USAID
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ENERGY POLICY PROGRAM

BEST PRACTICES IN HYDRO OPERATIONS & MAINTENANCE (O&M)

Oct - Dec, 2014

April 2015

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CONTENT

EXECUTIVE SUMMARY

This assessment report summarizes the responses from EPP's Best Practices in Hydro Operations and Maintenance (O&M) training feedback forms that participants completed in Islamabad between Oct-Dec, 2014.

The Best Practices in Operations and Maintenance training course was designed to develop practices in operating, maintaining, and managing power plant assets. This training not only benefited the participants, but their organization's daily O&M practices, thus improving overall energy services in Pakistan. The training gave participants' the opportunity to meet some truly exceptional professional trainers, and help interact with their colleagues outside of the office. The chart below details the locations of the participants:

Training Entities	Participants
Warsak Power Station	7
Tarbela Power Station	10
Ghazi Barotha Hydro Power Project	13
Chashma and Jinnah Hydel Power Station	6
Small Hydel Power Stations	5
WAPDA House Lahore	7
Mangla Power Station	12
Air University, Islamabad	2
Center for Advanced Studies in Engineering, Islamabad	6
National University of Science and Technology, Islamabad	2
National University of Computers and Emerging Sciences, Islamabad	1
Total	71

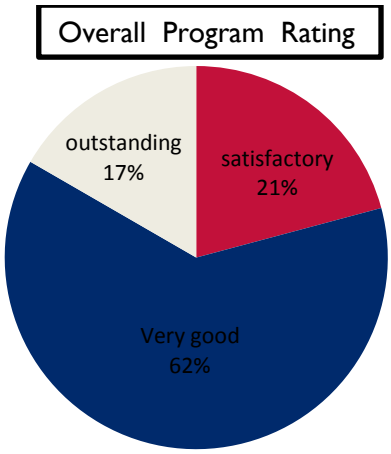
EPP conducted a post training evaluation session with the 71 participants. Participants were asked to elaborate the challenges they encountered, takeaways, and any suggestions for improving the future training. 61% of the participants have shown a positive response towards the training manual and the trainer (**Annex –I Trainers CV**). Participants recommended the following:

- Training duration should be increased
- Training should include field visits regarding the learning procedures of reliability centered maintenance (RCM), failure analysis, turbine, environmental impact assessment and control protection system of the plants.

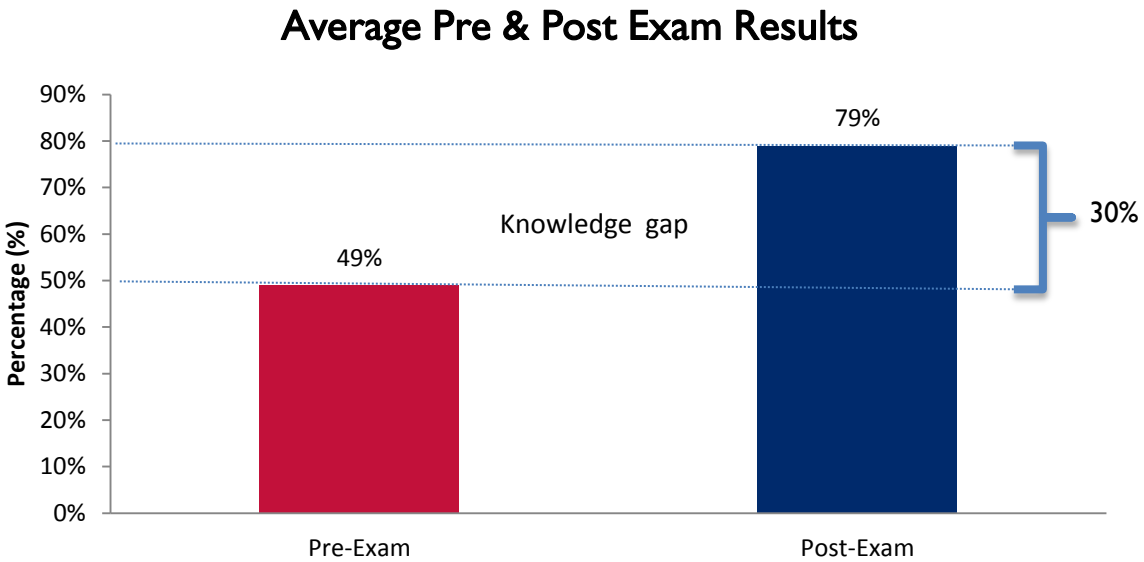
Annex IV – Batch feedback reports summarizes the overall assessment of the training program through the feedback provided by the participants. **Annex V – Pre and post exam results** show participant comprehension improvement from program start to finish.

TRAINING OUTCOMES

62% of the participants rated the overall program, its content, and trainers as "very good", 21% rated the overall program as "satisfactory" whereas, 17% rated the training outstanding. During the face-to-face post training sessions, participants highlighted recommendations and outcomes.



The trainers expressed that the training helped the participants in gaining more theoretical knowledge, and new approach to implement the learned skills, knowledge and attitudes towards better performance at their respective power stations. The pre and post training assessments clearly indicate a substantial increase in the participants' knowledge from the O&M training (**Annex V**). The participants scored an average score of 49% in the pre-exam. While at the conclusion of the training, the participants scored an average score of 79% in the post-exam.



NEXT STEPS

Having participants from different Hydro Power Plants provided a much-needed opportunity to learn from their colleagues. The process was designed to encourage the maximum engagement from participants on the topics discussed during the training program.

Communication Gaps

Participants have suggested hiring trainers, who have English as a first language as it makes communication more effective. Trainers should be made familiar with the techniques and technologies currently being followed at WAPDA and Power Stations before the start of the training course for relevance with the training syllabus. This will help improve interactions between the trainees and trainers. It is recommended to add a language qualifier to future training procurement items.

Site visits

Participants suggested that more filed visits should be organized for the Hydro Power Plants currently integrating the operations and maintenance best practices. These field visits should be combined with videos regarding the practical process of corrective and preventive maintenance systems, environmental impact assessment, control protection systems and Supervisory Control and Data Acquisition.

On-site Training

Moving forward, EPP will use participant recommendations to design an on-site training opportunity for a pilot hydro power plant. Depending on the pilot's success, EPP will suggest ongoing activities to be implemented by USAID's capacity building contract, Training for Pakistan, regarding technical and management interventions.

