
10/22/2018(Mon)	9:00～12:00	High temparature and pressure piping maintenance	Koji Yamada	Kanden Plant
	13:00～13:20	Labor safety	Takumi Mukai	
	13:30～16:30	Safety training	Takumi Mukai	
10/23/2018(Tue)	9:00～12:00	NDI	Koji Yamada	Kanden Plant
	13:00～16:30	NDI	Koji Yamada	

Date	Time	Course	Lecturer	Venue
10/24/2018(Wed)	9:00～11:00	Preventing accidents and disasters	Masashi Ashida	Kanden Plant
	11:00～12:00	Overall of GT, ST, HRSGand each structure	Koji Yamada	
	13:00～16:00	Overall of GT, ST, HRSGand each structure	Koji Yamada	
10/25/2018(Thu)	9:00～12:00	Making Action Plan		JICA Kansai
	13:00～16:00	Making Action Plan		
10/26/2018(Fri)	9:00～12:00	Making Action Plan		JICA Kansai
	13:00～14:00	Evaluation meeting		
	14:00～14:30	Closing ceremony		
	14:30～15:30	Internal evaluation meeting		
10/27/2018(Sat)	－	Departure from Japan		

Action Plan

Arab Republic of Egypt
Electricity Sector

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Action Plan

Plants & Participants

Arab Republic of Egypt
Electricity Sector

Name of the Plant	Names of the Participants
EEHC	Medhat Othman
Giza North	Ahmed Hassan
Sidi krir	Essam Attia
	Farag ELsayed
	Tamer Farouk
Talkha	Ibrahim Mohamed
	Ahmed Azazy
Elkorimat	Mohamed Korny
	Ahmed Mohamed

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Background: Current Situation at the TPP

Arab Republic of Egypt
Electricity Sector

- Shortage in spare parts
- Shortage in training
- Low efficiency of some power plants due to:
  - Degradation of some power plants.
  - Bad locations of some power plants.
- Poor connection between technical office and O&M departments in the power plants.
- Most of power plants working using fossil fuel.
- Weak of safety rules implementation.

What we have learned in Japan

Arab Republic of Egypt
Electricity Sector

useful skills/practice/ideas/knowledge we have acquired in Japan

1. Human Error Reduction
2. Different types of TPP
3. New Method For Alignment
4. Non Destructive Tests
5. Methods Of Blades & Harps Manufacturing
6. Importance Of Human Resource Development
7. Follow Safety Instructions

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Overview of the Action Plan

Arab Republic of Egypt
Electricity Sector

Overall goal	**Human Resource for effective O&M is developed at TPP.**
Project Purpose	Engineers at TPP improve their skills and knowledge on effective O&M
Objective 1	To Improve Skills of Engineers through On the Job Training (OJT)
Objective 2	To make sure the OJT for technicians is organized smoothly
Objective 3	Prevention of Human Errors
Objective 4	To Improve the Key Performance Index (KPI) of GT/ST/HRSG

Overview of the Action Plan

Arab Republic of Egypt
Electricity Sector

Financial Source	Budget of each TPP
Section responsible for supervision	JICA-trained participant
Section / Person responsible for implementation	JICA-trained O&M Section
Participants of OJT	Engineers
Risk /Possible Obstacles	Need co-operation taking action

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Detailed Plan of OJT for Objective 1

Arab Republic of Egypt
Electricity Sector

To improve Skills of Engineers through On-the-Job Training (OJT)

Training Subject 1: Service Life Diagnosis

Purpose:

- To understand the outline of Service Life Evaluation
- To understand the various type of deterioration events of Thermal Power
- To understand the evaluation methods and their process
- To understand important check points for evaluation

Training Items:

- Purpose of Service Life Evaluation
- Main Deterioration Events and their Mechanism of Deterioration
- Service Life Diagnosis Methods

Detailed Plan of OJT for Objective 1

Arab Republic of Egypt
Electricity Sector

Important Points:

- Why Service Life Evaluation is important.
- What are the main damage factors.
- How each damage factor causes what kind of damage on where.
- Where & how to check the damage, according to the kinds of damage.

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Detailed Plan of OJT for Objective 1

Arab Republic of Egypt
Electricity Sector

To improve Skills of Engineers through On-the-Job Training (OJT)

Training Subject 2: Vibration

Purpose:

- To understand the mechanism of vibration
- To understand the important checking points.

Training Items:

- Basics of Vibration
- Analysis of Vibration

Important Points:

- How vibrations occur.
- How to read and follow up the vibration trend and take action.

Detailed Plan of OJT for Objective 1

Arab Republic of Egypt
Electricity Sector

To improve Skills of Engineers through On-the-Job Training (OJT)

Training Subject 3: HRSG Problems

Purpose:

- FAC phenomena & Main causes.
- How to prevent FAC
- How to fix FAC damages.

Training Items:

- Basic of flow accelerated corrosion(FAC)
- Factors affect FAC
- Repair methods

Important Points:

- How FAC occurs
- How to prevent FAC
- How to repair the damage

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Detailed Plan of OJT for Objective 1

Arab Republic of Egypt
Electricity Sector

To improve Skills of Engineers through On-the-Job Training (OJT)

Training Subject 4: Operation troubleshooting

Purpose:

- To protect TPP equipment.

Training Items:

- Training operation staff to safe equipment during .startup in normal and emergency shutdown.

Important Points:

- start & stop equipment according to manufacture procedure.
- safe shutdown during trips.

Detailed Plan of OJT for Objective 1

Arab Republic of Egypt
Electricity Sector

To improve Skills of Engineers through On-the-Job Training (OJT)

Training Subject 5: Industrial Safety

Purpose:

- To improve safety at work

Training Items:

- Support engineers to organize safety training

Important Points:

- wearing a safety belt and experiencing a suspended load
- experience of climbing up and down stepladder
- experience of lifting & transport heavy loads
- experience of impact of falling object on helmet
- experience of getting caught in rotating objects
- experience of risk of electrical shock

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Detailed Plan of OJT for Objective 2

Arab Republic of Egypt
Electricity Sector

To make sure the OJT for technicians is organized smoothly

Training Subject 1: Support technicians

Purpose:

- Support technicians to apply their action plan

Training Items:

- supply them by data, tools and organize work to give them some time to apply their action plan.

Important Points:

- follow up and motivate them

Detailed Plan of OJT for Objective 3

Arab Republic of Egypt
Electricity Sector

Prevention of Human Errors

Training Subject 1: Prevention of Human Errors

Purpose:

- To prevent Human Errors

Training Items:

- learning & discussion human factors to reduce human errors
- learning & discussion about negative effect of human errors on TPP
- Reduce influence of human errors

Important Points:

- limitation of human senses
- increase awareness on importance of human life
- Reducing of economic loss.
- creative methods to reduce human errors

Detailed Plan of OJT for Objective 4

Arab Republic of Egypt
Electricity Sector

To Improve the Key Performance Index (KPI) for employees & equipments

Training Subject 1: Human Resource Development

Purpose:

- To improve the skills of employees

Training Items:

- Operation, Maintenance, Water Treatment and Technical Affairs of power plant
- Weekly test
- Training in the field.
- Simulator training.
- Solving problems.
- Visits to other power plants in the same company and in other companies.
- Visit to National Energy Dispatch Center.

Detailed Plan of OJT for Objective 4

Arab Republic of Egypt
Electricity Sector

Important Points:

- Basic informations
- things learned
- to see another types of TPP
- to see How is the work in National Energy Dispatch Center

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Detailed Plan of OJT for Objective 4

Arab Republic of Egypt
Electricity Sector

To Improve the Key Performance Index (KPI) for employees & equipments

Training Subject 2: Implementation of Preventive Maintenance with Fault Tree Analysis

Purpose:

- To improve the Key Performance Index (KPI) of GT/ST/HRSG

Training Items:

- Make FTA charts for some typical faults/troubles.
- Refer the FTA charts every time when faults/troubles occur in order to analyze the causes.
- Make additional FTA chart every time when special troubles occur and accumulate FTA charts.

Important Points:

- equipments, data and systems affected due to troubles

Detailed Plan of OJT for Objective 4

Arab Republic of Egypt
Electricity Sector

To Improve the Key Performance Index (KPI) for employees & equipments

Training Subject 3: Implementation of Heat Efficiency Management by analyzing data

Purpose:

- To improve the Key Performance Index (KPI) of GT/ST/HRSG

Training Items:

- Determine the standard value of heat efficiency of boiler/turbine/condenser
- Collect the data of heat efficiency
- Analyze the data to see if there are any deviations.
- Find out the causes
- Feed back with new values
- Continue to implement from Collecting data to Find out the causes once a month

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Detailed Plan of OJT for Objective 4

Arab Republic of Egypt
Electricity Sector

Important Points:

- Standard values need to be determined on the fixed load.
- Load - energy - fuel - operating hours - ……
- See if any notable deviations between standard values and actual values.
- To reduce or prevent the repeat of such an action
- fuel - air - …
- To adjust the Performance of TPP

Detailed Plan of OJT for Objective 4

Arab Republic of Egypt
Electricity Sector

To Improve the Key Performance Index (KPI) for employees & equipments

Training Subject 4: Implementation of Sustainable Management Cycle

Purpose:

- To improve the Key Performance Index (KPI) of GT/ST/HRSG

Training Items:

- Record the events of failures/troubles each time.
- Analyze the records periodically
- Identify the Root Causes and solve them
- Make the whole process from first point to third point routine and official.

Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance (Engineers)

Detailed Plan of OJT for Objective 4

Arab Republic of Egypt
Electricity Sector

Important Points:

- When, what, why it happened and how to repair
- Condition (data logging)
- Heat rate/Fuel consumption rate
- Whether the same equipment failed
- See if there are some tendency towards failure.
- Whether the Heat rate getting worse.
- To reduce or prevent the repeat of such an action.
- Activities should be repeatable by being incorporated in the organizational structure.

■**Detailed Plan of OJT for Objective 1: To Improve Skills of Engineers through On the Job Training (OJT)**

NO.	Training Subject	Purpose	Training Item		Effect	Important Points	Trainer	Where	How	Tools	Achievements		2018			2019									Remarks
													OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
1	Service Life Diagnosis	(1) To understand the outline of Service Life Evaluation (2) To understand the various type of deterioration events of Thermal Power plant (3) To understand the evaluation methods and their process (4) To understand important check points for evaluation	1-1	Purpose of Service Life Evaluation	(1)/(2)	- Why Service Life Evaluation is important	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA) - O&M Manual (provided by manufacturers)	Plan	No. of times			1										
												No. of participants			5										
											Result	No. of times													
												No. of participants													
			1-2	Main Deterioration Events and their Mechanism of Deterioration	(2)	- What are the main damage factors - How each damage factor causes what kind of damage on where.	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA) - O&M Manual (provided by manufacturers)	Plan	No. of times			1										
												No. of participants			5										
											Result	No. of times													
												No. of participants													
			1-3	Service Life Diagnosis Methods	(2)/(3)	- Where & how to check the damage, according to the kinds of damage	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA) - Manual (provided by manufacturers)	Plan	No. of times			1										
												No. of participants			5										
											Result	No. of times													
												No. of participants													
2	Vibration	(1) To understand the mechanism of vibration (2) To understand the important checking points.	2-1	Basics of Vibration	(1)	- How vibrations occur.	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA)	Plan	No. of times				1									
												No. of participants				5									
											Result	No. of times													
												No. of participants													
			2-2	Analysis of Vibration	(1)/(2)	- How to read and follow up the vibration trend and take action.	JICA-trained participant	TPP	Practical training	- Textbook (provided by JICA)	Plan	No. of times				1									
												No. of participants				5									
											Result	No. of times													
												No. of participants													
3	HRSG Problems	(1)FAC phenomena & Main causes. (2)How to prevent FAC (3)How to fix FAC damages	3-1	Basic of flow accelerated corrosion(FAC)	(1)	- How FAC occurs	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA)	Plan	No. of times					1								
												No. of participants					5								
											Result	No. of times													
												No. of participants													
			3-2	Factors affect FAC	(2)	- How to prevent FAC	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA) -Damage pipes due to FAC	Plan	No. of times					1								
												No. of participants					5								
											Result	No. of times													
												No. of participants													
			3-3	Repair methods	(3)	- How to repair the damage	JICA-trained participant	TPP	Practical training	- Textbook (provided by JICA)	Plan	No. of times					1								
												No. of participants					5								
											Result	No. of times													
												No. of participants													

■**Detailed Plan of OJT for Objective 1: To Improve Skills of Engineers through On the Job Training (OJT)**

NO.	Training Subject	Purpose	Training Item		Effect	Important Points	Trainer	Where	How	Tools	Achievements		2018			2019										Remarks
													OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
4	Operation troubleshooting	(1)To protect TPP equipment.	4-1	Training operation staff to safe equipment during startup in normal and emergency shutdown	(1)	start&stop equipment according to manufacture procedure safe shutdown during trips	JICA-trained participant	TPP	Lecture	- Manual (provided by manufacturers)	Plan	No. of times						1							
												No. of participants						5							
											Result	No. of times													
												No. of participants													
5	Industrial Safety	To improve safety at work	1	Support other engineers to organize safety training	1	- wearing a safety belt and experiencing a suspended load - experience of climbing up and down stepladder - experience of lifting & transport heavy loads - experience of impact of falling object on helmet - experience of getting caught in rotating objects - experience of risk of electrical shock	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA)	Plan	No. of times						1							
												No. of participants						5							
											Result	No. of times													
												No. of participants													

■**Activities for the Objective2: To make sure the OJT for technicians is organized smoothly**

NO.	Activities	Purpose	Detailed Actions		Important Points	Who to lead	Where	How	tools	Achievements		2018			2019										Remarks
												OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
1	Support technicians	Support technicians to apply their action plan	1	supply them by data,tools and organize work to give them some time to apply their action plan.	follow up and motivate them	JICA-trained technicians	TPP	support	- Textbook (provided by JICA)	Plan	No. of times							1							
											No. of participants							10							
										Result	No. of times													
											No. of participants													

■**Activities for the Objective 3: Prevention of Human Errors**

NO.	Activities	Purpose		Detailed Actions	Important Points	Who to lead	Where	How	tools	Achievements		2018			2019										Remarks
												OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
1	Prevention of Human Errors	To prevent Human Errors	3-1	learning & discussion human factors to reduce human errors	-limitation of human senses	JICA-trained technicians	TPP	Lecture	- Textbook (provided by JICA)	Plan	No. of times								1					
											No. of participants								5					
										Result	No. of times													
											No. of participants													
			3-2	learning & discussion about negative effect of human errors on TPP	-increase awareness on importance of human life -Reducing of economic loss.	JICA-trained technicians	TPP	Lecture	- Textbook (provided by JICA)	Plan	No. of times								1					
											No. of participants								5					
										Result	No. of times													
											No. of participants													
			3-3	Reduce influence of human errors	-creative methods to reduce human errors	JICA-trained technicians	TPP	Practical training	- Textbook (provided by JICA)	Plan	No. of times								1					
											No. of participants								5					
										Result	No. of times													
											No. of participants													

■**Detailed Action Plan for Objective 4: To Improve the Key Performance Index (KPI) for employees & equipment**

NO.	Activities	Purpose	Detailed Actions		Important Points	Who to lead	Where	How	tools	Achievements		2018			2019										Remarks
												OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
1	Human Resource Development	To improve the skills of employees	1-1	- Operation, Maintenance, Water Treatment and Technical Affairs of power plant '- Weekly test	Basic informations	Technical affairs department in TPP under supervision of Head of Technical Affairs Sector for Production Companies (JICA-trained participant)	TPP	Lecture	- Textbook (provided by JICA) - O&M Manual (provided by manufacturers) - Past experience of TPP engineers	Plan	No. of times				1										
			1-2	- Training in the field. '- Simulator training. '- Solving problems.	things learned in('1-1)			Practical training			No. of participants				5										
			1-3	- Visits to other power plants in the same company and in other companies. '- Visit to National Energy Dispatch Center.	to see another types of TPP How is the work in National Energy Dispatch Center			Observation		Result	No. of times														
											No. of participants														
2	Implementation of Preventive Maintenance with Fault Tree Analysis	To improve the Key Performance Index (KPI) of GT/ST/HRSG	2-1	Make FTA charts for some typical faults/troubles.	equipment, data and systems affected due to troubles	Maintenance engineers and Technical affairs engineers at TPP with the help and support of Head of Technical Affairs Sector for Production Companies (JICA-trained participant)	TPP	Lecture and Practical training	- Monitoring indicator is number of FTA charts newly made after this training. - Please confirm the number in the monthly meeting																	
			2-2	Refer the FTA charts every time when faults/troubles occur in order to analyze the causes.																					
			2-3	Make additional FTA chart every time when special troubles occur and accumulate FTA charts.																					