ANNEX I – TRAINERS CV

[Redacted]

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ANNEX II – TRAINING SYLLABUS

Best O&M Practices, Preventive Maintenance

- Design and Planning
- Plant Environment
- Corporate Business Plans and impact on Plant
- Operation management and organization of technology, reservoir, intake and dam (weir) structures
- Compliance with the agreed-upon amount of water taken from reservoir or river
- Reliability Improvement Programs
- Plant reliability Program Implementation
- Cost and Energy/Water Efficiency, best practice
- Operating costs and charges
- Total cost of implementing the plant
- Methods of assessing the effectiveness of investment and profitability
- Hydrology and Hydrological data assessment
- Models of water flow for erosion prevention
- Operational rules with respect to water flow
- Operation during flood
- Placing of appropriate technology,
- Geological conditions and the availability of suitable sites
- Surrounding nature and appropriate integration into the relief site, prescribing the construction Office or town-planner, a burdens in the construction of power plants, the burden of building connections, the threat to aquatic animals
- Removal and disposal of debris from the water according to the Act on waste,
- Types and construction of intake object
- Types and construction of feeder channels
- Construction of turbines and closing valves
- Construction of generators and their control
- Electrical diagram of a plant
- Electrical equipment
- Mechanical equipment

Plant Operation at Best Efficiency Point

- Types and division of Hydro Power Plants, types of water turbines – impulse / reaction, pumps, energetic and operational characteristics and its properties
- Construction/design of water turbines, gates and
- Mechanical equipment of water turbines, bearings, turbine auxiliaries, auxiliary systems for water turbine equipment, waterway systems, penstocks, surge shafts, valves and closing elements, etc.
- Model testing of water turbines, scale-up of parameters to the prototype, methods of measurement of hydraulic values, and uncertainty of measurement
- Testing during commissioning of the units
- Performance testing for verification of the guaranteed data – steady operation; performance testing for verification of the guaranteed data – transient operation
- Main standards for testing of water machines on model & in situ
- Measurement methods of Q, P, H including practical examples from measurement
- Calculation of measurement results and comparison/evaluation with guaranteed values Calculation of Power Plant efficiency, methods of optimization connected with operation of individual units to achieve the maximum Plant efficiency
- Cavitation tests on the model, sigma Plant, influence and consequences for the cavitation pitting on turbines

Instrumentation Protection and Controls for Hydro Plants and Switchyard

- Plant concept and configuration
- Main components of a power plant
- Fundamentals of Instrumentation and Control
- Control system, measurements and instruments used in a power plant control, measurement signaling, recording, logging, interlocks
- Monitoring and diagnostics systems for damage prevention
- Faults type and effects
- Fundamentals of protection systems
- Hazards in a power plant; hidden failures.
- Operational instrumentation outfit on turbines, turbine instruments connected into the automatic system and unit control
- Description of measurement methods & instruments, data analysis, measurement and valuation of vibrations / pressure pulsations , influence of vibrations / pulsations for service life of the units
- Online monitoring, diagnostics of the water turbines
- Calibration of sensors, methods of calibration on site
- Principles of the expert analysis, database of failure Prevention and preceding of the equipment failures

Supervisory Control and Data Acquisition (SCADA) systems

- Systems overview and construction
- Incorporation of power plant to distribution network monitoring system
- Design requirements for a Plant
- Performance Monitoring
- Performance Testing
- Instrument Data Validation
- Periodic Test Program and test procedures
- Online Performance Monitoring
- Index tests, optimization of cam in dependence on changes of operational conditions, optimal operation of two and more units
- Description of measurement methods, analysis of measured data
- Diagnostics of vibrations, pressure pulsations
- Description and reasons of emergency states at the Power Plant
- Types of governing systems – power control, water flow control, water level controls

Generator protection and Excitation systems

- The course provides general overview of construction, maintenance and adjustment of the system.

Governing system (electrical digital part and hydraulic power part) governors — Maintenance issues

- Course provides brief interview to systems used and their construction, operation and maintenance.
- Description of Governor Hydraulic Pressure Unit (HPU), functions of individual blocks of HPU, activation and adjustment, examples from operation of the Power Plants.

Reliability Analysis and operation of intake structure, water reservoir, gates and all associated plant equipment

- Course will provide introduction to best practice in maintenance management and hydrology. Construction of Main Equipment of the plant will be introduced.

- Maintenance Organization and planning
- Maintenance documents
- Plant Maintenance program development
- Maintenance and Performance Data Collection
- Failure Analysis
- Maintenance Program Implementation
- Maintenance Cost analysis and reporting
- Spare parts monitoring and planning
- O&M outsourcing, Contract Types
- Lean maintenance methodologies
- CM Power data analysis
- PA555-1 / PAS55-2

International standards applicable for hydro power industry including testing codes for the commissioning of hydro power plants (turbines, generators and transformers)

- Introduction to IEC and EN standards.

Repair and maintenance of GIS, numerical protection relays and Digital Control System

- Introduction to the repair and maintenance of GIS, protection relays and DCS of the hydro power plant.

ANNEX III – PARTICIPANTS CONTACT INFORMATION

[Redacted]

[Redacted]

ANNEX IV – BATCH FEEDBACK REPORTS

TRAINING DATES: OCTOBER 20TH-31ST, 2014

The Energy Policy Program (EPP) successfully delivered the first of the three anticipated training courses on *Best Practices in Hydro Operations and Maintenance (O&M)* from October 20th– 31st, 2014 in Islamabad, Pakistan. Twenty four participants (16 males and 8 females) International power sector experts Filip Kysnar, Petr Kalandra, Tomáš Hladík, Zdenek Cepa from Czech Republic led the training courses.

The two-week course was focused on Best O&M Practices, Preventive Maintenance, Plant Operation at Best Efficiency Point, Instrumentation Protection and Controls for Hydro Plants and Switchyard, Supervisory Control and Data Acquisition (SCADA) systems, Generator protection and Excitation systems, Governing system (electrical digital part and hydraulic power part) governors — Maintenance issues, Reliability Analysis and operation of intake structure, water reservoir, gates and all associated plant equipment, International standards applicable for hydro power industry including testing codes for the commissioning of hydro power plants (turbines, generators and transformers), Repair and maintenance of GIS, numerical protection relays and Digital Control System.

Key Participant Indicators

- Number of Participants Trained: 24
- Gender Disaggregation: 16 Male and 8 Females

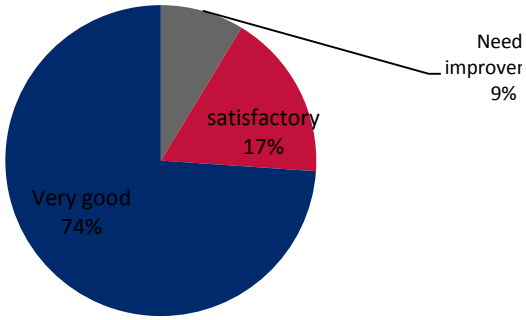
Upon conclusion of the course, post-training evaluation forms with ten questions were presented to and completed by all of the participants. The summary data from the evaluation forms is presented below:

Please tick in appropriate box: ***5 outstanding, 4 very good, 3 satisfactory, 2 needs improvement, 1 did not meet expectations***

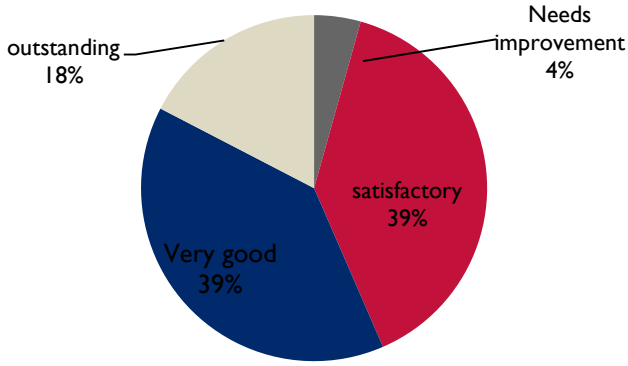
I. Program Rating	Did not meet expectations	Needs improvement	satisfactory	Very good	outstanding
Relevance to your organization's work area	0	2	4	17	0
Structure of the program	0	1	9	9	4
Topics covered in the program	0	4	6	12	1
Quality of class room interactions	0	1	8	11	3
Quality of training and reading materials	0	3	5	14	1
Appropriateness of reading materials	0	2	7	13	1
Quality of Speakers/Trainers	0	2	7	12	2
II. Program Content and Trainers	**Did not meet expectations**	**Needs improvement**	**satisfactory**	**Very good**	**outstanding**
Training Content & Relevance	0	3	6	13	1
Trainer/Speaker Effectiveness	0	1	5	16	1

According to participant responses, the below pie charts illustrate the "satisfaction rating figures" for each category:

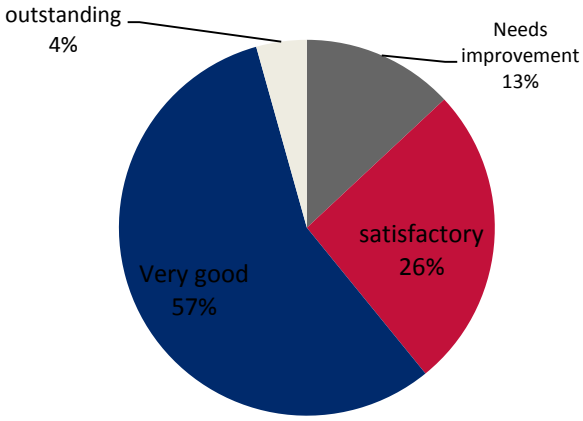
Relevance to your organization's work area



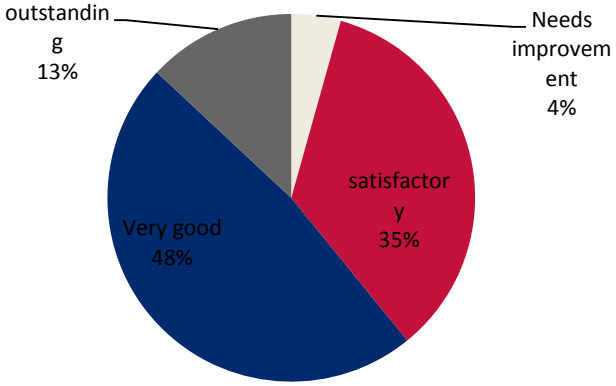
Structure of the program



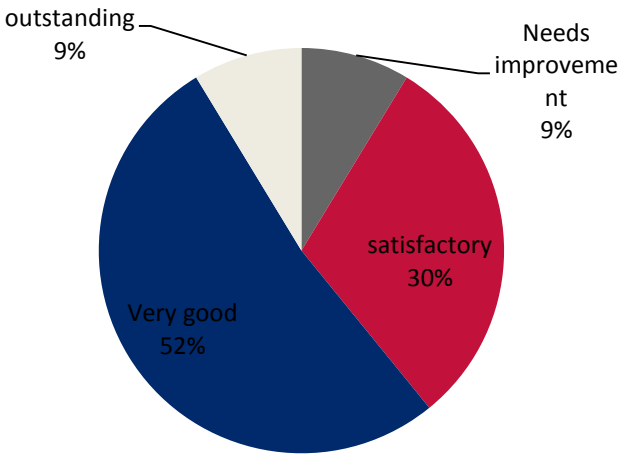
Training Content & Relevance



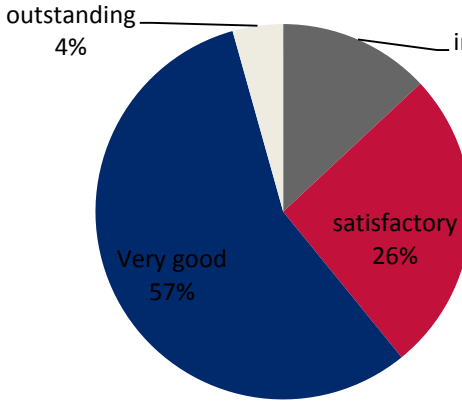
Quality of class room interactions



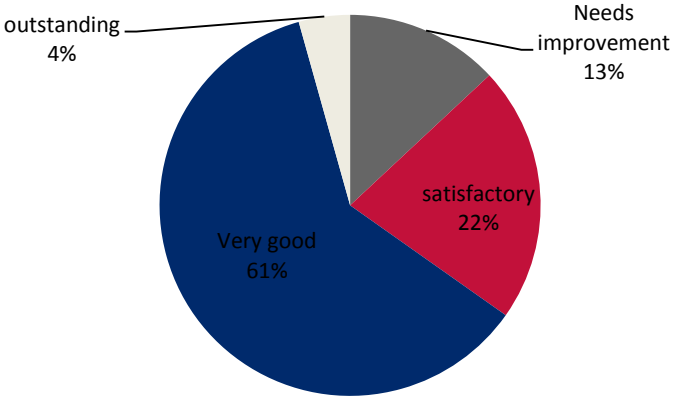
Quality of Speakers/Trainers



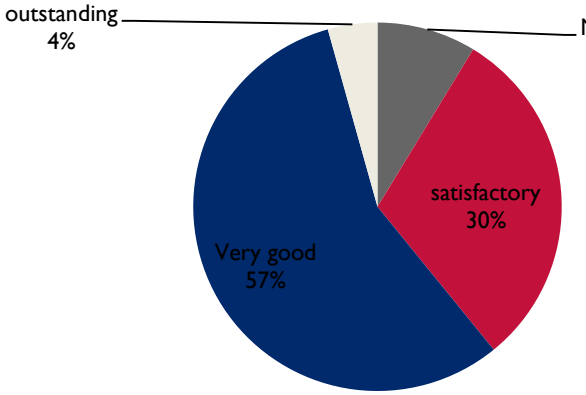
Training Content & Relevance

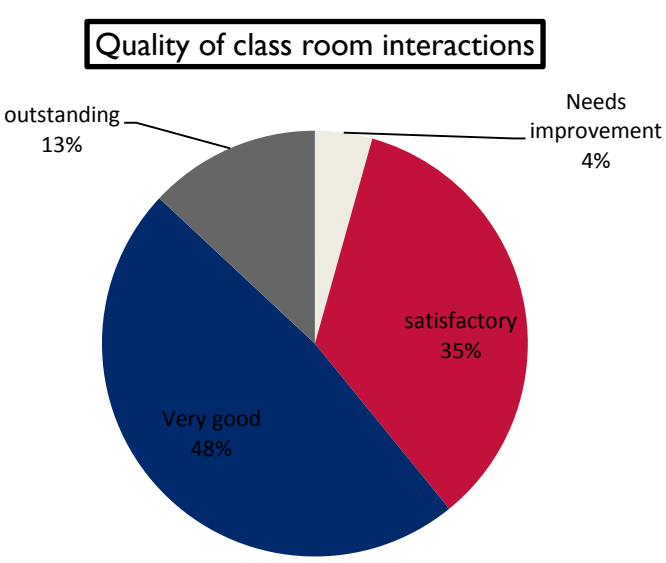


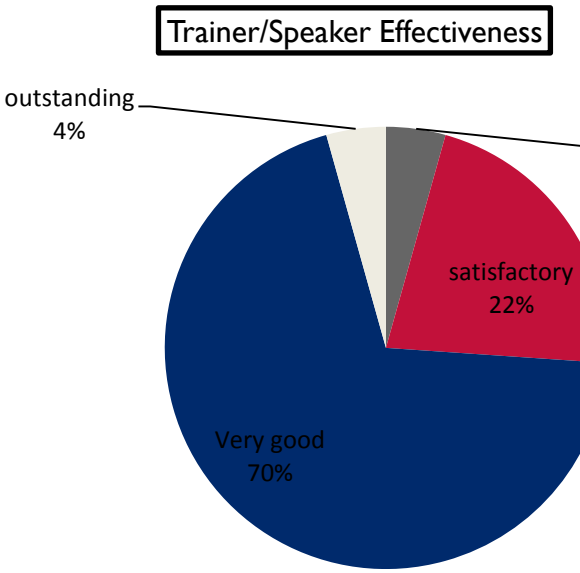
Quality of training and reading materials