■**Detailed Action Plan for Objective 4: To Improve the Key Performance Index (KPI) for employees & equipment**

NO.	Activities	Purpose	Detailed Actions		Important Points	Who to lead	Where	How	tools	Achievements	2018			2019									Remarks
											OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
3	Implementation of Heat Efficiency Management by analyzing data	To improve the Key Performance Index (KPI) of GT/ST/HRSG	3-1	Determine the standard value of heat efficiency of boiler/turbine/condenser	- Standard values need to be determined on the fixed load.	Technical affairs engineers and Operation engineers at TPP with the help and support of Head of Technical Affairs Sector for Production Companies (JICA-trained participant)	TPP	Lecture and Practical training	- Please confirm whether the process of 3-2 to 3-4 is properly implemented at each TPP in the monthly meeting - If not properly implemented, please advise the Tipp's responsible organization.														
			3-2	Collect the data of heat efficiency.	Load - energy - fuel - operating hours - ……																		
			3-3	Analyze the data to see if there are any deviations.	See if any notable deviations between standard values and actual values.																		
			3-4	Find out the causes	- To reduce or prevent the repeat of such an action																		
			3-5	Feed back with new values	fuel - air - …																		
			3-6	Continue to implement from 3-2 to 3-4 once a month.	- To adjust the Performance of TPP																		
4	Implementation of Sustainable Management Cycle	To improve the Key Performance Index (KPI) of GT/ST/HRSG	4-1	Record the events of failures/troubles each time.	- When, what, why it happened and how to repair - Condition (data logging) - Heat rate/Fuel consumption rate	Maintenance engineers and Technical affairs engineers at TPP with the help and support of Head of Technical Affairs Sector for Production Companies (JICA-trained participant)	TPP	Lecture and Practical training	- Please confirm whether the process of 4-1 to 4-3 is properly implemented at each TPP in the monthly meeting - If not properly implemented, please advise the TPP's responsible organization.														
			4-2	Analyze the records periodically	- Whether the same equipment failed - See if there are some tendency towards failure. - Whether the Heat rate getting worse.																		
			4-3	Identify the Root Causes and solve them	- To reduce or prevent the repeat of such an action																		
			4-4	Make the whole process (4-1 to 4-3) routine and official.	- Activities should be repeatable by being incorporated in the organizational structure.																		

The second survey itinerary

Date	Time	Venue/aim	Counterpart	Accomodation
22/06/2019(Sat)	23:45-04:50	Move (KIX—DXB)	—	Night Flight
23/06/2019(Sun)	08:15-10:05	Move (DXB - CAI)	—	Cairo
24/06/2019(Mon)	11:00-12:00	[Destination]JICA Egypt Office [Purpose] Prepaaration meeting with JICA Egypt staff members	JICA	Cairo
25/06/2019(Tue)	11:00-14:00	[Destination]WDEPC Office [Purpose]Explanation of the project, information gathering and interviews with JICA-trained participants	WDEPC (Alexandria)	Cairo
26/06/2019(Wed)	11:00-14:00	[Destination]MDEPC Office [Purpose]Explanation of the project, information gathering and interviews with JICA-trained participants	MDEPC (Talkha)	Cairo
27/06/2019(Thu)	11:00-14:00	[Destination]UEEPC ffice [Purpose]Explanation of the project, information gathering and interviews with JICA-trained participants	UEEPC (Kuriemat)	Cairo
28/06/2019(Fri)	All	Document Preparation	—	Cairo
29/06/2019(Sat)	All	Document Preparation	—	Cairo
30/06/2019(Sun)	All	Document Preparation	—	Cairo
01/07/2019(Mon)	10:00-13:00	[Destination]CEPC Office [Purpose]Explanation of the project, information gathering and interviews with JICA-trained participants	CEPC (Cairo)	Cairo
02/07/2019(Tue)	14:00-15:00	[Destination]JICA Egypt Office [Purpose] Pre-meeting for Wrap up meeting	—	Cairo
03/07/2019(Wed)	10:00-12:00	[Destination]EEHC Office [Purpose]Wrap up meeting and MoM signing	EEHC (Cairo)	Night Flight
	18:40-0:25	Move (CAI－DXB)	—	
04/07/2019(Thu)	3:40-17:50	Move (DXB－KIX)	—	—

Attendance list in the second survey hearing on Action Plan

Venue	!st/2nd	Name	Responsible field	Title	Attendance
CEPC	1st	Mr.BADERELDINE Moustafa Esmat Ahmed	Gas Turbine Maintenance	Engineer	✓
	1st	Mr.IBRAHEM Ayman Ibrahem Mohamed	Turbine Maintenance	Engineer	✓
	1st	Mr.MEWAFY Abdelrahman Saad Abdelrahman	Turbine Maintenance	Engineer	Due to another business
	1st	Mr.MOHAMED Emad Abdelrahim Rashidy	Turbine Maintenance	Technician	✓
	1st	Mr.IBRAHEM Khtab Ragab	Turbine Maintenance	Technician	Due to another business
	1st	Mr.SHAHIN Mohamed Said Elsayed	Turbine Maintenance	Technician	✓
	2nd	Mr.HASSAN Ahmed Hassan Farag	Operation Engineer	Engineer	✓
	2nd	Mr.AWWAD Hassan Awwad Hassan	Operation Technician	Technician	✓
	2nd	Mr.FARAG Mahmoud Aly Abdellatif	Operation Technician	Technician	✓
	2nd	Mr.ELSAYYAD Amr Mohamed Hamdy Abdelazim	Technician	Technician	✓
MDEPC	1st	Mr.SAAD Ayman Saad Azer	Operation Management.	Engineer	✓
	1st	Mr.ELSAEIDY Ibrahim Ahmed Osman	Mechanical Maintenance	Engineer	✓
	1st	Mr.KALIFA Mohamed Helal	Turbine Maintenance	Technician	✓
	1st	Mr.ABDELHAFEZ Elshahat Abdalla	Mechanical	Technician	✓
	2nd	Mr.EMARA Ahmed Elsayed Azzazi	Gas Turbine Mec.Maint.Eng.	Engineer	✓
	2nd	Mr.YOUNIS Ibrahim Mohamed Shabana	Lead Operation Eng.	Engineer	✓
	2nd	Mr.MOUSA Ali Abouzeid Mousa Abouzeid	Gas Turbine Mec.Maint.Eng.	Technician	✓
	2nd	Mr.BAYOUMI Ali Ghanem Ali	Comb.Cycl.Oper.Techn.	Technician	✓
WDEPC	1st	Mr.ELSHEKH Mohamed Hamdy Ibrahim Abdelmak	Turbine Maintenance	Engineer	Due to another business
	1st	Mr.ABDELHAMID Tarek Moustafa Mohamed	Operation Dept.	Engineer	Due to job change
	1st	Mr.AWAD Abdelmoneim Ali Ahmed Mohamed	Mechanical Maintenance	Engineer	✓
	1st	Mr.ABDELAAL Omar Mohamedyoussef	Turbine Maintenance	Technician	✓
	1st	Mr.BASHA Ashraf Abdelaziz	Turbine Maintenance	Technician	✓
	1st	Mr.ELTAHAN Mohamed Abdallah	Turbine Maintenance	Technician	✓
	2nd	Mr.NAKHLA Essam Attia Nagib	Director of Boiler Dept	Engineer	✓
	2nd	Mr.KAMAR Tamer Farouk Aly Hassan	Shift Charge Engineer	Engineer	✓
	2nd	Mr.TELEB Farag Elsayed Ibrahim	Shift Charge Engineer	Engineer	✓
	2nd	Mr.GABALA Mohamed Ibrahim Abdelaziz	Technical Supervisor	Technician	✓
	2nd	Mr.ASHERY Mohamed Abdelmotaleb Mohamed Mansour	Technical Supervisor	Technician	✓
	2nd	Mr.ALY Mohamed Moustafa Mohamed	Technical Supervisor	Technician	✓

Venue	!st/2nd	Name	Responsible field	Title	Attendance
UEEPC	1st	Mr.KAOUD Mekhaimer Abozeid Mekhaimer	Maint.Dept.of Water Treat.	Engineer	Due to another business
	1st	Mr.TAWFIK Mohamed Aboueleyoun Hassan Oraby	Maint.Dept.of Boiler	Engineer	Due to another business
	1st	Mr.ABBAS Amir Kamal Abdellatif	Turbine Maintenance	Technician	Due to another business
	1st	Mr.ELIAN Samir Ayesh Abdelazim	Mechanical Maintenance	Technician	✓
	1st	Mr.MOHAMED Sayed Ali Mahmoud	Mechanical Maintenance	Technician	✓
	2nd	Mr.FAYED Mohamed Korany Mohamed	Maintenance Manager Eng	Engineer	✓
	2nd	Mr.MOHAMED Ahmed Mohamed Abdelmohsen	Mechanical Maint.Eng.	Engineer	✓
	2nd	Mr.SALEH Khaled Sayed Mohamed	Mechanic. Maint.Supervisor	Technician	✓
	2nd	Mr.TAHA Walid Mohamed Mahmoud Mohamed	Operation Technician	Technician	✓

Minutes of Meeting
for
The Second Wrap-Up Meeting
on
The Project for Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance
between
Japan International Cooperation Agency
and
The Government Of Arab Republic Of Egypt

Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the follow-up mission (hereinafter referred to as "the Mission") for "The Project for Capacity Building & Strengthening of Thermal Power Generation Operation & Maintenance" (hereinafter referred to as "the Project") to discuss the detail of the Project with the officials of Egyptian Electricity Holding Company (hereinafter referred to as "EEHC") for the effective and successful implementation.

The JICA Mission and the officials of EEHC hereby confirmed the result of discussions in the wrap up meeting (hereinafter referred to as "the Meeting") on 3rd July 2019, at EEHC Head Office, chaired by Eng. Gaber Desouki Moustafa, the chairman of EEHC.

As a result of discussions in the Meeting, the Japanese side and Egyptian side have confirmed the main items described in the Annex.

Cairo, 3rd July 2019

Mr. Hiroki Hirahata
JICA Expert / Chief Advisor

Eng. Gaber Desouki Moustafa
Chairman
Egyptian Electricity Holding Company

ANNEX

1. Progress of the Project

The JICA Expert Team has explained the scope of works, the work flowchart, overall schedule and the progress made after the first wrap-up meeting including the second training courses in Japan implemented from November to December 2018. The JICA Expert Team requested further support from the Egyptian side for the implementation and monitoring of Action Plans by JICA-trained engineers & technicians, even after finishing the Project.
The Egyptian side acknowledged the contents of the explanation and agreed to meet the request from the JICA Expert Team.

2. Results of the Mission

(1) Outline of the Mission

The JICA Expert Team implemented the Mission on Egypt from 25th June to 3rd July 2019, to achieve the below purposes;

- ✓ Reviewing the activities that JICA-trained engineers & technicians disseminated their knowledge and skills obtained to the training course to other colleagues at thermal power plants (hereinafter referred to as "TPPs"),
- ✓ Discussing current situation for further improvement of O&M at TPP as the next action.

The JICA Expert Team made presentation about each topic based on Attachment 2.

(2) Result of the review of Action Plan Implementation

The JICA Expert Team explained the result of review of Action Plan implementation as follows. Egyptian side confirmed the contents.

(Actual Conditions)

- ✓ JICA-trained engineers & technicians implemented their Action Plan almost as previously arranged, and a series of their dissemination activities can help to improve the Operation and Maintenance (hereinafter referred to as "O&M") capacity at TPPs.
- ✓ They disseminated their knowledge and skills to their colleagues by mainly utilizing training materials provided by JICA Expert Team, on small unit basis, from a practical viewpoint.
- ✓ Operation team and maintenance team started to communicate with each other after the training program in Japan, and it helped them to enhance their knowledge and skills of operation and maintenance.
- ✓ Technicians started training for safety, and the effect is that they were able to complete two overhaul works without any accidents and injuries.
- ✓ Engineers applied the useful knowledge acquired in Japan to actual

work, such as Operation troubleshooting, Human Error Reduction and Non Destructive Tests

- ✓ Despite of hard tasks during major overhaul, some of them made the most of the limited opportunities of disseminating their knowledge; vibration analysis and HRSG (Heat Recovery Steam Generator) maintenance were especially useful and effective to them because these contents could meet their O&M needs directly.
- ✓ On the other hand, their various duties in each workplace often seem to restrict them to implement the action plan.
- ✓ For some action plan item, technicians need more training equipment such as welding, large size valves.

(Suggestion from JICA Expert Team)

- ✓ JICA Expert Team would like to request Egyptian side for the further understanding and continuous support for Action Plan implemented by JICA-trained engineers & technicians, even after the Project.
  - ➢ Coordinating Engineers/Technicians work to implement their Action Plan as planned.
  - ➢ Preparing necessary equipment and materials for Action Plan implementation.

(3) Result of the discussion for further improvement of O&M

The JICA Expert Team explained the result of discussion of current situation for further improvement of O&M at TPPs as follows. Egyptian side took note of it.

- ✓ The JICA Expert Team comprehensively analyzed the O&M issues of TPPs in Egypt and identified the countermeasures (not limited to Action Plan).
- ✓ As for the O&M issues that JICA-trained engineers and technicians can deal with, almost all of the countermeasures are covered with O&M training course in Japan and their Action Plan.
- ✓ On the other hand, through discussion with management/ JICA-trained engineers and technicians, there are other O&M issues to be involved by management.
- ✓ Management are expected to take the following countermeasures:
  - ➢ Sharing information on technical failures/troubles and labor accident with not only management, but also engineers and technicians.
  - ➢ Adopting evaluation system based on technical knowledge and skills for engineers and technicians, not only depending on the length of work.

3. Conclusion

Based on the implementation of the capacity building project for O&M at TPPs for around 2 years, the JICA Expert Team concluded that the Project is practical and effective to improve O&M capacity, and suggested that Egyptian side to implement the following contents for further improvement of O&M at TPPs.

- ✓ Practice makes perfect,
- ✓ Self-disciplined learner,
- ✓ Insatiable challenge.

Attachment 1 Attendance List in the Wrap-Up Meeting
Attachment 2 Presentation Materials
Attachment 3 Minutes of Meetings during the Mission

Capacity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

Wrap-up Meeting Attendance List

Date: 3rd / July / 2019

Time: 10 : 10 - 11 : 30

Place: EEHC Office

No.	Name	Position	Company	Signature
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Wrap-up Meeting Attendance List

No.	Name	Position	Company	Signature

Page: 2/2 E

Kansai Electric Power
power with heart

OVERVIEW of FINAL REPORT (Draft)

July 2019

Japan International Cooperation Agency (JICA)

The Kansai Electric Power Co., Inc.

Contents

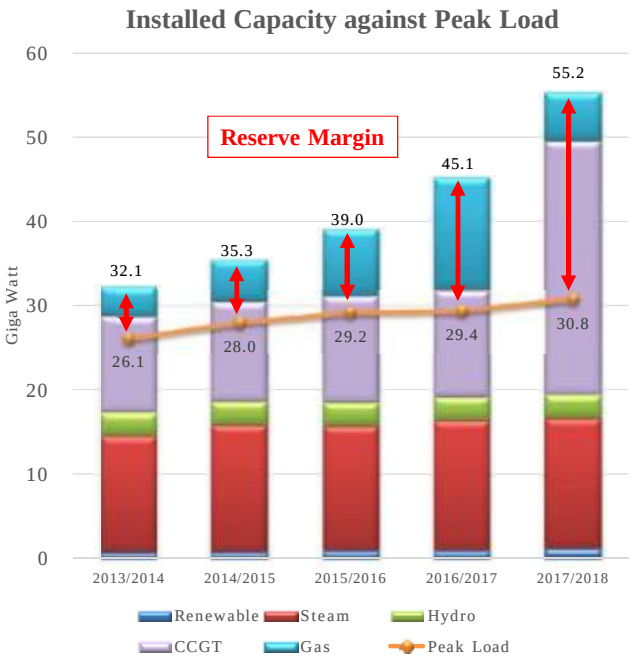
1. Background: Power Supply and Demand in Egypt

3

No additional thermal power plants are needed under the 8th Five-Year Plan (2017-2022), EEHC (2017/18*1)

Current Situation

- **Meeting the peak load** in 2017/2018 that reached 30.8GW without load shedding.
- **Increase of total installed capacity** to the unified national grid up to 55.2GigaW, including Fast Track Plan and Siemens Project.
- Consequently, progressive **increase of reserve margin** relative to peak load.