Appropriateness of reading mate




Quality of class room interactions
outstanding
13%
Needs
improvement
4%
satisfactory
35%
Very good
48%


Trainer/Speaker Effectiveness
outstanding
4%
satisfactory
22%
Very good
70%

SPECIFIC PARTICIPANT FEEDBACK

Please share any other observation or comments regarding the trainer/training program/logistics:

Participants were asked to share their observations and comment regarding the trainer, training and logistics, all of them have shared their observations. Almost all the participants found the training very beneficial for them while mentioning:

"All the trainers were very competitive and experienced in their relative fields. Training program and all the other facilities provided by EPP were excellent"

"I found the training course very knowledgeable and no doubt that the training will prove to be beneficial to us regarding the modern O&M techniques"

"Training content was more as compared to the training course duration"

"Training content needs improvement as it covers more of the management part of the hydro power plant. Moreover, there should be industrial visits for better practical learning of the learned techniques"

"The training program was very good and the trainers were excellent, but some of them had interaction issues due to their native accents. The communication was good but not understandable at times"

Before you received this training, how would you describe your knowledge of operation and maintenance systems and procedures required for Hydro power?

Keeping in view all the responses it showed that before this training most of the participants had limited knowledge and after the training all of them have developed significantly, participants said:

"Before this training, our knowledge about the O&M practices was very limited but after receiving training from the international trainers, our O&M skills have improved"

"I have got so many trainings from WAPDA, but this Operations & Maintenance training was more comprehensive"

"I work at Mangla Power Station, where I have experienced confusion performing the O&M activities which are now cleared with all the lessons learned"

"Most of the procedures were of routine use of practices, but now we can make a systematic approach towards Operations and maintenance practically"

What specific skill did you gain as a result of this training?

Participants were asked to address the specific skills that they have gained during this training; and they wrote:

"I gained more insight about international standards, asset management, optimal operation techniques, and HPP structures"

"I got to know about the modern techniques which are implemented internationally that I did not know before this training. Moreover, got a chance to work closely for the course of the training with fellow engineers from WAPDA and Hydro Power Plants"

"I learned to deal with fault diagnostics, equipment testing procedures, assessment models and lean maintenance techniques. Trainers have explained this entire topic in detail which would help us in performing these operations"

How will your organization benefit from Hydro Operation and Maintenance (O&M) training in both the short term and long term?

The training strategy was based on organizational improvements so that the staff and the organization can achieve their set targets, objectives and both personal and corporate goals. Participants were asked to express how their organization will be benefited from Hydro Operation and Maintenance training in short and long term, they shared:

"Whatever I have gained from this training, I will forward the manuals and presentations to other fellow colleagues at Hydro power plant"

"Revision of existing of O&M tools and valuable knowledge will increase the efficiency of the power plants thus increasing the operations and maintenance procedures"

"Our organizations will definitely get benefit from the training content taught by experienced trainers because these procedures and techniques will help us improve the planning and management at the plants"

"I belong from an educational institution so this O&M training will help us to deliver more practical knowledge base on the training content taught during the training course. It will also help in overcoming the prevailing problems of Hydro Power Plant in our country"

What was missing in the Hydro Operation and Maintenance Training?

Participants shared their respective views and stated:

"Training duration was short and training content required more time for better understanding"

"Some of the issues regarding the switchyard equipment, design and contractual details, details on SCADA and protection required more details"

"Training should be a mix of theoretical and practical learning followed by industrial trips"

"Materials were not given on the major overhauling of the tribune. Techniques of reassembling the turbines, running the statically balance, turbine shifts and alignments, and how to center the turbine unit"

Do you have any suggestions for how we could improve future Operation and Maintenance trainings?

All the participants have different views about how to improve future Hydro Operation and Maintenance trainings, most of the participants have complained about the time duration they thought the time period for such technical training could have been increased, as they mentioned:

"Trainers should be made familiar to the techniques and technologies used at WAPDA prior to the training course for relevant information in the presentations. This will improve interactions between the trainees and trainers proving to be more beneficial"

"Provide the presentations and other training material in soft copy as well"

"Training duration should be increased keeping in view the lengthy training content which needs time for better comprehension"

"Similar training should be organized for maximum number of engineers from WAPDA to improve the skill set in achieving the organizational goals"

Training dates: November 10th – 21st, 2014

The Energy Policy Program (EPP) successfully delivered the first of the three anticipated training courses on Best Practices in Hydro Operations and Maintenance (O&M) from November 10th-21st, 2014 in Islamabad, Pakistan. Twenty three participants (20 males and 3 females) International power sector experts Filip Kysnar, Petr Kalandra, Tomáš Hladík, Zdenek Cepa from Czech Republic led the training course.

The two-week course was focused Best O&M Practices, Preventive Maintenance, Plant Operation at Best Efficiency Point, Instrumentation Protection and Controls for Hydro Plants and Switchyard, Supervisory Control and Data Acquisition (SCADA) systems, Generator protection and Excitation systems, Governing system (electrical digital part and hydraulic power part) governors — Maintenance issues, Reliability Analysis and operation of intake structure, water reservoir, gates and all associated plant equipment, International standards applicable for hydro power industry including testing codes for the commissioning of hydro power plants (turbines, generators and transformers), Repair and maintenance of GIS, numerical protection relays and Digital Control System.

Key Participant Indicators

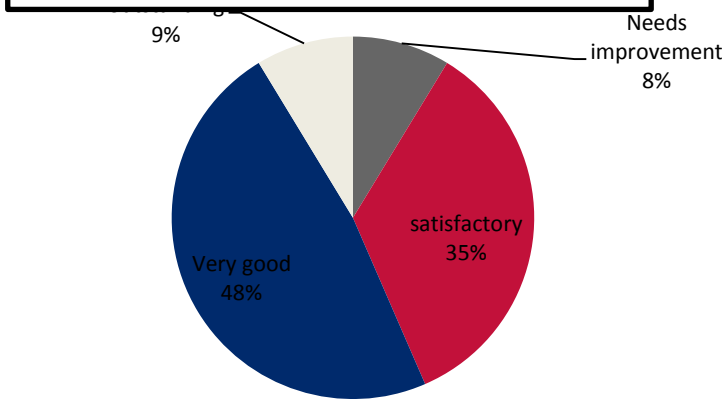
- Number of Participants Trained: 23
- Gender Disaggregation: 20 males and 3 females

Upon conclusion of the course, post-training evaluation forms with ten questions were presented to and completed by all of the participants. The summary data from the evaluation forms is presented, below:

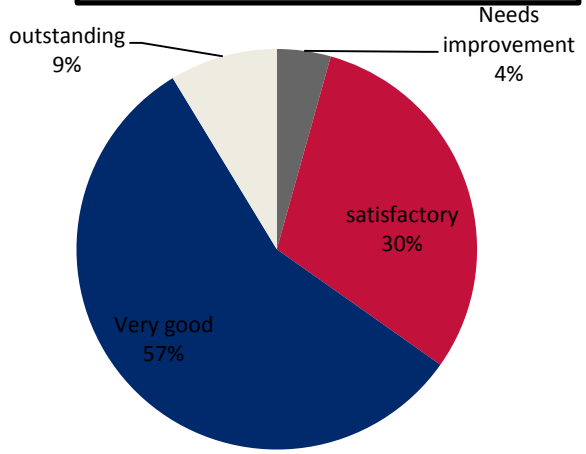
Please tick in appropriate box: ***5 outstanding, 4 very good, 3 satisfactory, 2 needs improvement, 1 did not meet expectations***

I. Program Rating	Did not meet expectations	Needs improvement	Satisfactory	Very good	Outstanding
Relevance to your organization's work area	0	2	8	11	2
Structure of the program	0	1	7	13	2
Topics covered in the program	0	2	7	13	1
Quality of class room interactions	1	2	7	8	5
Quality of training and reading materials	0	2	6	14	1
Appropriateness of reading materials	0	2	6	15	0
Quality of Speakers/Trainers	0	6	9	8	0
II. Program Content and Trainers	**Did not meet expectation**	**Needs improvement**	**Satisfactory**	**Very good**	**Outstanding**
Training Content & Relevance	0	3	6	13	1
Trainer/Speaker Effectiveness	0	4	11	7	1

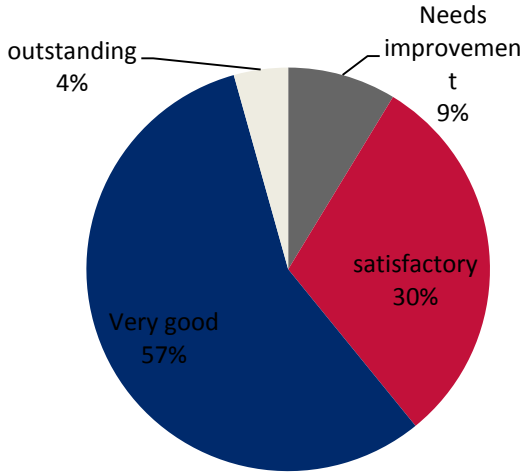
Relevance to your organization's work area



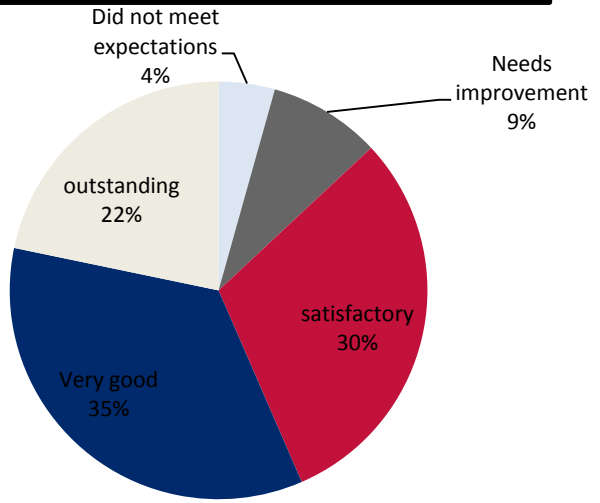
Structure of the program



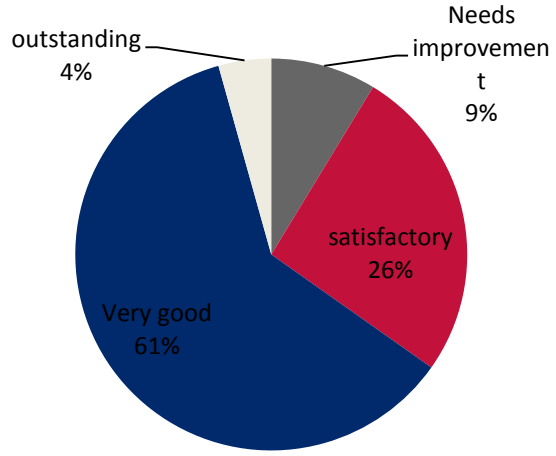
Topics covered in the program



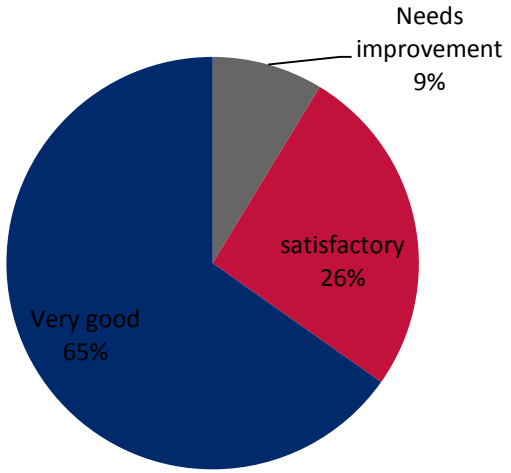
Quality of class room interactions



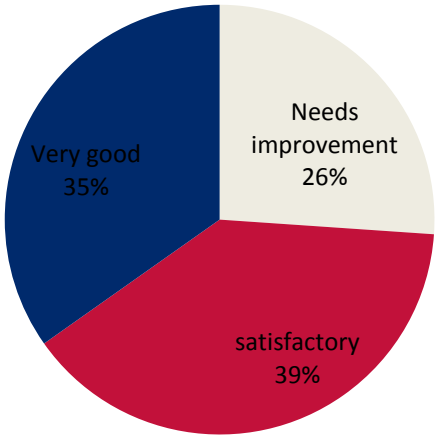
Quality of training and reading materials



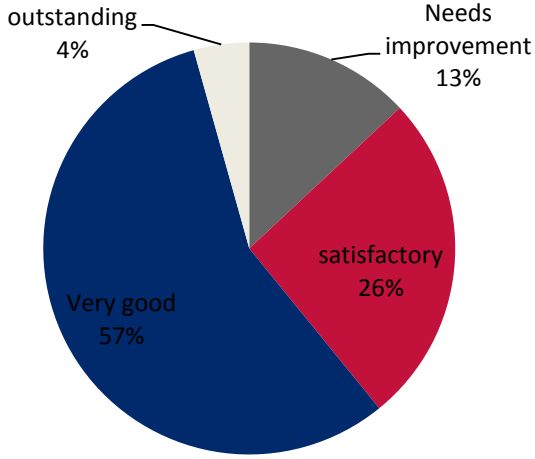
Appropriateness of reading materials

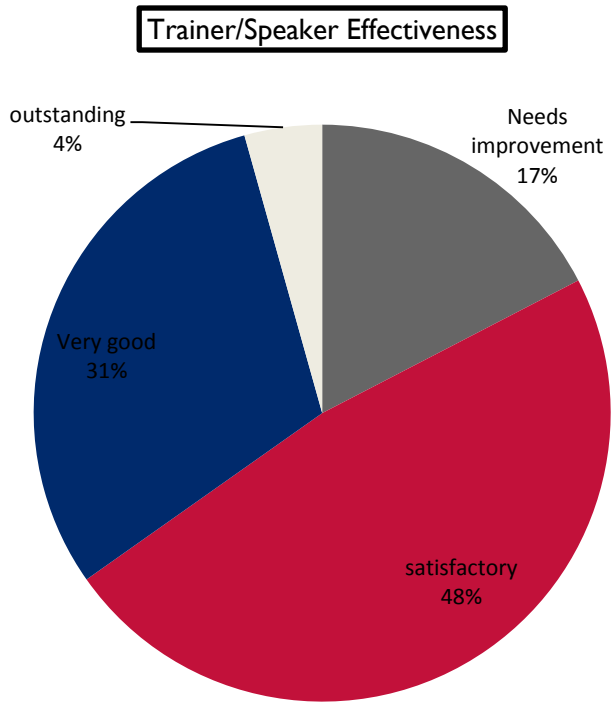


Quality of Speakers/Trainers



Training Content & Relevance




Trainer/Speaker Effectiveness
outstanding
4%
Needs
improvement
17%
Very good
31%
satisfactory
48%