*1: EEHC Annual Report 2017/2018

1. Background: Diversifying Generation Capacity Mix

4

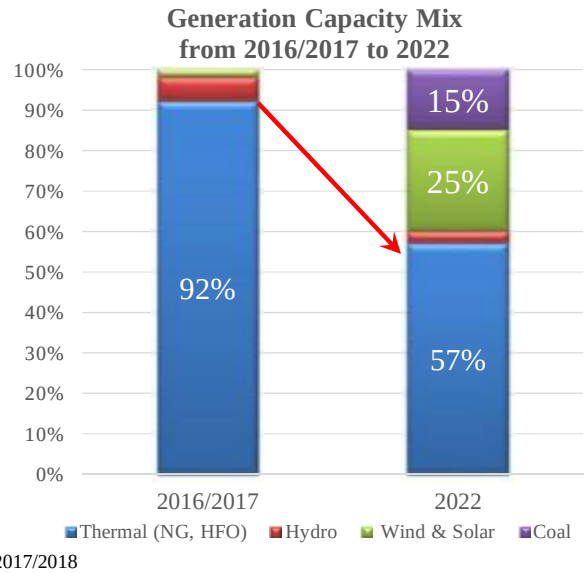
Current Situation*1

- **Excessive reliance on thermal assets** (90+% of installed capacity)
- Frequent power outages due to natural gas and fuel shortage

Various countermeasures to **overcome the undiversified power generation mix** taken by EEHC.

Recent Activity for Improving Energy Mix

- **The renewable energy** will generate over 20% of electricity.
- **Combined Cycle power plant, Clean coal thermal power plant** and **Pump & Storage Power** will be installed.
- **Nuclear power plant** will be installed.



*1: MoERE Addressing Egypt's Electricity Vision 2015, : EEHC Annual Report 2017/2018

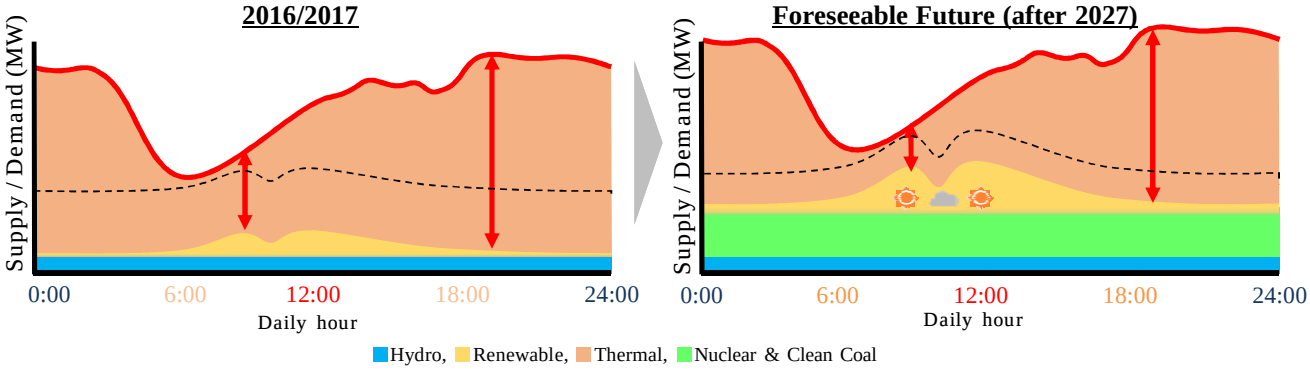
1. Background: Drastic Change in Role of TPPs

5

In the near future, many existing thermal power plants are increasingly required to **switch the operation from base & cyclic to peak (including standby reserve)**.

Main Dominant Factors:

- ü Recent peak load growth relatively stable.
  - ➡ **No more drastic change in demand growth expected in next decade.**
- ü Brand-new clean coal/nuclear power plant as base load operation.
- ü Positive installation of intermittent renewable energy sources.



1. Background: Foreseeable Issues in O&M at TPPs

6

Foreseeable Critical Issues (O&M needs)

- ü Frequent Partial Load
  - ➡ **Thermal efficiency deteriorates at the partial load** because power plants are designed to attain the best performance at the rated output
- ü Frequent Start-up & Shut-down
  - ➡ TPPs suffer from not only creep damage at base & moderate cyclic operation but also **fatigue damage at intense cyclic & peak operation**.
- ü 1/3 installed capacity is over 20 years.
  - ➡ **Aging impact on O&M quality and cost** (especially major overhaul)
- ü Increase in Standby Reserve
  - ➡ Standby reserve TPPs require some amount of fixed O&M cost.

ü Considering the current situation, EEHC is expected to **improve plant performance** and **respond to peak demand fluctuation:**
Thermal efficiency, availability factor and unplanned outage rate etc.

1. Background: Why is O&M at TPPs important?

7

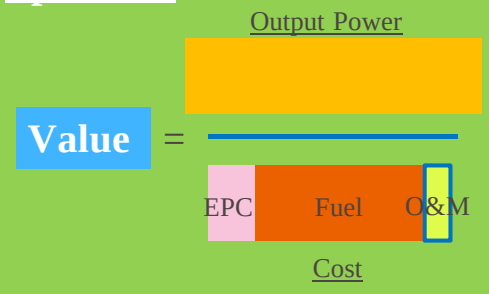
Ø *What value does EPCO create?*

$$\text{Value} = \frac{\text{Output}}{\text{Input}} = \frac{\text{Output Power (kWh)}}{\text{Cost (\$)}}$$

[=CAPEX+ OPEX (Fuel, O&M)]

Ø *Why is adequate O&M at TPPs important?*

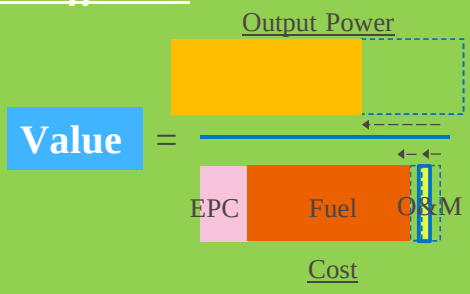
Optimized *O&M*



From a long-term viewpoint, **proper O&M can lead to optimize the value.**

>

Insufficient *O&M*



Insufficient O&M can cause **frequent forced outage, deteriorating efficiency.**

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2. Project Summary: Capacity Building for O&M at TPPs 9

This JICA project aims to implement capacity building for O&M at TPPs in order to make continuous technical support for MoERE/EEHC.

Project Purpose

Overall Goal	Capacity of O&M of Thermal Power Plants (TPPs) is strengthened.
Project Goal	Training capacity on O&M of EEHC is strengthened.

Project Output

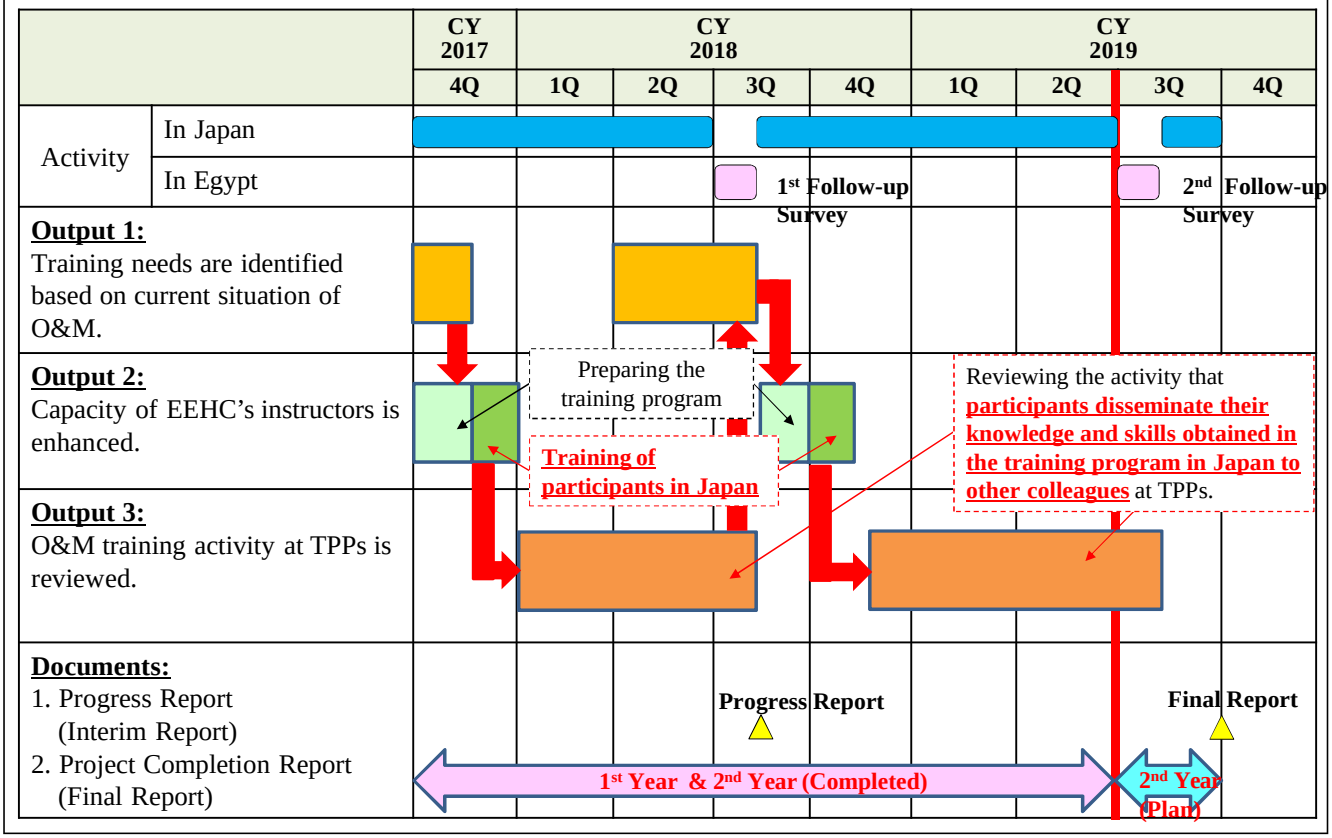
Output 1	Training needs are identified based on current situation of O&M.
Output 2	Capacity of EEHC instructors is enhanced.
Output 3	O&M training activity at TPPs is reviewed.

2. Project Summary: Capacity Building for O&M at TPPs 10

Targeted Type of Power Generation	Gas Turbine Combined Cycle (GTCC)
Project Sites	EEHCs' Thermal Power Plants (TPPs) in Cairo and its suburbs
Counterpart	Ministry of Electricity and Renewable Energy (MoERE), Egyptian Electricity Holding Company (EEHC), Cairo Electricity Production Company (CEPC), Middle Delta Electricity Production Company (MDEPC), West Delta Electricity Production Company (WDEPC) and Upper Egypt Electricity Production Company (UEEPC) etc.
Beneficiaries	O&M instructors of EEHC and its trainees (Engineers & Technicians)
Duration	October 2017 – September 2019 (2 years)

2. Project Summary: Work Flowchart

11



2. Project Summary: 2nd Follow-up Survey

12

We visited MoERE/EEHC & each Electricity Production Company (EPC) as follows.

Date		Events			
25-June	Tue.	Alexandria	Meeting with management and JICA-trained participants (engineers & technicians)	WDEPC	
26-June	Wed.	Talkha		MDEPC	
27-June	Thu.	Kuriemat		UEEPC	
1-July	Mon.	Cairo		CEPC	
2-July	Tue.	Cairo	Pre-Meeting	JICA	
3-July	Wed.	Cairo	Wrap-up Meeting	MoERE/EEHC	

According to the following agenda, **we divided the meeting into 3 groups** at each EPC site.

Counterpart	Agenda
1.Management	Ø Final report presentation Ø Discussion about potential needs of technical support as the next phase.
2.JICA-trained engineers	Ø Reviewing the training activity implemented by JICA-trained participants. Ø Discussion about issue analysis of O&M at TPPs. Ø Additional lectures: Air Cooled Condenser (ACC) & Tool Box Meeting (TBM)
3.JICA-trained technicians	

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1. Background: Why is O&M at TPPs important?
2. Project Summary: Capacity Building for O&M at TPPs
3. **O&M Training in Japan (2nd Year Completed: 2018)**
4. Action Plan Implementation
5. Issue Analysis of O&M in TPP
6. Conclusion

3. O&M Training in Japan: Overall Framework

14

Job Report Presentation: Participatory (Active)
To grasp actual condition of O&M at TPPs.

Lecture & practical training at KANSAI's Training Center: Passive
To learn each essence on the training program and how to teach them to others efficiently.

Site visit to Kansai's TPPs and Japanese manufacturer's factory: Passive
To understand high-level safety & quality management at their sites directly.

Workshop for Issue Analysis: Participatory (Active)
To analyze current issues, in logical manner, especially on the cause & effect basis.

Action Plan Presentation: Participatory (Active)
To make action plan for disseminating their knowledge & skills obtained in the training program in Japan to other colleagues.

3. O&M Training in Japan: Mechanical Maintenance

15

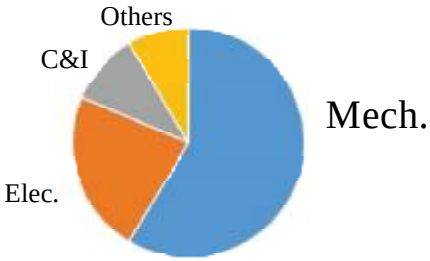
For improving O&M in TPPs, We KANSAI focused on energy management (Common), especially **Mechanical Maintenance**.

(1) Failure impact

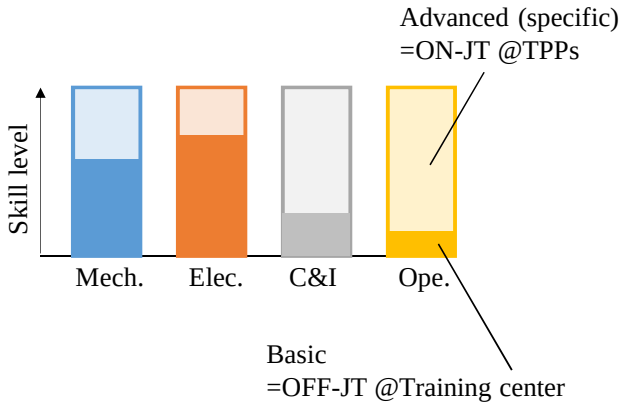
Mechanical ≒ Electrical > C&I

(except for the causes of miss operation)

(2) Maintenance budget



(3) ON-JT and OFF-JT



3. O&M Training in Japan: Training Program in 2018

16

	Engineers	Technicians
Energy Management (Common)	ü Introduction of the latest technology in TPP (inc. USC)	ü Introduction of the latest technology in TPP (inc. USC)
	ü Experience-based Safety Training → 17	ü Experiential Safety Training
	ü Human Resource Development → 18	ü Experiential Quality Training
	ü Quality Management	ü Prevention of Accidents and Disasters
	ü Thermal Efficiency Management	ü Occupational HSE (especially Safety)
	ü Lessons Learned from Accidents	
	ü Human Error Prevention	
	ü Effective Maintenance for Quality Electric Power Infrastructure	
Mechanical Maintenance	ü Maintenance of GTCC	ü General System and Outline of GTCC
	ü Remaining Life Assessment (advanced)	ü Maintenance of High Temperature and High Pressure Piping
	ü Feed Water Treatment	ü Overhauling Rotary Pumps
	ü Basic Training of Vibration (Balancing)	ü Metal Material
	ü Non-Destructive Inspection	ü Basics of Non-Destructive Inspection Skills
	ü Welding Quality Management in Japan (inc. Welding Defect)	ü Welding Procedure Management
Site Visit	ü Site Visit on TPP and Manufacture's factory → 19	ü Site Visit on TPP and Manufacture's factory → 19
JICA Original	ü Issue Analysis	ü Issue Analysis
	ü Methodology to Formulate Action Plan → 20	ü Methodology to Formulate Action Plan → 20

3. O&M Training in Japan: Course Examples (1)

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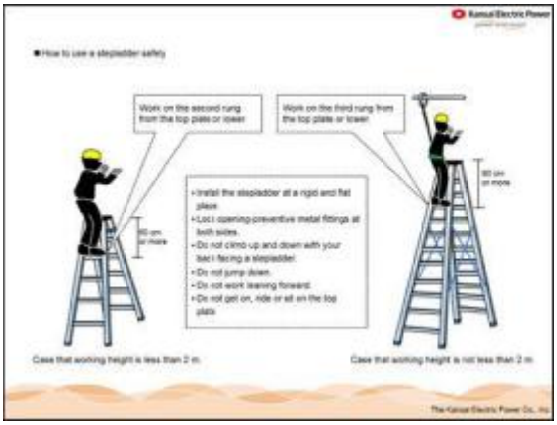
Example: Experience-based Safety Training (Practical Training)

Training Item

Safety training using following;
1. Ladder
2. Safety belt
3. Electric shock
4. Be caught by rotation
5. Helmet