SPECIFIC PARTICIPANT FEEDBACK

Participants were asked to share their observations and comment regarding the trainer, training and logistics, all of them have shared their observations. Almost all the participants found the training very beneficial for them while mentioning:

"The training was fantastic but I think trainers should be from some English country because there was a communication gap. Though the trainers were exceptionally competent but still have issues communicating in English"

"Training manual should include more real life examples for better understanding of the real issues happening at the plants. Trainer's communication skills needs improvement"

"The training was highly beneficial as it covered almost all the area of hydro power plant right from design, planning, feasibility etc. up to commissioning operations and proper maintenance"

"Training content was good but important parts of the plant like PPEs, first aid, safety equipment should be included as well. Moreover, some chapters related to firefighting should also be included for awareness and safety measurements"

"Training content needs improvement as it covers more of the management part of the hydro power plant. Moreover, there should be industrial visits for better practical learning"

"Training content was really lengthy and requires more time. Training should be for at least a month"

Before you received this training, how would you describe your knowledge of operation and maintenance systems and procedures required for hydro power?

Keeping in view all the responses it showed that before this training most of the participants had limited knowledge and after the training all of them have developed significant skills and knowledge about the operation and maintenance techniques, as the participants said:

"Before this training, I was unaware of the modern developments in the field of operation and maintenance techniques at Hydel plants. All the training content was skillfully demonstrated and explained during the O&M training"

"Before the O&M training we lacked knowledge about the international standards being followed at the Hydro plants. We had very limited knowledge before enrolling into this training program but after receiving the training from the international trainers, our O&M skills have significantly improved"

"As an engineering student, I have known all the theoretical knowledge but had a very little idea of the practical workings at the plant. This training has helped me in understanding the plant in depth along with the operation and maintenance practices and techniques"

"Before the training, our knowledge about O&M practices was restricted to our plants"

What specific skill did you gain as a result of this training?

Participants were asked to address the specific skills that they have gained during this training; and they wrote:

"I gained more insight about international standards, maintenance management, and effective spare parts management"

"Details of corrective/preventive maintenance systems, protection and control systems, project feasibility were discussed in great depth and gave a good insight about their workings at the plant"

"Learned a lot about design, planning, feasibility, environmental impact assessment, asset management, control protection systems of the power plants"

"Our technical knowledge regarding the technical details about the turbines, SCADA and other electrical system has improved a lot significantly"

How will your organization benefit from Hydro Operation and Maintenance (O&M) training in both the short term and long term?

The training strategy was based on organizational improvements so that the staff and the organization can achieve their set targets, objectives and both personal and corporate goals. Participants were asked to express how their organization will be benefited from Hydro Operation and Maintenance training in short and long term, they shared:

"I am confident that I will be able to contribute considerably to benefit my organization due to the skills I have gained from this training"

"Our organization train youth which will promote higher managerial level and decision making ranks; so this training might add in towards the positivity of the O&M operations"

"Implementation of the learned skills and attitudes will be beneficial for the organization in achieving maximum output and performance at the highest level of efficiency for better organizational long term performance"

"From now onwards we will be able to identify the cause of the faults by following the latest techniques and in the long term implementation of the skills learned will be beneficial for our organization"

"Surely, this training will have huge impact on Hydro plants. Skills gained will be utilized to achieve organizational goals much more efficiently"

"In short-term I will try to implement all the skills and techniques I gained during this training and in the long-term impact I will train my fellow colleagues and subordinates for better future performance"

What was missing in the Hydro Operation and Maintenance Training?

Participants shared their respective views and stated:

"Topics related to firefighting should also be included for awareness and safety requirements"

"Topics e.g. financial analysis, economic analysis, sensitivity analysis, profit and loss statement were missing from the training content"

"The quality of trainer's English language was poor and a major reason of communication barrier throughout the training"

"Training should include more industrial trips. It would help all the participants to understand the practical aspects of the training"

"Training content was good but important parts of the plant like PPEs (Personal Protection Equipment), first aid, safety equipment should be included as well. Moreover, some chapters related to firefighting should also be included for awareness and safety requirements"

"Videos, they give a good insight and knowledge about the topics. It helps enhance the understanding of students like me"

Do you have any suggestions for EPP, how we could improve future operation and maintenance trainings?

All the participants have different views about how to improve future Operation and Maintenance trainings, most of the participants have complained about the time duration they thought the time period for such technical training could have been increased, they mentioned:

"Fresh graduate should be given a chance to learn new best practices as it will be helpful in their future careers"

"Course duration should be extended from two-weeks, trainers should have some idea of Pakistani power stations. More field visits should be arranged"

"Trainers should be made familiar to the techniques and technologies used at power plants in Pakistan prior to the training course for relevant information in the presentations. This will improve interactions between the trainees and trainers proving to be more beneficial"

"Training duration should be increased keeping in view the lengthy training content which needs time for better comprehension"

"EPP should also arrange visits to the plants and different working environment so, that trainees can see actually what are the working procedures according to the techniques learned"

Training dates: December 8th – 19th, 2014

The Energy Policy Program (EPP) successfully delivered the first of the three anticipated training courses on Best Practices in Hydro Operations and Maintenance (O&M) from December 8th – 19th, 2014 in Islamabad, Pakistan. Twenty three participants (20 males and 4 females) International power sector experts Filip Kysnar, Petr Kalandra, Tomáš Hladík, Zdenek Cepa from Czech Republic led the training course.

The two-week course was focused Best O&M Practices, Preventive Maintenance, Plant Operation at Best Efficiency Point, Instrumentation Protection and Controls for Hydro Plants and Switchyard, Supervisory Control and Data Acquisition (SCADA) systems, Generator protection and Excitation systems, Governing system (electrical digital part and hydraulic power part) governors — Maintenance issues, Reliability Analysis and operation of intake structure, water reservoir, gates and all associated plant equipment, International standards applicable for hydro power industry including testing codes for the commissioning of hydro power plants (turbines, generators and transformers), Repair and maintenance of GIS, numerical protection relays and Digital Control System

Key Participant Indicators

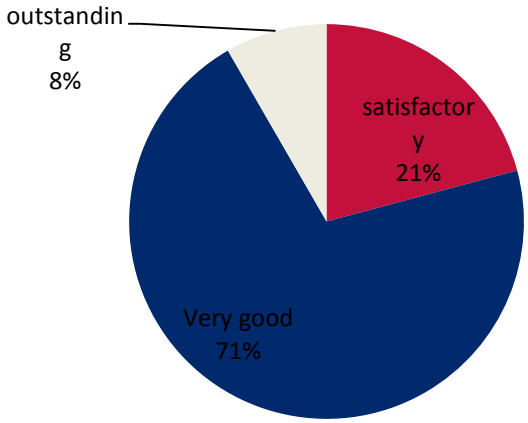
- Number of Participants Trained: 24
- Gender Disaggregation: 20 males and 4 females