Training Materials



Effects of Training:

- ü **Can understand the importance of labor safety and equipment safety**
- ü **Can improve capability to properly use safety equipment ready for emergency situations**

3. O&M Training in Japan: Course Examples (2)

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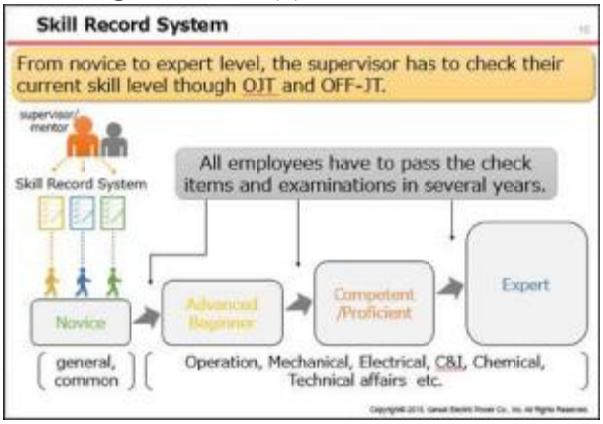
Example: Human Resource Development in Kansai (Lecture)

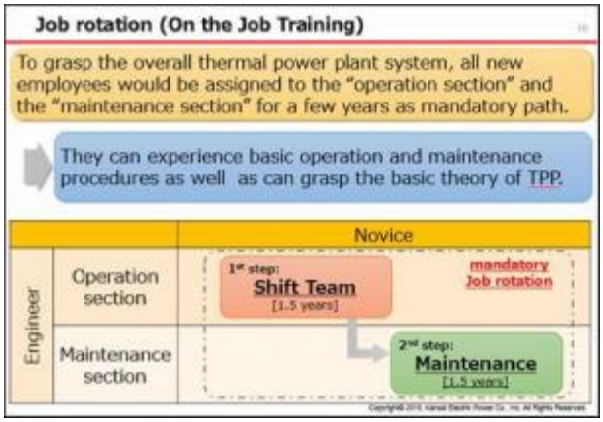
Training Item

Introduction of KANSAI's Human Resource Development
- Overall HRD structure
- Induction Training
- Refresher Training
- Training Philosophy and Contents

Training Materials (1)



Training Materials (2)



Effects of Training:

- ü **Can grasp HRD current situation in Japanese electrical power company**
- ü **Can find out the hints for improving HRD structure in Egypt**

3. O&M Training in Japan: Course Examples (3)

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Example: Tour of Himeji No.2 TPP (Site Visit)

About Himeji No.2 TPP

1. Largest TPP of KANSAI (4,119 MW)
2. Introduced latest GTCC technology, and achieved high thermal efficiency of 60%
3. LNG terminal is adjacent to TPP, and integratedly operated

Effects of Training:

- ü **Can grasp O&M current situation in Japanese electrical power company**
- ü **Can understand the 5S methodology ("Sort", "Set In order", "Shine", "Standardize" and "Sustain") and its effects on quality of work**
- ü **Can understand how to well-operate aged-facilities**

3. O&M Training in Japan: Action Plan Presentation

20

Implementing their action plan in TPPs enables **not only participants but also their colleagues** to improve their O&M knowledge & skills.

About Action Plan

- ü Participants will be core instructors, and disseminate the knowledge and skills learned during O&M Training in Japan when they come back to Egypt.
- ü Participants made and presented Action Plan which illustrates the detailed actions to improve quality of work, such as On-the-Job Training at their TPP.

Introduction of Participant's Action Plan

Engineer

1. On-the-Job training (Service life evaluation, Vibration, HRSG, Trouble shooting and Industrial safety)
2. Support technicians to implement their Action Plan
3. Prevention of Human Errors
4. Improve KPI for employee and equipment

Technician

1. Maintenance and Inspection of Pumps
2. Welding (Lecture and Practical Training)
3. Non-Destructive Inspection
4. Industrial Safety
5. Maintenance and Inspection of Valves
6. High temperature and High pressure Piping

3. O&M Training in Japan: Other Activities

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We provided the participants with comprehensive O&M training as well as **opportunities to learn Japanese culture.**

- **Japanese Language Lesson:**

- **Sightseeing in Kyoto:**
  for Engineers & Technicians

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1. Background: Why is O&M at TPPs important?
2. Project Summary: Capacity Building for O&M at TPPs
3. O&M Training in Japan (2nd Year Completed: 2018)
4. **Action Plan Implementation**
5. Issue Analysis of O&M in TPP
6. Conclusion

4. Action Plan Implementation:

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■Detailed Plan of OJT for Objective 1: To Improve Skills of Engineers through On the Job Training (OJT)

NO.	Training Subject	Purpose	Training Item		Effect	Important Points	Trainer	Where	How	Tools	Achievements		2018 OCT	2018 NOV	2018 DEC	2019 JAN	2019 FEB	2019 MAR	2019 APR	2019 MAY	2019 JUN	2019 JUL	2019 AUG	2019 SEP	Remarks
1	Service Life Diagnosis	(1) To understand the outline of Service Life Evaluation (2) To understand the various type of deterioration events of Thermal Power plant (3) To understand the evaluation methods and their process (4) To understand important check points for evaluation	1-1	Purpose of Service Life Evaluation	(1)/(2)	- Why Service Life Evaluation is important	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA) - O&M Manual (provided by manufacturers)	Plan	No. of times			1										
												No. of participants			5										
											Result	No. of times													
												No. of participants													
			1-2	Main Deterioration Events and their Mechanism of Deterioration	(2)	- What are the main damage factors - How each damage factor causes what kind of damage on where.	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA) - O&M Manual (provided by manufacturers)	Plan	No. of times			1										
												No. of participants			5										
											Result	No. of times													
												No. of participants													
			1-3	Service Life Diagnosis Methods	(2)/(3)	- Where & how to check the damage, according to the kinds of damage	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA) - Manual (provided by manufacturers)	Plan	No. of times			1										
												No. of participants			5										
											Result	No. of times													
												No. of participants													
2	Vibration	(1) To understand the mechanism of vibration (2) To understand the important checking points.	2-1	Basics of Vibration	(1)	- How vibrations occur.	JICA-trained participant	TPP	Lecture	- Textbook (provided by JICA)	Plan	No. of times				1									
												No. of participants				5									
											Result	No. of times													
												No. of participants													
			2-2	Analysis of Vibration	(1)/(2)	- How to read and follow up the vibration trend and take action.	JICA-trained participant	TPP	Practical training	- Textbook (provided by JICA)	Plan	No. of times				1									
												No. of participants				5									
											Result	No. of times													
												No. of participants													

4. Action Plan Implementation: Findings of the Mission

24

(Actual Conditions)

- JICA-trained engineers & technicians implemented their Action Plan **almost as previously arranged**, and a series of their dissemination activities can help to **improve the O&M capacity at TPPs.**
- They disseminated their knowledge and skills to their colleagues by mainly utilizing **training materials provided by JICA Expert Team**, **on small unit basis**, from a practical viewpoint.

4. Action Plan Implementation: Findings of the Mission

25

(Actual Conditions) Effect of the Action Plan

- Operation team and maintenance team **started to communicate with each other** after the training program in Japan, and it helped them to enhance their knowledge and skills of operation and maintenance.
- Technicians **started training for safety**, and the effect is that they were able to complete two overhaul works without any accidents and injuries.
- Engineers **applied the useful knowledge acquired in Japan to actual work**, such as operation troubleshooting, human error reduction and non destructive inspection.

4. Action Plan Implementation: Findings of the Mission

26

(Actual Conditions)

- Despite of hard tasks during major overhaul, **some of them made the most of the limited opportunities of disseminating their knowledge**; vibration analysis and HRSG (Heat Recovery Steam Generator) maintenance were especially useful and effective to them because **these contents could meet their O&M needs directly.**
- On the other hand, **their various duties in each workplace often seem to restrict them to implement the action plan.**
- For some action plan item, **technicians need more training equipment** such as welding, large size valves.

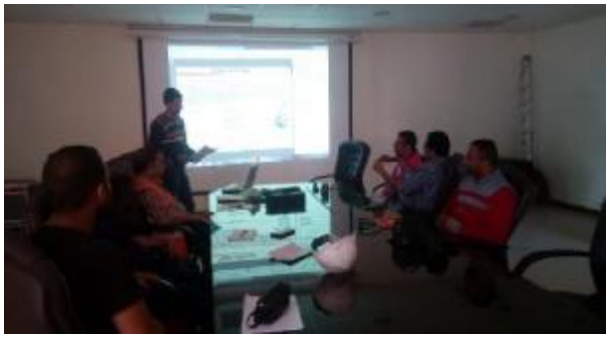
4. Action Plan Implementation: Findings of the Mission

27

(Suggestion from JICA Expert Team)

ü JICA Expert Team would like to request Egyptian side for **the further understanding and continuous support for Action Plan implemented by JICA-trained engineers & technicians**, even after the Project.

- Ø Coordinating Engineers/Technicians work to implement their Action Plan as planned.
- Ø Preparing necessary equipment and materials for Action Plan implementation.



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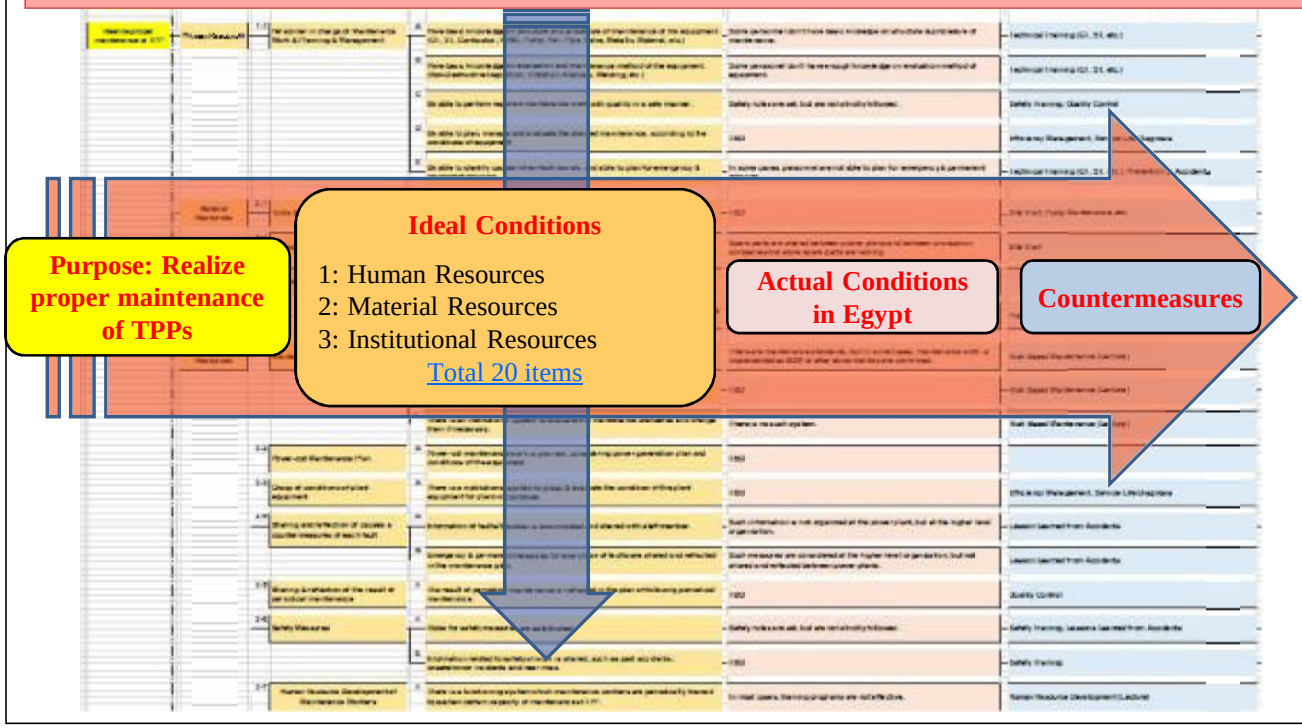
1. Background: Why is O&M at TPPs important?
2. Project Summary: Capacity Building for O&M at TPPs
3. O&M Training in Japan (2nd Year Completed: 2018)
4. Action Plan Implementation
5. **Issue Analysis of O&M in TPP**
6. Conclusion

5. Issue Analysis of O&M in TPP: Basic Concept

29

JICA Expert Team comprehensively analyzed O&M issues of TPPs in Egypt and identified the countermeasures (not limited to Action Plan)



5. Issue Analysis of O&M in TPP: Human Resources

30

Category	Ideal Condition	Actual Condition	Countermeasure
Human Resources	Every personnel has basic knowledge on structure and maintenance procedure of the equipment.	Some personnel don't have basic knowledge on structure & maintenance procedure of the equipment.	Dissemination from Participants (E/T) about **GTCC (GT, ST, HRSG) etc.**
	Every personnel has basic knowledge on evaluation and maintenance method of the equipment.	Some personnel don't have enough knowledge on evaluation method of equipment.	Dissemination from Participants (E/T) about **NDI, Remaining Life Assessment, balancing etc.**
	Every personnel can perform required maintenance work with quality in a safe manner.	Safety rules are set, but are not strictly followed.	Dissemination from Participants (E/T) about **Safety/Quality Training etc.**
	Be able to plan, manage and evaluate the planned maintenance, according to the conditions of equipment.	Almost all personnel are able to do within the range of O&M manuals.	Dissemination from Participants (E/T) about **Maintenance of GTCC etc.**
	It's possible to identify causes when fault occurs, and plan for emergency & permanent measure.	In some cases, some personnel are not able to plan for emergency & permanent measure.	Dissemination from Participants (E/T) about **Maintenance of GTCC etc.**

5. Issue Analysis of O&M in TPP: Material Resources

31

Category	Ideal Condition	Actual Condition	Countermeasure
Material Resources	Tools and Jigs necessary for maintenance are neatly stored in designated areas, well managed and available on demand.	In some TPPs, participants keep tools and jigs tidy and in order.	Dissemination from Participants (E/T) about **5S methodology, etc.** If needed, **management may be responsible to procure it.**
	Consumables & Spare parts are stored, well managed and available on demand.	Spare parts are managed by computerized system and shared between TPPs and EPCs.	Dissemination from Participants (E/T) about **5S methodology, etc.** If needed, **management may be responsible to procure it.**
	All manuals of each equipment are available on demand.	Some manuals are existing, but are not well organized.	Making exiting manuals set in order. (E/T). If needed, **management may request the supplier/vender for additional manual.**
	Work procedures for each maintenance of each equipment are written, well kept and available on demand.	In some TPPs, work procedures are well kept in computerized system and can be shared at each TPP.	Making exiting procedures set in order. (E/T). If needed, **management may request the supplier/vender for additional manual.**

5. Issue Analysis of O&M in TPP: Institutional Resources

32

Category	Ideal Condition	Actual Condition	Countermeasure
Institutional Resources (1)	Each equipment has prescribed maintenance standards such as frequency, details of maintenance work.	There are maintenance standards, but in some cases, maintenance is implemented as BDM or after abnormalities are confirmed.	Dissemination from Participants (E) about **Risk Based Maintenance etc.**
	Each equipment has standard check points.	Based on O&M manuals, each equipment has standard check points. But, only within the range of O&M manuals.	Dissemination from Participants (E) about **Risk Based Maintenance etc.**
	There is an institutional system to evaluate the maintenance standards and change them if necessary.	In some TPPs, There is no such system. In other TPPs, it is managed at the head office.	Dissemination from Participants (E) about **Risk Based Maintenance etc.**
	Power-cut maintenance work is planned, considering power generation plan and conditions of the equipment.	Power-cut maintenance can be implemented as planned because there are sufficient reserve margin at present.	There is no gap between ideal and actual condition.
	There is a institutional system to grasp & evaluate the condition of the plant equipment for planning purpose.	In some TPPs, There is no such system. In other TPPs, it is managed at the head office.	Dissemination from Participants (E) about **Thermal Efficiency Management, Service Life Diagnosis etc.**

5. Issue Analysis of O&M in TPP: Institutional Resources

33

Category	Ideal Condition	Actual Condition	Countermeasure
Institutional Resources (2)	Information of faults/troubles is accumulated and shared with staff member.	Information is shared through Chief Engineers but not informed to engineers and technicians, and it would take much times and they cannot grasp the details.	Dissemination from Participants (E) about **Lesson Learned from Accidents etc.** Information sharing on technical failures/troubles by engineers & technicians.
	Emergency & permanent measures for every type of faults are shared and reflected in the maintenance plan.	Information is shared through Chief Engineers but not informed to engineers and technicians, and it would take much times and they cannot grasp the details.	Dissemination from Participants (E) about **Lesson Learned from Accidents etc.** Information sharing on technical failures/troubles by engineers & technicians.
	The result of periodical maintenance is reflected in the plan of following periodical maintenance.	Based on O&M manuals, these are implemented. But, only within the range of O&M manuals.	Dissemination from Participants (E/T) about **Quality Control etc.**
	Rules for safety measures are established.	Safety rules are set, but are not strictly followed.	Dissemination from Participants (E/T) about **Safety Training**, but **management should take the initiative in the organization.**
	Information related to safety at work is shared, such as past accidents, unsafe/minor incidents and near miss.	Information is shared through Chief Engineers but not informed to engineers and technicians, and it would take much times and they cannot grasp the details.	Dissemination from Participants (E/T) about **Safety Training** Information sharing on labor accidents by engineers & technicians.
	There is a functioning system which maintenance workers are periodically trained to sustain certain capacity of maintenance.	In most cases, training programs are not effective. And there is no institutional to evaluate the skills of engineers and technicians.	Dissemination from Participants (E/T) about **Human Resource Development.** Adopting evaluation system based on technical knowledge & skills for engineers & technicians, not only depending on the length of work.

5. Issue Analysis of O&M in TPP: Findings of the Mission

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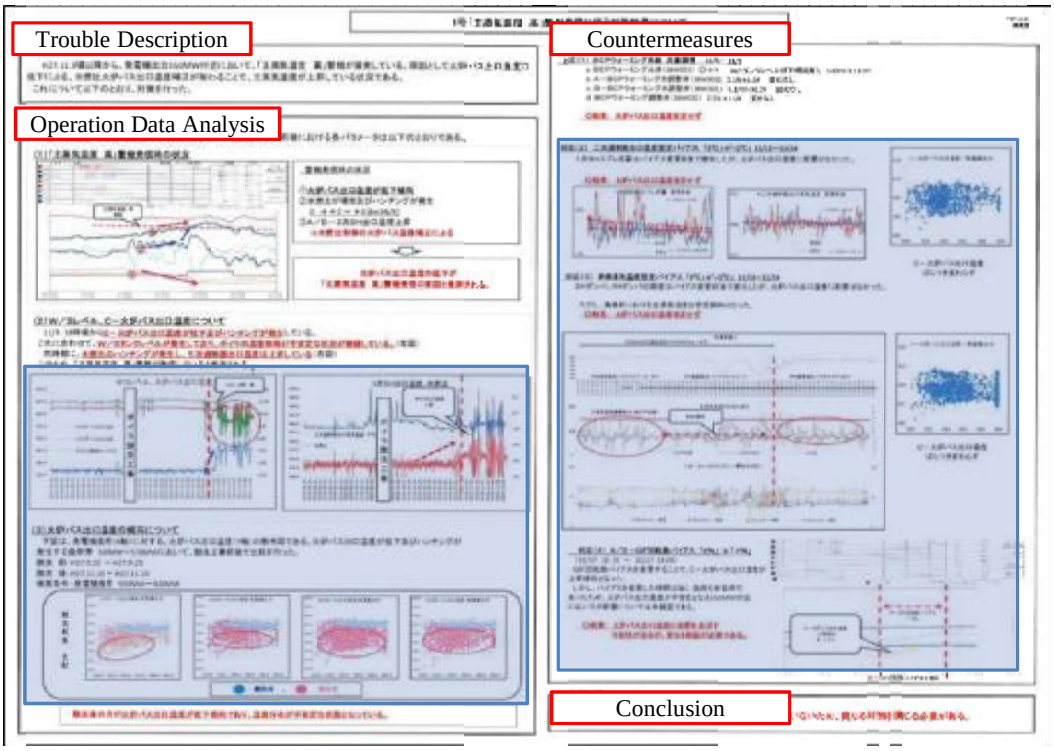
(Suggestion from JICA Expert Team)

- As for the O&M issues that JICA-trained engineers & technicians can deal with, **almost all of the countermeasures are covered with O&M training course in Japan and their Action Plan.**
- On the other hand, through discussion with management/ JICA-trained engineers & technicians, there are other **O&M issues to be involved by management.**
- Management are expected to take the following countermeasures:
  - **Sharing information** on technical failures/troubles & labor accidents with not only management, **but also engineers & technicians.**
  - **Adopting evaluation system based on technical knowledge & skills** for engineers & technicians, not only depending on the length of work.

5. Issue Analysis of O&M in TPP: Information Sharing

35



5. Issue Analysis of O&M in TPP: KANSAI's Skill Evaluation

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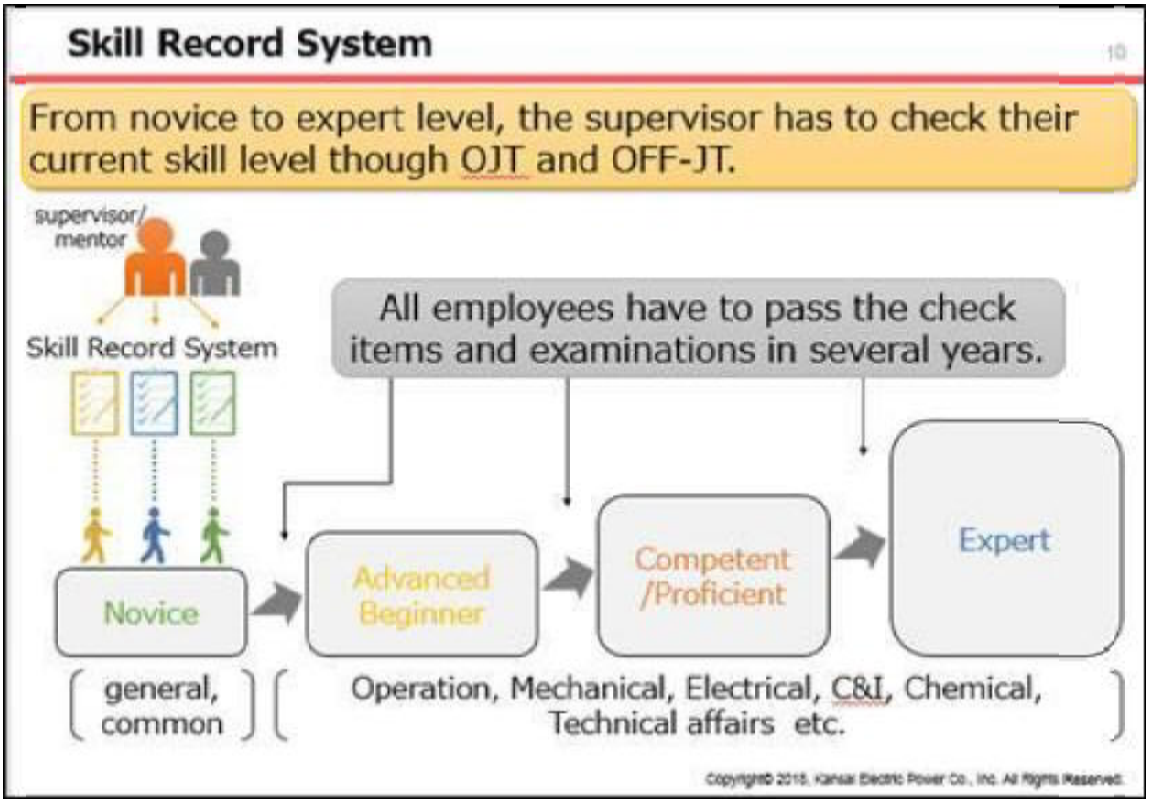

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6. **Conclusion**

6. Conclusion

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Summary of the JICA project

- We've already implemented the capacity building project for O&M at TPPs for around 2 years as follows:
  - Conducting **O&M training in Japan** based on the training needs and the current situation.
  - Reviewing **dissemination from JICA-trained participants to other colleagues** about knowledge and skills obtained in Japan.
- Through analyzing the O&M issues at TPPs, we suggest **the project is practical and effective to improve O&M capacity.**

For further improvement of O&M at TPPs

The key success factor (KSF) is …

- **Practice makes perfect**: keeping the dissemination even after the project.
- **Self-disciplined learner**: avoiding excess dependence on manufacturer.
- **Insatiable challenge**: demonstrating the latest O&M technology.

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Thermal Power Division
The Kansai Electric Power Co.,Inc.

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Reference

General Information: The Kansai Electric Power Co., Inc.

General Information: The Kansai Electric Power Co., Inc.

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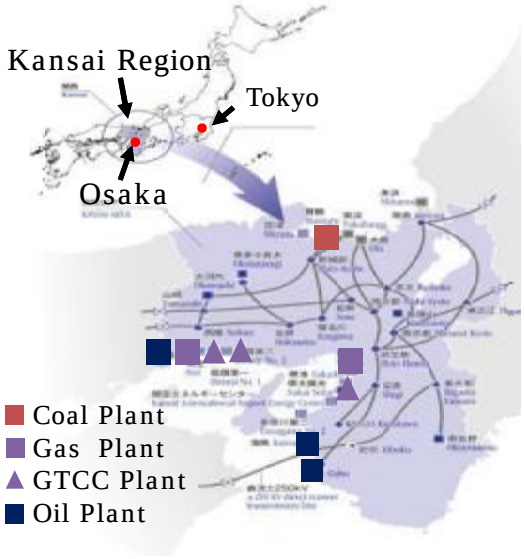
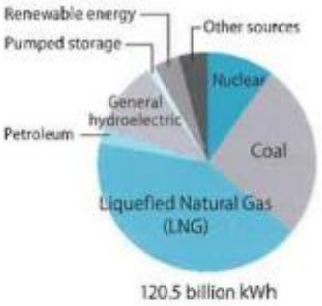


- Established in 1951
- Electricity Sales : 120.5 billion kWh
- Capacity of power-generation: 34.2 GW

Composition of power sources (supply and demand record by source)



Nuclear	10%
Coal	26%
Liquefied Natural Gas (LNG)	42%
Petroleum	2%
General hydroelectric	11%
Pumped storage	1%
Renewable energy	4%
Other sources	4%

- Power generated by KEPCO to meet demand
- Includes power received from other companies
- Figures may not add up due to rounding off

Capacity of power-generating facilities (breakdown by power source)

Thermal power	19.430 GW	(12 facilities)
Hydroelectric power	8.226 GW	(152 facilities)
Nuclear power	6.578 GW	(3 facilities)
Renewable energy	0.011 GW	(3 facilities)

- KEPCO power-generating facilities only
- Figures may not add up due to rounding off

(As of 31th March 2018)

KANSAI's GTCC and Coal Fired Power Plants

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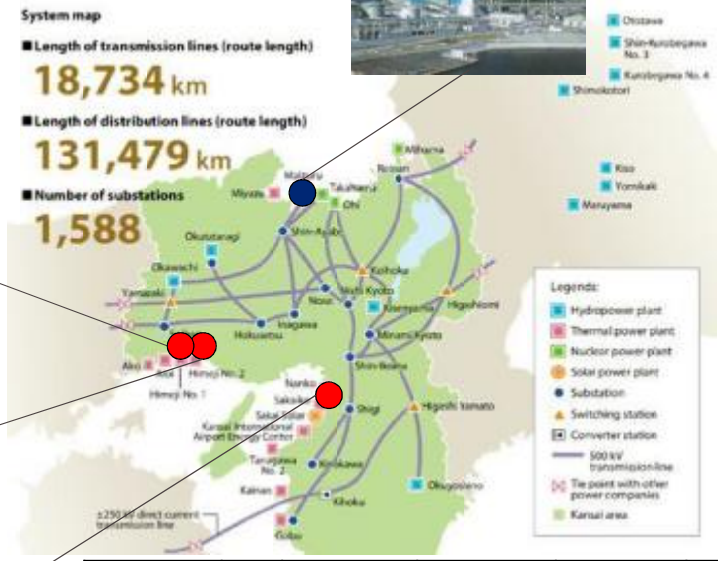
④Maizuru

①Himeji No.1

②Himeji No.2

③Sakaiko



Power Plant	Unit	Fuel	Manufacturer	Capacity	COD
Himeji No.1	5	LNG (GTCC)	MHPS	729 MW	1995.4
	6	LNG (GTCC)	Hitachi (GE)	713 MW	1996.5
Himeji No.2	1-6	LNG (GTCC)	MHPS	481 x 6 MW	2013.8 - 2015.3
Sakaiko	1-5	LNG (GTCC)	MHPS	400 x 5 MW	2009.4 - 2010.9
Maizuru	1	Coal	MHPS	900 MW	2004.8
	2	Coal	Toshiba (IHI)	900 MW	2010.8

KANSAI's Power Generation Portfolio

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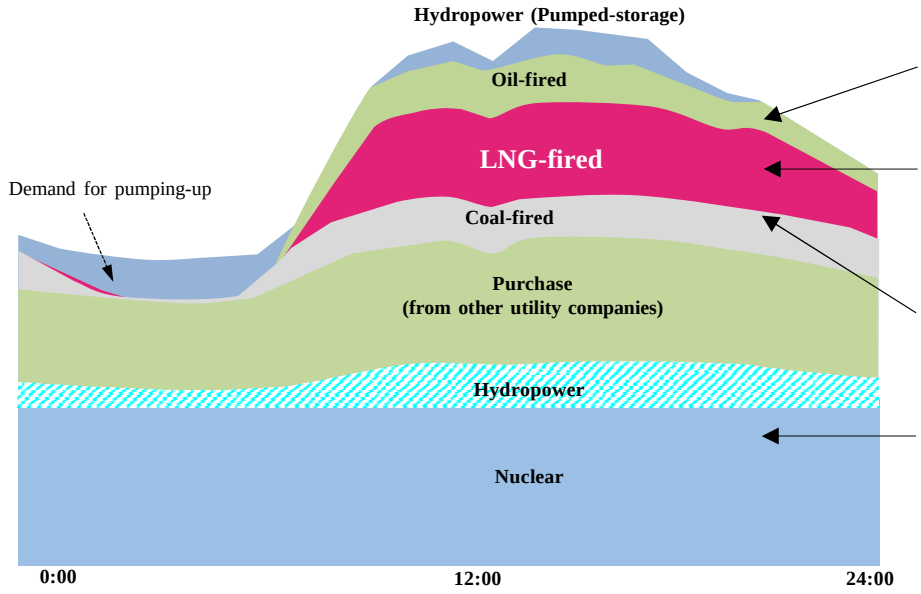
Kansai Electric: Long history in Responding demand fluctuation

In Kansai's power generation portfolio, LNG and Oil thermal power plants have been responding to peak demand fluctuation and contribute to the consistent and stable supply of electricity.



Oil: **Peak ~ Standby Reserve**
- Cost: High
- Flexibility: High

LNG: **Cyclic ~ Peak Load**
- Cost: Middle ~ High
- Flexibility: Middle

Coal: **Base Load**
- Cost: Low
- Flexibility: Low

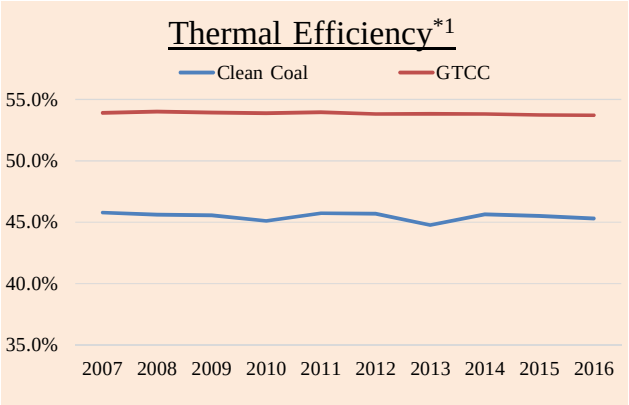
Nuclear: **Base Load**
- Cost: Low
- Flexibility: Low

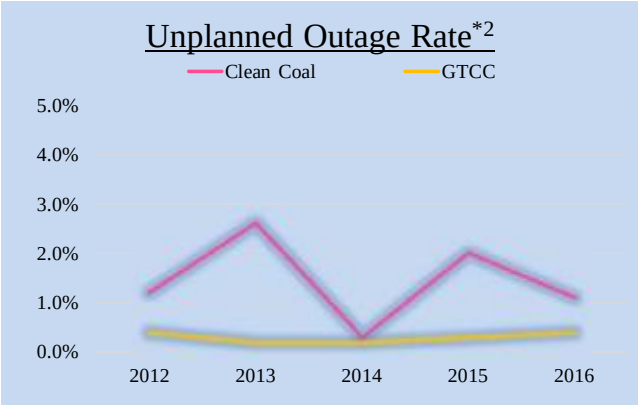
KANSAI's Quality Management

44

Kansai has accumulated precious experience and maintained technical knowledge and skill of high quality O&M for over 65 years.