Upon conclusion of the course, post-training evaluation forms with ten questions were presented to and completed by all of the participants. The summary data from the evaluation forms is presented, below:

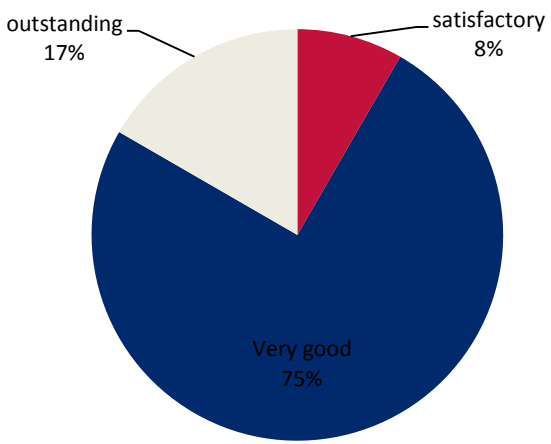
Please tick in appropriate box: ***5 outstanding, 4 very good, 3 satisfactory, 2 needs improvement, 1 did not meet expectations***

I. Program Rating	Did not meet expectations	Needs improvement	satisfactory	Very good	outstanding
Relevance to your organization's work area	0	0	5	17	2
Structure of the program	0	0	2	18	4
Topics covered in the program	0	2	4	13	5
Quality of class room interactions	0	3	7	12	2
Quality of training and reading materials	0	0	5	15	4
Appropriateness of reading materials	0	0	6	16	2
Quality of Speakers/Trainers	0	3	3	15	3
II. Program Content and Trainers	**Did not meet expectation**	**Needs improvement**	**satisfactory**	**Very good**	**outstanding**
Training Content & Relevance	0	0	2	17	5
Trainer/Speaker Effectiveness	0	3	6	15	0

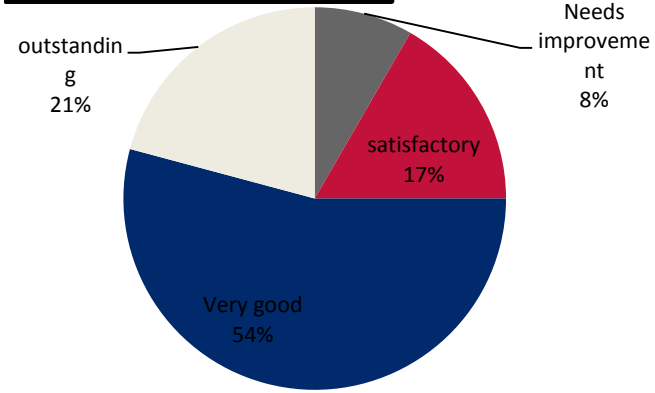
Relevance to your organization's work area



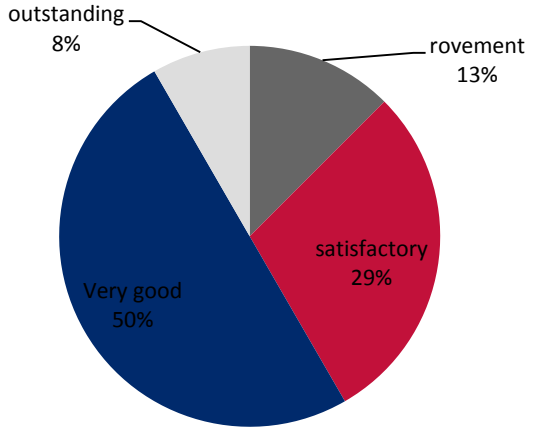
Structure of the program



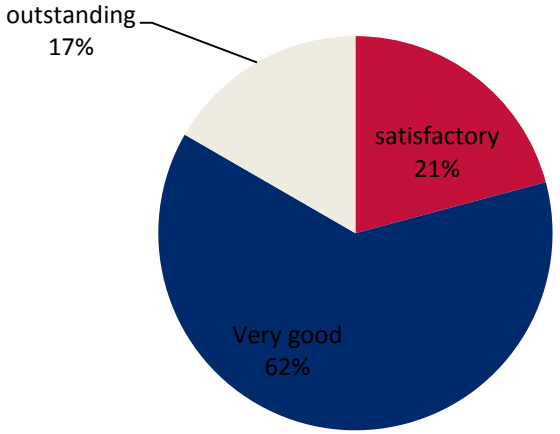
Topics covered in the program



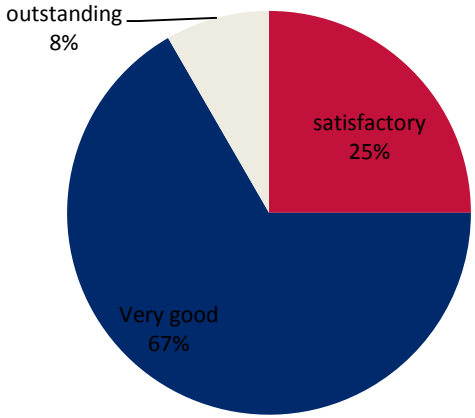
Quality of class room interactions



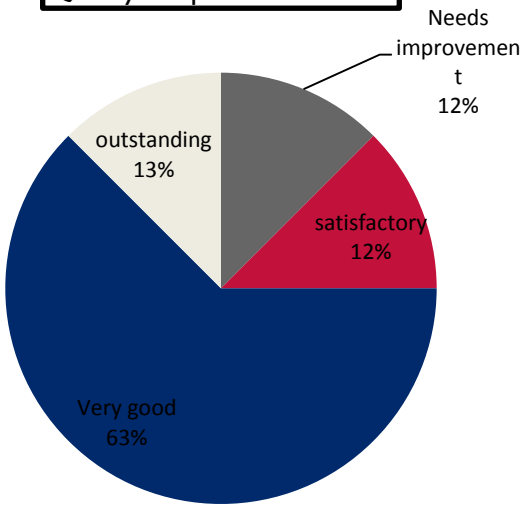
Quality of training and reading materials