The following know-how contributes to **low degradation of thermal efficiency** and **low unplanned outage rate**; for example,
"thermal efficiency management", "non-destructive inspection", "safety management", "quality management", and "remaining life assessment" etc.





*1: Gross, LHV basis

*2: Unplanned Outage Rate (%) =
No. of days of unplanned outage / (No. of days of operation + No. of days of unplanned outage)

KANSAI's GTCC Performance Improvement

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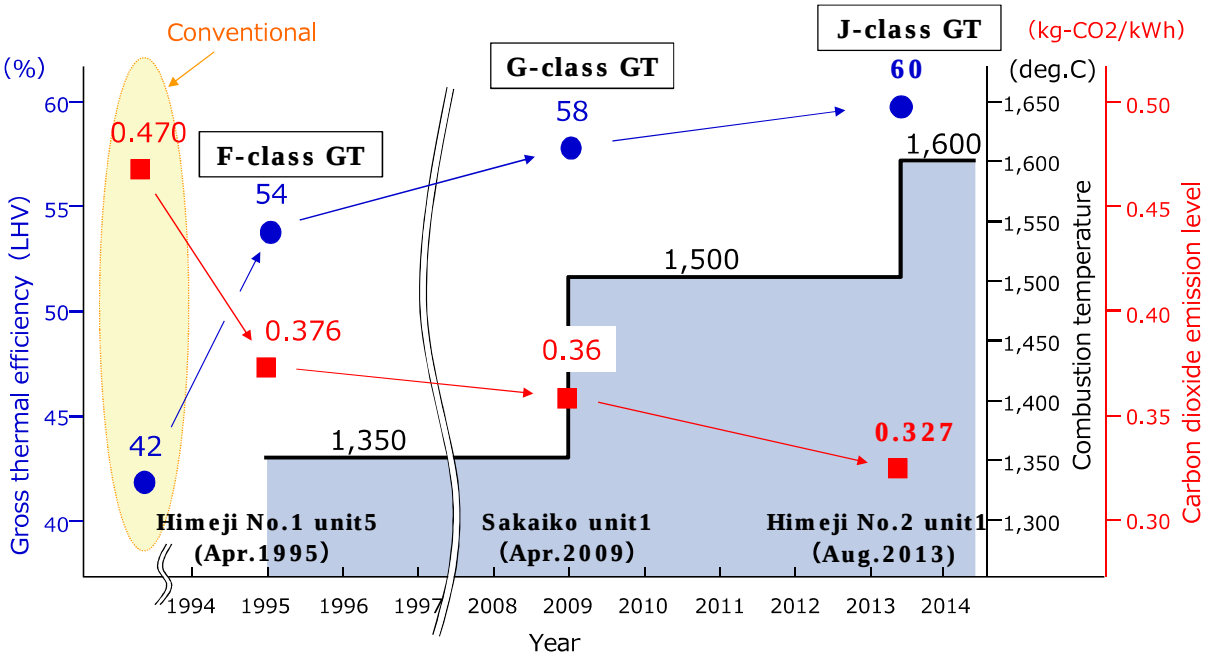

n 30% reduction of fuel consumption and carbon dioxide emission compared to conventional power plants.

Kansai Value Creation Service

K-VaCS

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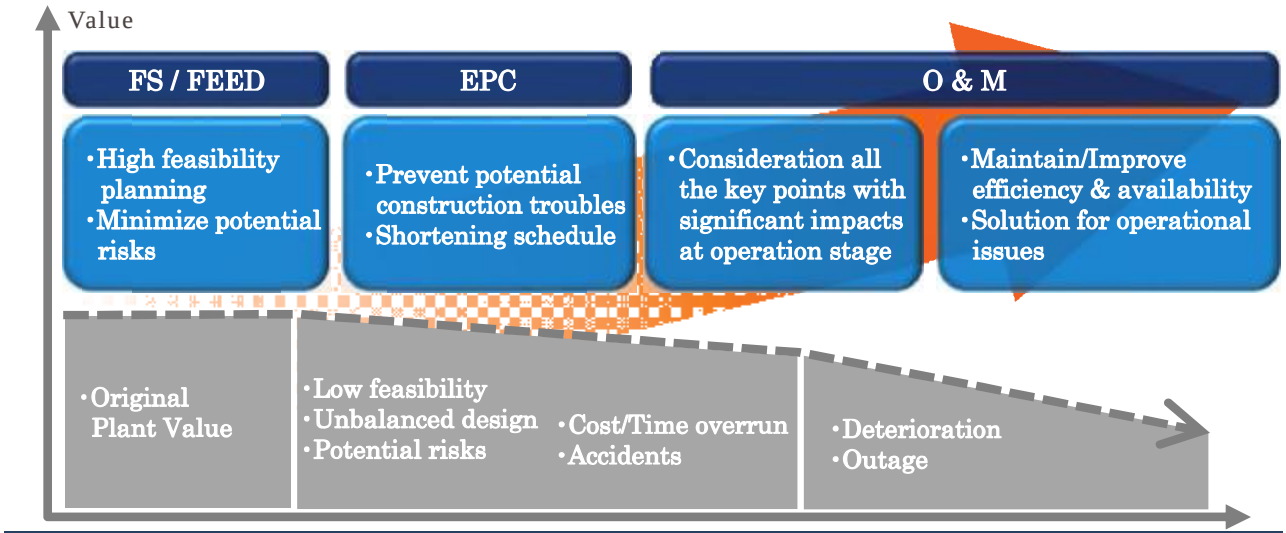

- Comprehensive solution for managing Thermal Power Plant
- Provide "Value Creation" service integrated with IoT / AI technology

KANSAI's Overseas Project (as of April 2019)

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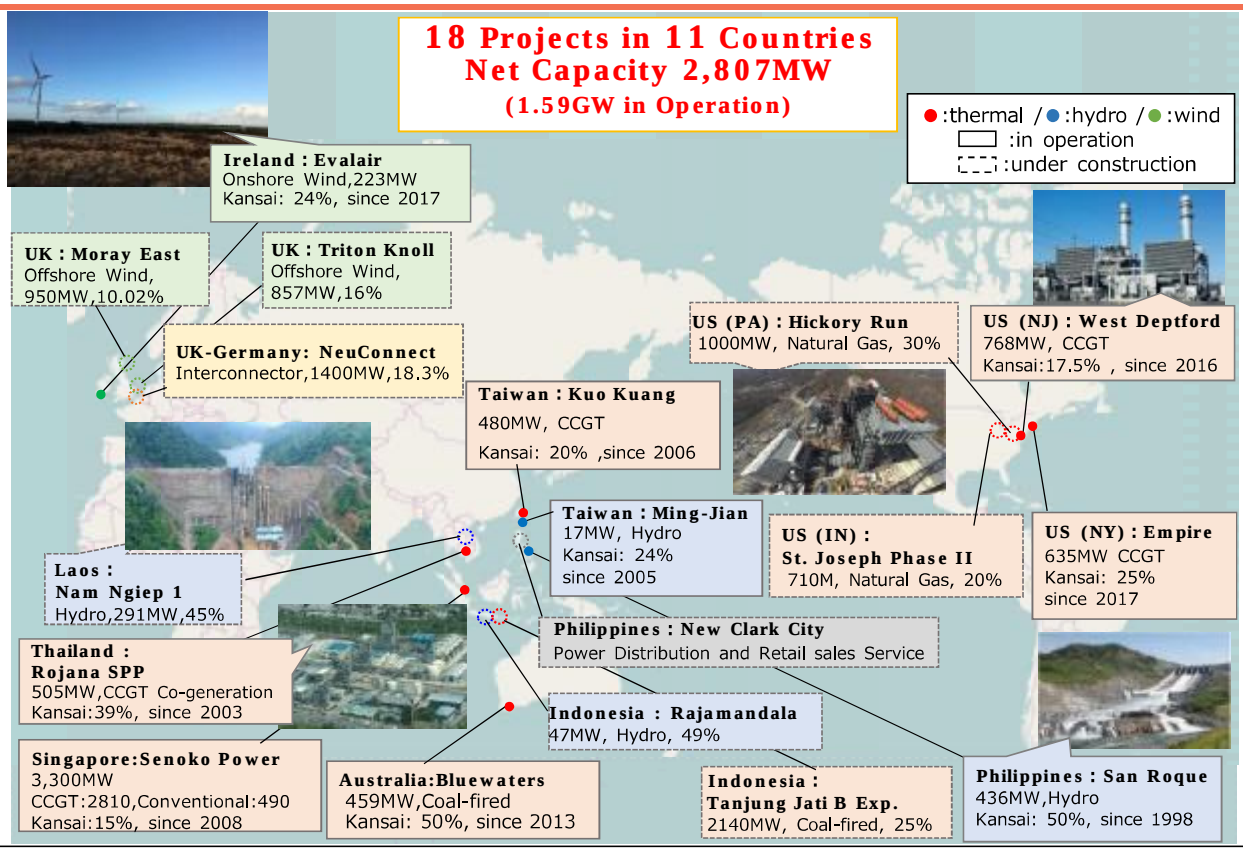

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Reference

KANSAI's Technical Proposal:
Introducing RBM Setup & improving Analytic Capability

KANSAI's Technical Proposal

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For sustainable and efficient O&M, the following steps are necessary

Step1. Record the events and storage

Maintenance : Record the failures systematically every time.
(when, what, how to repair, why)

Operation : Record the condition(data logging)

Step2. Analyze the records periodically

Maintenance : Have the same equipment failed ?

Operation : Is there trend toward failure?

Step3. Identify and solve root-causes

Identify and solve root causes (countermeasures) of unexpected problems/risk factors through use of analytical data.

KANSAI's Technical Proposal

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(1) Introducing RBM (Risk Based Maintenance)

Maintenance Optimization via RBM

Optimize Maintenance plan by utilizing a risk matrix that evaluates both PoF (Probability of failure) and CoF (Consequences of Failure).

Benefits of RBM

- Ø Can avoid impact for high-risk equipment
- Ø Can reduce cost for low-risk equipment
- Ø **Lead to reduce maintenance cost while keeping high quality**

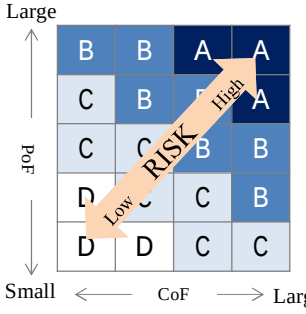
Risk High Area

- Consider measures to reduce risk
- Modify equipment
- Strengthen the inspection of equipment
- Change operation

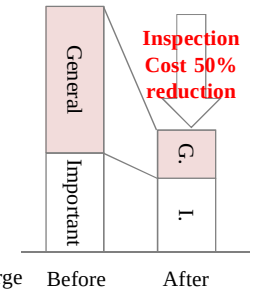
Risk Low Area

- Consider measures to reduce cost
- Reduce inspection scope
- Extend inspection interval

Risk Matrix of RBM



Effect (example)



Note: It is possible that RBM scope is limited to equipment beyond existing LTSA.

KANSAI's Technical Proposal

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(2) Improving Analytic Capability (e.g. Introduction of FTA)

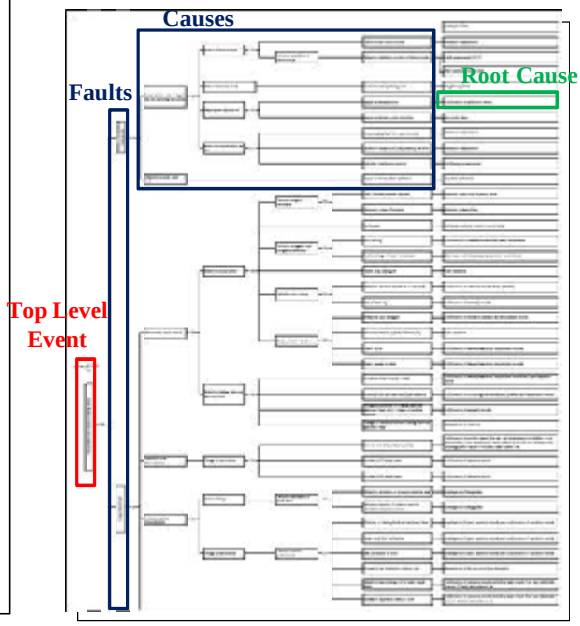
About Fault Tree Analysis (FTA)

1. Deductive Analytic Method
2. Visually indicating a failure path
3. Can identify the root causes of Trouble

Benefits of Fault Tree Analysis

- When trouble happens, engineers and technicians **can easily check the possible causes** at glance
- Engineers and technicians **can quickly identify the root causes of the trouble**
- Can prevent the recurrence of the trouble
- **Lead to reduce down-time of TPP**

Fault Tree Analysis Structure



KANSAI's Technical Proposal

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- At the request of MoERE/EEHC, KANSAI can offer **comprehensive technical service package** as the next phase (after this project).
- And we'd like to clarify **potential needs of technical support** (not limited to capacity building) through discussion with counterparts in this follow-up survey.

No.	Item	Beneficiaries	Number of Participants	Duration
(1)	**O&M Enhancement by introducing RBM** (Implementation Support)	Engineer/Technician (Maintenance)	40	1 year
(2)	**O&M Enhancement by improving Analytic Capability (Data Analysis, FTA etc.)** (Capacity Building)	Engineer/Technician (Maintenance) and Operator		

KANSAI's Technical Proposal

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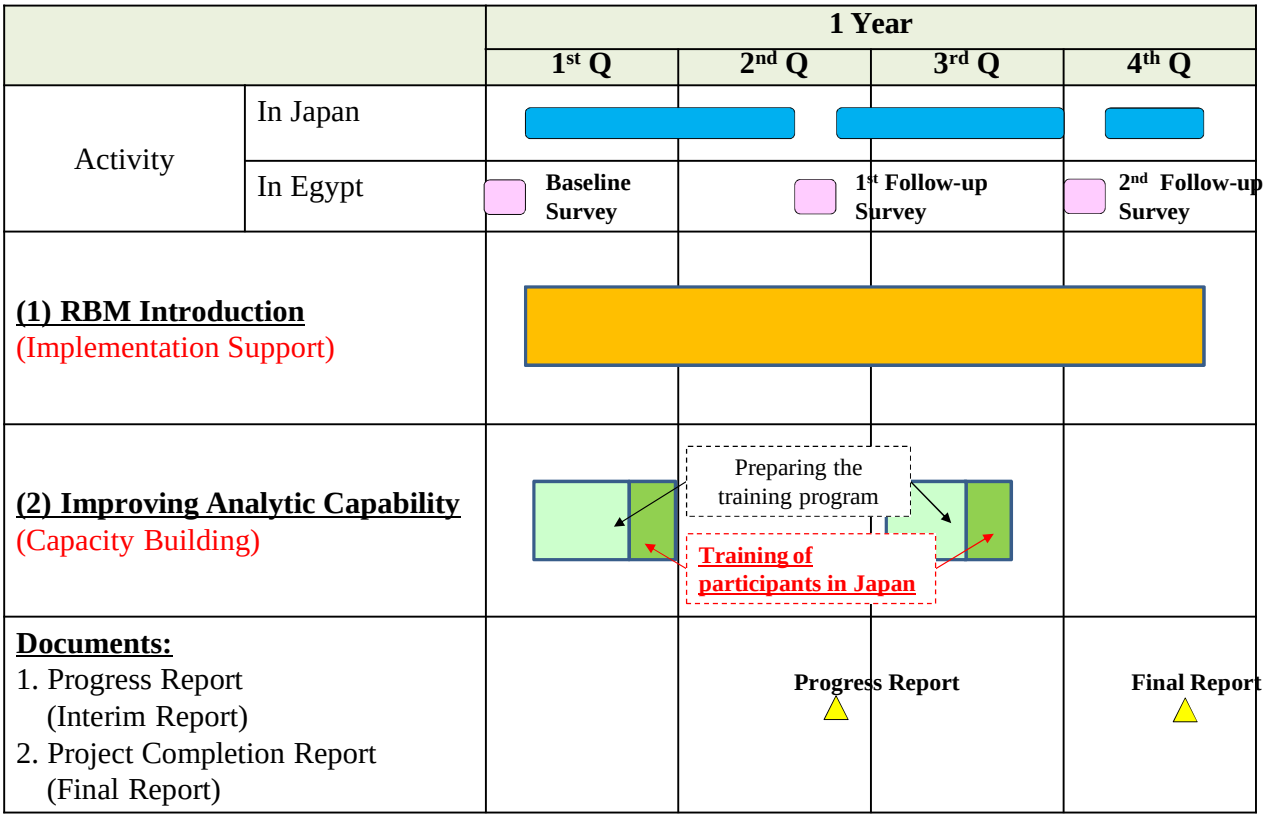

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Reference

KANSAI's Technical Proposal: Digitalization

KANSAI's Technical Proposal: Digitalization

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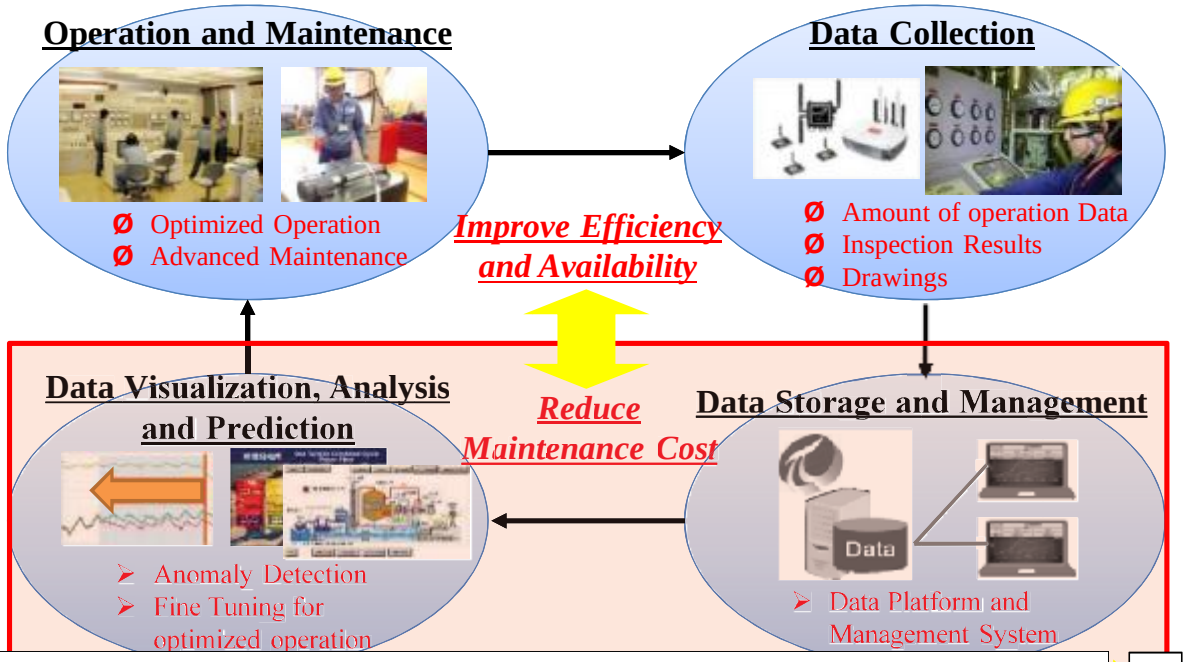
Digitalization for Power Generation



KANSAI can help Egypt to digitalize O&M in TPPs through introducing PI System. → 56 ~ 62

ü **Digitalization accelerate optimization of O&M in TPPs** through effects such as improvement of efficiency, availability and work productivity and technical transfer with ease.

KANSAI's Technical Proposal: Digitalization

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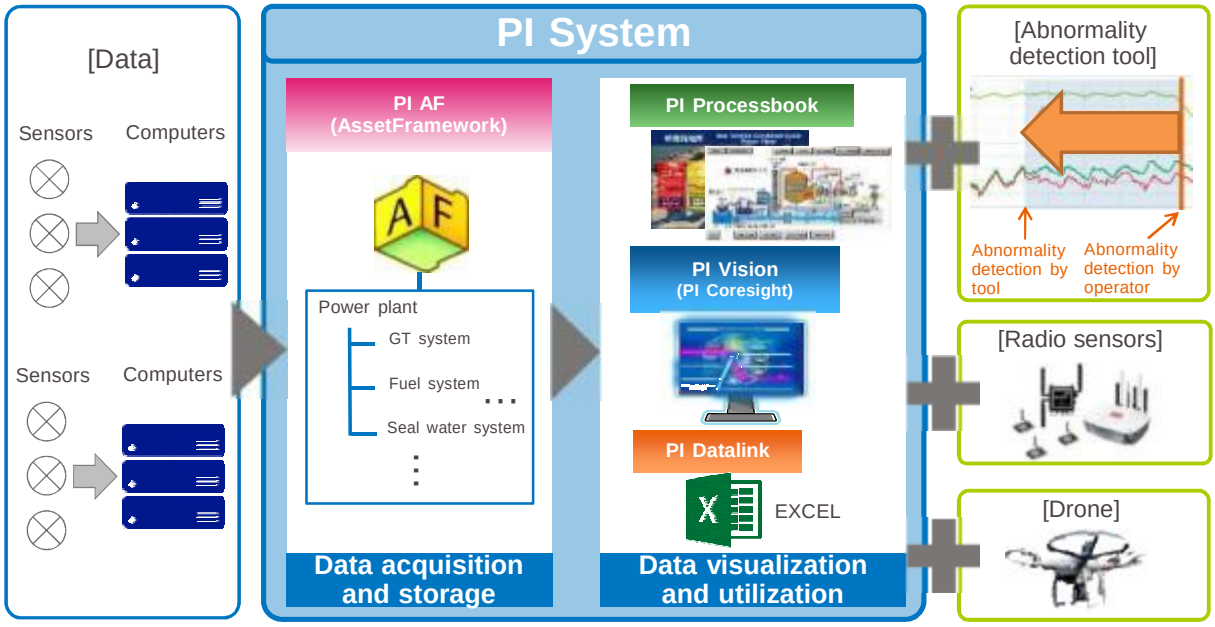
About PI System: World Standard Data Management System used in various industries



ü Capable of **collecting, storing and easily visualizing a large amount of O&M data in TPPs**

ü Offers high extendibility with new sensors, analysis tools, etc.

KANSAI's Technical Proposal: Digitalization

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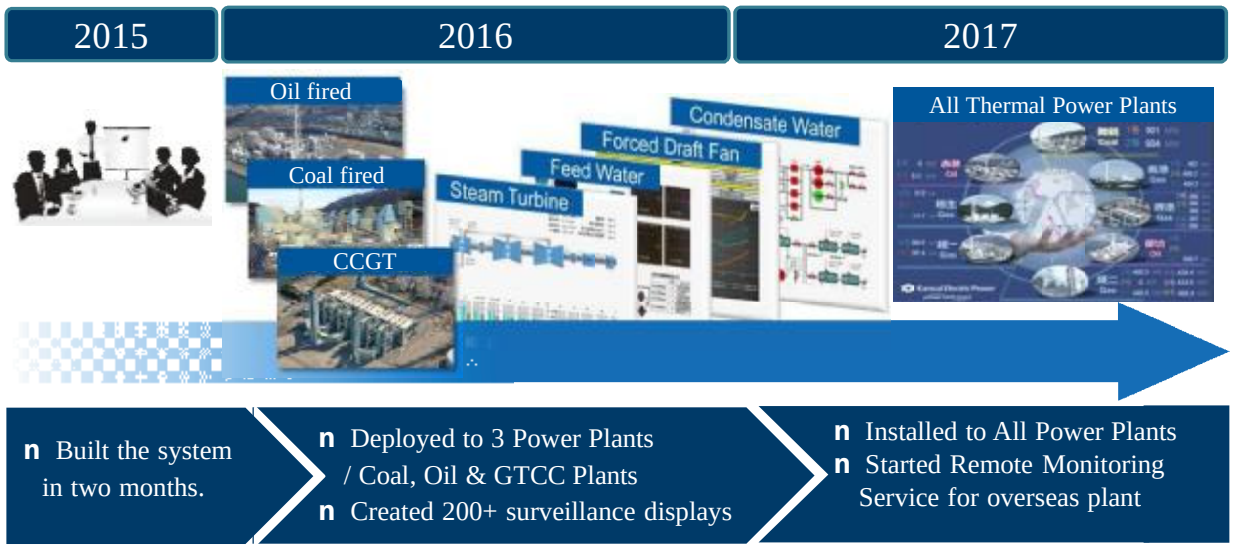
O&M Enhancement by Digitalization (Overview of PI System Installation)



- n Built the system in two months.
- n Deployed to 3 Power Plants / Coal, Oil & GTCC Plants
- n Created 200+ surveillance displays
- n Installed to All Power Plants
- n Started Remote Monitoring Service for overseas plant

ü KAISAI is the first Japanese power generation company to introduce PI System (world standard data management system)

ü Have track records of providing dizitalization service to other companies utilizing PI System

KANSAI's Technical Proposal: Digitalization

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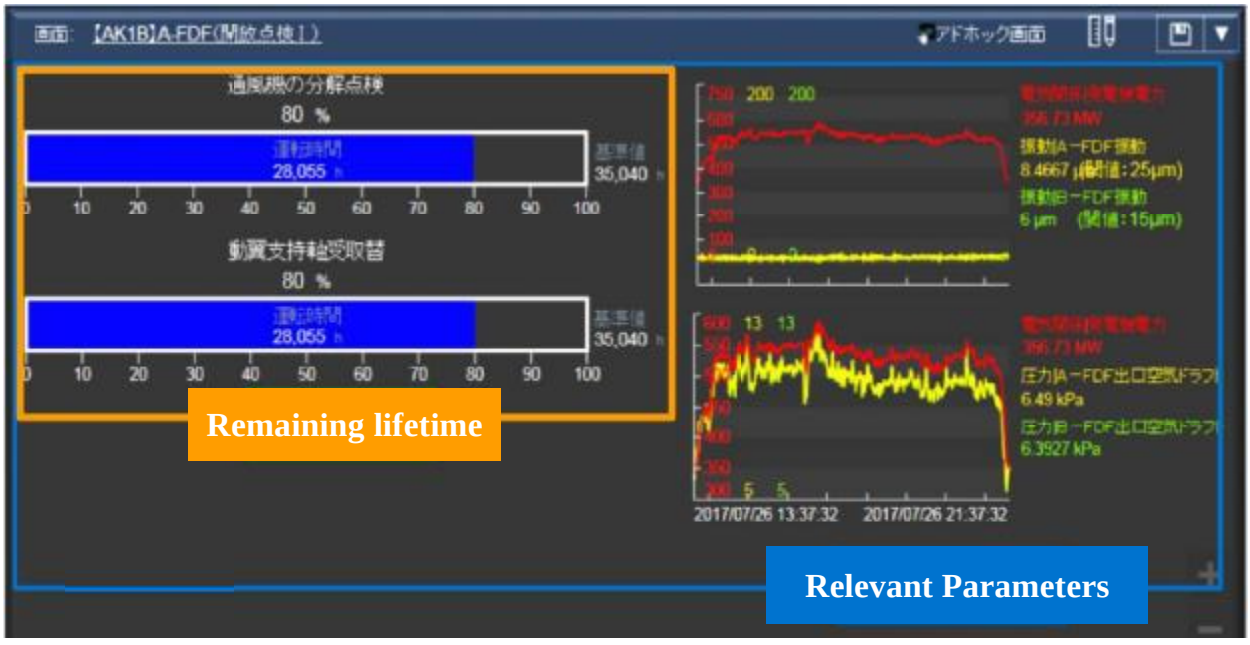
O&M Enhancement by Digitalization (Use example at our Power Plant)



ü Monitor parameters relevant to the lifetime of equipment and estimate the remaining lifetime for a proper maintenance plan

KANSAI's Technical Proposal: Digitalization

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O&M Enhancement by Digitalization (Cost Savings at our Power Plant)

Item	Description
Plant Performance Improvement	Monitoring of GT Intake Air Filter Differential Pressure
	GT Performance Monitoring (Fine-tuning of IGV setting)
	Monitoring of Economizer Inlet Water Temperature
	Monitoring of Fuel Gas Heater Outlet Gas Temperature
Unplanned Down Time Reduction	Monitoring of Circulation Water Pump
	Monitoring of IGV
Maintenance Cost Reduction	Equipment Remaining Life Management
Quality Improvement	Automation of Performance Test Record Collection

ü Estimate approx. **3 Million USD** / year cost savings at our CCGT Power Station

KANSAI's Technical Proposal: Digitalization

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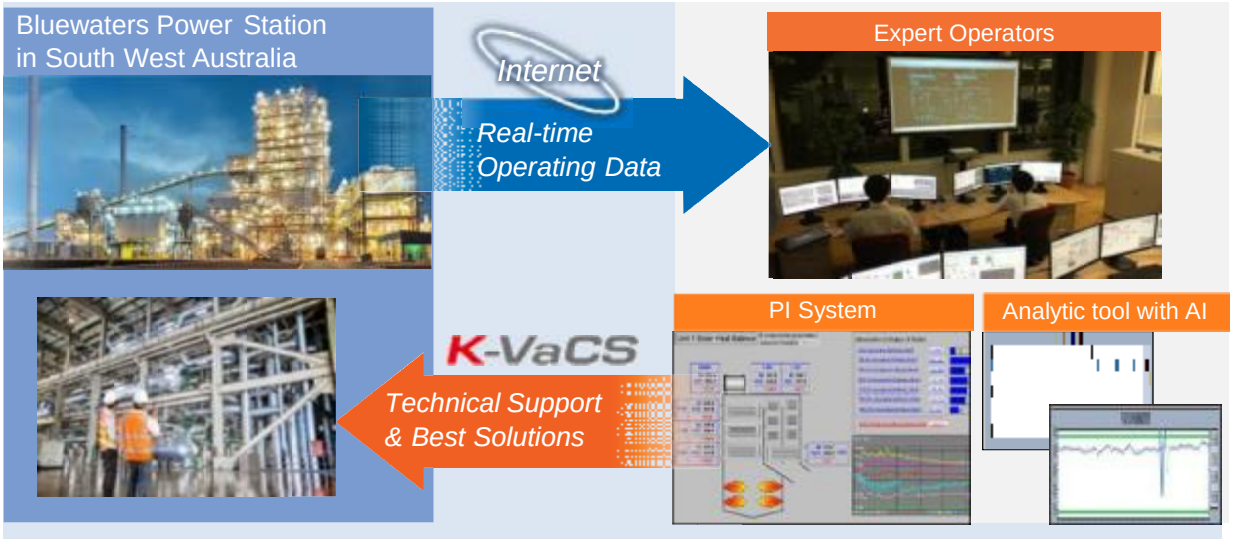
O&M Enhancement by Digital Transformation (Remote Monitoring Sevrice)



ü Our early anomaly detection system not only detects and reports signs of an anomaly using AI, but **we can propose overall solutions from the business owner's perspective** that includes procedures designed by our experts

KANSAI's Technical Proposal

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- At the request of MoERE/EEHC, KANSAI can offer **digitalization solution service package** as the next phase (after this project).
- And we'd like to clarify **potential needs of technical support** (not limited to capacity building) through discussion with counterparts in this follow-up survey.