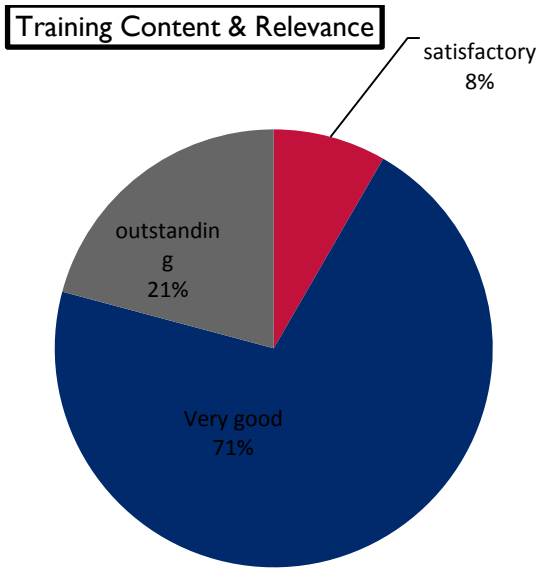


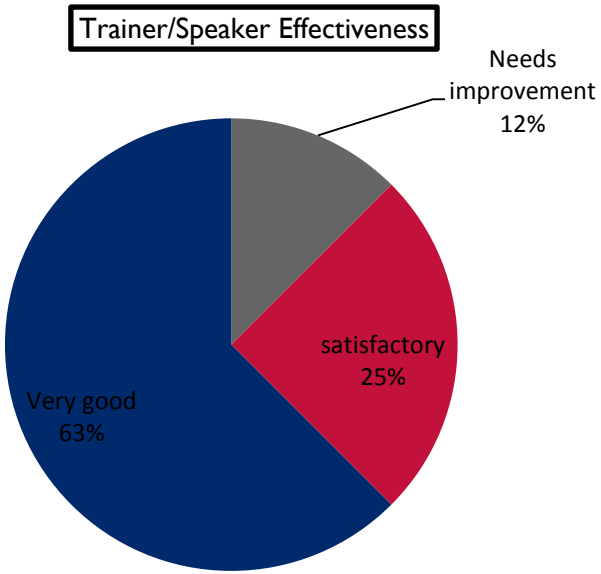
Appropriateness of reading materials



Quality of Speakers/Trainers




Training Content & Relevance
satisfactory
8%
outstandin
g
21%
Very good
71%


Trainer/Speaker Effectiveness
Needs
improvement
12%
satisfactory
25%
Very good
63%

PARTICIPANTS' FEEDBACK

Participants were asked to share their observations and comment regarding the trainer, training and logistics, all of them have shared their observations. Almost all the participants found the training very beneficial for them while

"Few of the trainers had language problems due to which they could not deliver according to their actual potential"

"The trainers were competent and they had a lot of the knowledge regarding the program but one of the trainers had a problem of communication due to language barrier"

"Training was very useful and helpful for us from management point of view. In addition to all the new and advance systems of operations and maintenance of Hydel power station information delivered"

"As I have recently graduated, so I have learned a lot from this training. The trainers were exceptionally competent and experienced in their fields. Their way of delivering their knowledge was impressive"

"Training was very effective and improved our operation and maintenance skills. Period of training should be long to cover all the topics and it should split into sections e.g. Electrical, Mechanical and Civil Section"

"Training was excellent, skill boosting, practical and equipped us with modern day techniques followed by international Hydel power plants"

Before you received this training, how would you describe your knowledge of operation and maintenance systems and procedures required for hydro power?

Keeping in view all the responses it showed that before this training most of the participants had limited knowledge and after the training all of them have developed significant skills and knowledge about the O&M techniques, as they stated:

"Knowledge of operation and maintenance along with a procedure was good but there were some flaws which were covered in this training"

"After the training my vision of operations and maintenance systems by learning of latest techniques has improved"

"Before the training all in the work carried out normally but now it will be in appropriate ways"

"Since I have 7 years of experience and learning just doesn't stop at any stage. I learned many dos and don'ts from this training which I was overlooking previously"

"Before this training, we were unaware of the new techniques and the training had really provided us an opportunity to live in this environment to learn and share our ideas with our fellow friends, we are confident after doing trainings"

"Before this training, I was unaware of the modern developments in the field of operation and maintenance techniques at Hydel plants. All the training content was skillfully demonstrated and explained during the O&M training"

"Before the training, our knowledge about O&M practices was restricted to our plants"

What specific skill did you gain as a result of this training?

Participants were asked to address the specific skills that they have gained during this training; and they wrote:

"I gained skills from the design aspect of training, more insight about FIDIC standards, maintenance management, and effective spare parts management"

"The knowledge of operation and maintenance system before training was also very good that helped us in enhancing our existing knowledge"

"Following are the skills I gained during the training; asset management –PAS 55 and ISO 5500, failure analysis, and reliability centered maintenance (RCM)"

"Better preventive maintenance of plant and inventory of store and spare parts planning and proper documentation and history for fault rectification"

"O&M practices helped in plant operations at best efficiency point, instrumentation protection and control of plant and switchyard, SCADA system, governing system and reliability analysis"

"I learned maintenance of power plants especially equipment testing and fault diagnosing"

"Learned the new trends being followed all over the world in Hydro power plants, we have updated our knowledge, skills and attitudes as per the latest techniques in operation and maintenance field of power plant"

"Learned a lot about asset management, condition assessment of the power house with the use of new and latest equipment and techniques"

How will your organization benefit from Hydro Operation and Maintenance (O&M) training in both the short term and long term?

The training strategy was based on organizational improvements so that the staff and the organization can achieve their set targets, objectives and both personal and corporate goals. Participants were asked to express how their organization will be benefited from Hydro Operation and Maintenance training in short and long term, they shared:

"Our organization which is purely deals with engineering and electrical power so we will after imparting these techniques will apply in our practical fields that will be beneficial definitely"

"Certainly the organization and especially power sector will be enhanced in both long and short term"

"My organization will benefit from this training in the field of O&M of the power houses rehabilitation of the old equipment and their maintenance"

"I will share my knowledge what I have gained from this training with the colleagues and follow the missing steps, which were previously ignored"

"This training helped us in bringing positive change to the way we use to take decisions concerning the operation and maintenance field"

"We will apply the latest techniques and procedures we learned at our work stations along with the ideas of renewable energy sources in the current energy crisis situation in Pakistan"

"Proper planning of spare part inventory, improve preventive and pro-active maintenance for new projects and their respective planning, contract system and its implementation"

"The trainers were helpful with regards to operation and maintenance of Hydro power plant. By adopting the procedures learnt during training and implementing those will benefit in the long term"

"Our organization will be benefited by this training on long term basis once we introduce the advance and new systems at the power station"

"From now onwards we will be able to identify the cause of the faults by following the latest techniques and in the long term implementation of the skills learned will be beneficial for our organization"

"Surely, this training will have huge impact on Hydro plants. Skills gained will be utilized to achieve organizational goals much more efficiently"

"It will help improve the management activities and implementation of newly learned techniques"

What was missing in the Hydro Operation and Maintenance Training?

Participants shared their respective views and stated:

"A little more interaction and orientation of training from O&M perspective should have been included. Language barrier was also an issue for few of the trainers"

"Trainers should focus more on the maintenance part because their main focus was on the commissioning side of the training"

"There must be some insight about the project management and financial management topics in the training"

"Less video related to the topics were showed"

"A visit to Hydro power plant was missing as some students has never been to any of the plants, and they had some difficulties understanding the actual systems"

"Time period of the training course covering the topics was limited and it is very difficult to learn completely in short time period"

"Group discussion on relevant topics"

Do you have any suggestions for EPP, how we could improve future operation and maintenance trainings?

All the participants have different views about how to improve future Operation and Maintenance trainings, most of the participants have complained about the time duration they thought the time period for such technical training could have been increased, they mentioned:

"Such trainings should be arranged frequently and should cover the topics in more detail"

"EPP/Trainers should know the level of engineers/technology installed at the power station so that they can guide us for transition of technology and innovation of power plant"

"Duration of the training program must be increased along with visits of international power plants"

"EPP should improve training by introducing group discussions and practical tour of the field"

"EPP should also arrange visits to the plants and different working environment so, that trainees can see actually what are the working procedures according to the techniques learned"

"Training should be more specific instead of generation, live mechanical maintenance, electrical maintenance, procurement and contract management etc."

ANNEX V – PRE & POST EXAM RESULTS

[Redacted]

[Redacted]

[Redacted]

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