No.	Item	Beneficiaries	Number of Participants	Duration
(1)	**O&M Enhancement by introducing PI System** (Implementation Support)	Engineer/Technician (Maintenance) and Operator	40	1 year
(2)	**Training of PI System** (Capacity Building)			

KANSAI's Technical Proposal

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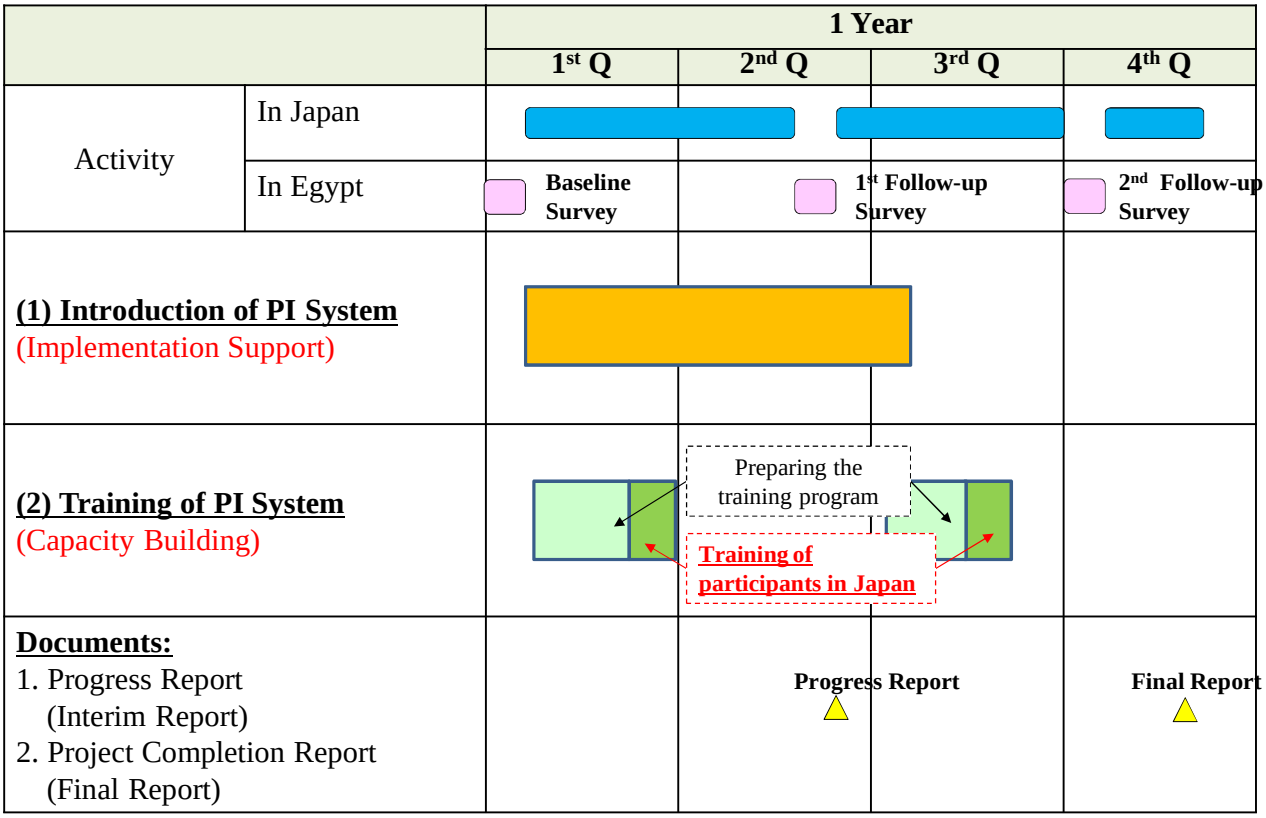

Minutes of Meeting

Project	Capacity Building and Strengthening of Thermal Power Generation Operation & Maintenance in Egypt (the 2nd follow-up survey by JICA expert)
Title	2nd survey in West Delta EPC
Date	25th June 2019
Time	11:30 - 14:30
Place	West Delta EPC Conference Rooms
Attendees	See Attachment "attendance list (West Delta EPC : Mgt / Eng / Tech)"

Record of Discussions

NO	ITEM DETAILS
1.	**Introduction**
1.1	This meeting was convened with the objective to discuss the below agenda point: 1) Presentation of JICA Capacity building O&M "Overview of Draft Final Report"(Management) 2) Discussion about potential needs of technical support as the next phase(Management) 3) Hearing the answers of Kansai's questionnaire, JICA's questionnaire and APs activities (Engineers/Technicians) 4) Discussion about the Issue Analysis of O&M at TPPs. (Engineers/Technicians) 5) Additional lectures: Tool Box Meeting (TBM) 6) Others (if any)
2.	**Overview of Draft Final Report(Management)**
2.1	JICA expert (KANSAI) made the presentation on "Overview Of Final Report (Draft)", containing "Project Summary", "O&M Training in Japan", "Issue Analysis in O&M at TPPs" and "Potential Needs Of Technical Support As The Next Phase" 1) JICA expert (KANSAI) explained the reason why we focused on mechanical maintenance, and management understood the reason, and also showed interest in electrical maintenance. 2) Management explained that usual O&M manuals are available, but that special manuals cannot be obtained from manufacturers. JICA expert explained the importance to negotiate with the manufacturers. 3) Management understood the importance of O&M for equipment not covered by LTSA, such as ST, HRSG and BOP, and showed interest in especially Risk-Based-Maintenance (RBM).

NO	ITEM DETAILS
3.	**Interview and discussion with JICA-trained engineers and technicians**
	1) Hearing the answers of Kansai's questionnaire, JICA's questionnaire and APs activities (E) They disseminated their knowledge to their colleagues by utilizing JICA experts' materials. JICA expert received their activity report and pictures. (T) They disseminated their knowledge to their colleagues by utilizing JICA experts' materials. JICA expert asked them to send their activity report and pictures. 2) Discussion about the Issue Analysis of O&M at TPPs. (Sidi Krir) (E) Their manuals and documents are stored in each sections. And there are no management system and librarian. Kansai recommended that their manuals are managed in one big library, where they can revise to the latest and manage lending. (E) Their skills and knowledge are evaluated only by experience periods. They asked us for KANSAI's skill evaluation system because they want to estimate their own skill level. (E) They can share failures, troubles and incidents in other TPPs through Chief Engineers. But it would take much times and they cannot grasp the details. JICA experts explained KANSAI's information sharing system (*) and they have some concerns. *After the incidents, TPP will reports the phenomenon and causes to HQ and HQ will share them to related TPPs. All personnel can access the information on the web. (T) Technicians suggested that having a regular meeting of engineers and technicians is necessary to share the situation on the equipment, work detail and attention point for safety work. 3) Additional lectures: Tool Box Meeting (TBM) JICA expert made the explanations on above technical issue briefly. The participants could understand the necessity and importance of pre-work meeting called "TBM" to ensure the safety, and shared material of ACC (Air-Cooled Condenser) with JICA-trained engineers.

Capacity Building for Operation & Maintenance of Therma Power Plant
in Arab Republic of Egypt

WEIC Meeting with Management Attendance List

Date: 25 / Jun / 2019

Time: 11 : 30 - 13 : 30

Place: Conference room

No.	Name	Position	Company	Signature
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Kansai Electric Power

Capacity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

WEIC's Meeting Participant Attendance List

Date: 25 / 6 / 2019

Time: 11 : 30 - 13 : 30

Place: WEIC

No.	Name	Position	Company	Signature
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Kansai Electric Power

26th Jan. 2019

Attendance List

No.	Name	Position	Company	Signature
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JICA

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Kansai Electric Power

Minutes of Meeting

Project	Capacity Building and Strengthening of Thermal Power Generation Operation & Maintenance in Egypt (the 2nd follow-up survey by JICA expert)
Title	2nd survey in Middle Delta EPC
Date	26th June 2019
Time	11:00 - 14:30
Place	Middle Delta EPC Conference Rooms
Attendees	See Attachment “attendance list (Middle Delta EPC : Mgt / Eng / Tech)”

Record of Discussions

NO	ITEM DETAILS
1.	**Introduction**
1.1	This meeting was convened with the objective to discuss the below agenda point: 1) Presentation of JICA Capacity building O&M “Overview of Draft Final Report”(Management) 2) Discussion about potential needs of technical support as the next phase(Management) 3) Hearing the answers of Kansai’s questionnaire, JICA’s questionnaire and APs activities (Engineers/Technicians) 4) Discussion about the Issue Analysis of O&M at TPPs. (Engineers/Technicians) 5) Additional lectures: Air Cooled Condenser (ACC) & Tool Box Meeting (TBM) 6) Others (if any)
2.	**Overview of Draft Final Report(Management)**
2.1	JICA expert (KANSAI) made the presentation on “Overview Of Final Report (Draft)”, containing “Project Summary”, “O&M Training in Japan”, “Issue Analysis in O&M at TPPs” and “Potential Needs Of Technical Support As The Next Phase” 1) Management understood the impact on O&M in TPPs in case of frequent start-up and shut-down. JICA expert explained some specific equipment that will be influenced by the change of operation, such as boiler tubes and outer-casing.

NO	ITEM DETAILS
3.	**Interview and discussion with JICA-trained engineers and technicians**
	1) Hearing the answers of Kansai’s questionnaire, JICA’s questionnaire and APs activities (E) They disseminated their knowledge to their colleagues by utilizing JICA experts’ materials. JICA expert received their activity reports (Action Plans) and asked them to send pictures. Their APs shows they implemented their dissemination in small group periodically and constantly. JICA expert admired their activity and asked their bosses to support their APs. (T) They disseminated their knowledge to their colleagues by utilizing JICA experts’ materials. JICA expert asked them to send their activity report (Action Plans) and pictures. (T) Technicians talked that management's cooperation for the implementation of the Action Plan would be better. The reason is that technicians were too busy to teach many trainees in the form of lectures. And JICA expert asked their bosses to support their APs. 2) Discussion about the Issue Analysis of O&M at TPPs. (E) They can share failures, troubles and incidents in other TPPs through Chief Engineers. But it would take much times and they cannot grasp the details. (E) They can share the information related to each maintenance work through computerized system at every TPP in MDEPCO. 3) Additional lectures: Tool Box Meeting (TBM) 3) Additional lectures: Air Cooled Condenser (ACC) & Tool Box Meeting (TBM) JICA expert (Kansai) made the explanations on above technical issues briefly. The participants could obtain the knowledge of structure and careful points on Air cooled Condenser And they could understand the necessity and importance of pre-work meeting called “TBM” to ensure the safety.

Capacity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

Management Meeting with MOEPC Attendance List

Date: 27 / June / 2019

Time: 11 : 00 ~ 12 : 00

Place: Conference room

No.	Name	Position	Company	Signature
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JICA

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Kansai Electric Power

Capacity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

MEPC Meeting with Egyptian Side Attendance List

Date: 24 / June / 2019

Time: 13 : 30 ~ 14 : 30

Place: MEPC

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JICA

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Kansai Electric Power

JICA Hearing from Expert Tel. Attendance List

No	Name	Position	Company	Signature
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JICA

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Kansai Electric Power

POWER and beyond

Minutes of Meeting

Project	Capacity Building and Strengthening of Thermal Power Generation Operation & Maintenance in Egypt (the 2nd follow-up survey by JICA expert)
Title	2nd survey in Upper Egypt EPC
Date	27th June 2019
Time	10:50 - 15:00
Place	Upper Egypt EPC Conference Rooms
Attendees	See Attachment “attendance list (Upper Egypt EPC : Mgt / Eng / Tech)”

Record of Discussions

NO	ITEM DETAILS
1.	**Introduction**
1.1	This meeting was convened with the objective to discuss the below agenda point: 1) Presentation of JICA Capacity building O&M “Overview of Draft Final Report”(Management) 2) Discussion about potential needs of technical support as the next phase(Management) 3) Hearing the answers of Kansai’s questionnaire, JICA’s questionnaire and APs activities (Engineers/Technicians) 4) Discussion about the Issue Analysis of O&M at TPPs. (Engineers/Technicians) 5) Additional lectures: Air Cooled Condenser (ACC) & Tool Box Meeting (TBM) 6) Others (if any)
2.	**Overview of Draft Final Report(Management)**
2.1	JICA expert (KANSAI) made the presentation on “Overview Of Final Report (Draft)”, containing “Project Summary”, “O&M Training in Japan”, “Issue Analysis in O&M at TPPs” etc. 1) Management understood that Egypt has progressive increase of reserve margin at present. JICA expert explained that in general it is difficult to predict the power demand accurately.

NO	ITEM DETAILS
3.	**Interview and discussion with JICA-trained engineers and technicians**
	1) Hearing the answers of Kansai’s questionnaire, JICA’s questionnaire and APs activities (E/T) They disseminated their knowledge to their colleagues by utilizing JICA experts’ materials. JICA expert received their activity reports (Action Plans) and activity pictures (PowerPoint). Their APs shows they implemented their dissemination in small group practically, periodically and constantly. JICA expert admired their activity and asked their bosses to support their APs. (E) Engineers implemented some APs even though they were busy because of the overhaul work. And they told that the vibration and HRSG problem were especially useful because these were directly related to their facing troubles. (T) Technicians talked that management's cooperation for the implementation of the Action Plan would be better. The reason is that technicians were busy to teach many trainees in the form of lectures, and there are few opportunities for education because they are limited when there is actual work. And JICA expert asked their bosses to support their APs. 2) Discussion about the Issue Analysis of O&M at TPPs. (E) They can share failures, troubles and incidents in other TPPs through Chief Engineers. But it would take much times and they cannot grasp the details. (E) They can share the information related to each maintenance work through computerized system at every TPP in UEEPCO. (E) They have the evaluation system of piping thickness. After measuring the piping thickness, they evaluate the remaining life assessment. That shows they have some technique level to grasp the condition of equipment. (E) They have all manuals of each equipment, but some manuals do not include enough information such as assemble and disassemble procedure. In such case, work quality is dependent on the personnel skills of workers. (T) Some maintenance personnel are not skilled enough. In the background, JICA Experts think the reason that transferred technicians are not hired with the necessary skills for maintenance work of the power plant and that they have to gain experience through work rather than training. (T) The know-how obtained during work is reflected in the work procedure.

	3) Additional lectures: TBM (Tool Box Meeting) & ACC (Air Cooled Condenser) JICA expert made the explanations on above technical issues briefly. The participants could understand the necessity and importance of pre-work meeting called "TBM" to ensure the safety. And JICA expert hand the ground design of the ACC to engineer with brief explanation.

Capacity Building for Operation & Maintenance of Thermal Power Plant in Arab Republic of Egypt

Management Meeting with UPPC Attendance List

Date: 27 / June / 2019

Time: 10 : 30 - 12 : 30

Place: Conference room

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Capacity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

Meeting with Eg.P Tec. Attendance List

Date: 25 / Jun / 2019

Time: 11 : 00 ~ 12 : 30

Place: EEHC

No.	Name	Position	Company	Signature
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JICA

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Kansai Electric Power

Meeting with Eg.P Tec. Attendance List

No.	Name	Position	Company	Signature
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JICA

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Kansai Electric Power

Minutes of Meeting

Project	Capacity Building and Strengthening of Thermal Power Generation Operation & Maintenance in Egypt (the 2nd follow-up survey by JICA expert)
Title	2nd survey in Cairo EPC
Date	1st July 2019
Time	10:00 – 11:30 (Cairo EPC), 12:00 – 15:30 (Cairo North TPP)
Place	Cairo EPC Conference Room, Cario North TPP Conference Room
Attendees	See Attachment “attendance list (Cariro EPC : Mgt / Eng / Tech)”

Record of Discussions

NO	ITEM DETAILS
1.	**Introduction**
1.1	This meeting was convened with the objective to discuss the below agenda point: 1) Presentation of JICA Capacity building O&M “Overview of Draft Final Report”(Management) 2) Discussion about potential needs of technical support as the next phase(Management) 3) Hearing the answers of Kansai’s questionnaire, JICA’s questionnaire and APs activities (Engineers/Technicians) 4) Discussion about the Issue Analysis of O&M at TPPs. (Engineers/Technicians) 5) Additional lectures: Air Cooled Condenser (ACC) & Tool Box Meeting (TBM) 6) Others (if any)
2.	**Overview of Draft Final Report(Management)**
2.1	JICA expert (KANSAI) made the presentation on “Overview Of Final Report (Draft)”, containing “Project Summary”, “O&M Training in Japan”, “Issue Analysis in O&M at TPPs” etc. 1) Management told that at present thermal efficiency was not deteriorated. JICA expert explained that they will face the issue in the near future due to the change of operation of TPPs, and management understood the situation. 2) Management told that most troubles occurred in TPPs are I&C related, but understood that mechanical maintenance had greater impact than other maintenance such as electronic and I&C.

NO	ITEM DETAILS
3.	**Interview and discussion with JICA-trained engineers and technicians**
	1) Hearing the answers of Kansai’s questionnaire, JICA’s questionnaire and APs activities (E/T) They disseminated their knowledge to their colleagues by utilizing JICA experts’ materials. JICA expert received their activity reports (Action Plans) and activity pictures (PowerPoint). Their APs shows they implemented their dissemination in small group practically, periodically and constantly. JICA expert admired their activity and asked their bosses to support their APs. (T) They told that operation team and maintenance team started to communicate with each other after the training program in Japan, and that it helped them to enhance their knowledge and skills of operation and maintenance. (T) They started training for safety, and the effect is that they were able to complete two overhaul works without any accidents and injuries. 2) Discussion about the Issue Analysis of O&M at TPPs. (E) They can share failures, troubles and incidents in other TPPs through Chief Engineers. But it would take much times and they cannot grasp the details. (E) They can partially plan, manage and evaluate the planned maintenance, but mostly dependent on manufacturers. (E) They sometimes evaluate and change the maintenance standards regarding the equipment not covered by LTSA. 3) Additional lectures: TBM (Tool Box Meeting) & ACC (Air Cooled Condenser) JICA expert made the explanations on above technical issues briefly. The participants could understand the necessity and importance of pre-work meeting called “TBM” to ensure the safety. And JICA expert hand the ground design of the ACC to engineer with brief explanation.

Capacity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

Meeting with CEPC Attendance List

Date: 19 / July / 2019

Time: 12 : 30 - 13 : 20

Place: CEPC office

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Kansai Electric Power

Capacity Building for Operation & Maintenance of Thermal Power Plant
in Arab Republic of Egypt

Hearing for Participants Attendance List

Date: 1st / July / 2019

Time: 14 : 05 - 15 : 20

Place: Cairo North Power Station

No.	Name	Position	Company	Signature
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Kansai Electric Power

Hearing for Participants Attendance List

No.	Name	Position	Company	Signature
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