

(Final report)

A Work Plan  
For  
The “North-East Asian Training Center  
for Pollution Reduction in Coal-fired Power plant”

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# **1. Objective and scope of the Center**

## **A. Objective: necessity and objective**

In many locations in North-East Asia, localized air pollution is a serious problem. And most of the air pollution problems identified in this region are confined to areas of densely populated metropolitan region, areas of heavy industrialization and areas of high coal consumption. In many of the large urban areas of North-East Asia, pollutant concentrations are already exceeded the World Health Organization (WHO) limits recommended for particulate matter and sulfur dioxide. And the continuous development of fossil fuel energy systems, mostly involving coal combustion, will affect seriously the global environment, local and regional ecosystems and public health with increasing emissions of carbon dioxide, sulfur dioxide, nitrogen oxides, and particulate matter.

In order to prevent this impending environmental crisis, the countries in North-East Asia would need to take action to prevent increasing pollution through help and cooperation among countries. And it is necessary to consider operation and maintenance (O&M) improvements, retrofits and refurbishment to increase their efficiency and to make lower their pollution emissions for existing coal-fired power plants,.

It could be said that establishing training center for pollution reduction in coal-fired power plant is timely project preventing these problems.

The main objectives of the training center could be:

- (1) to assist power plants in North-East Asia region by providing necessary training related to environmentally sound power generation including pollution control,
- (2) to respond to requests from various North-East Asian countries for training on power plant O&M practice and retrofit and upgrade technologies for increasing power plant efficiency and decreasing emissions of air pollutants, and
- (3) to discuss on new technologies and current RD&D activities of

participating countries

The North-East Asia Training Center for Pollution Reduction in Coal Fired Power Plant would provide information and improve understanding of environmental situations for operators and managers of coal-fired power plants through training. The training center would enhance the capacity of member countries in coal-fired power plant best operating and maintenance practices, and equipment upgrades and retrofits to increase power plant efficiency and decrease emissions of air pollutants. Training center would provide the necessary technical skills and expertise to other national centers in North-East Asia.

#### B. Scope of the center : Managerial staffs and organization

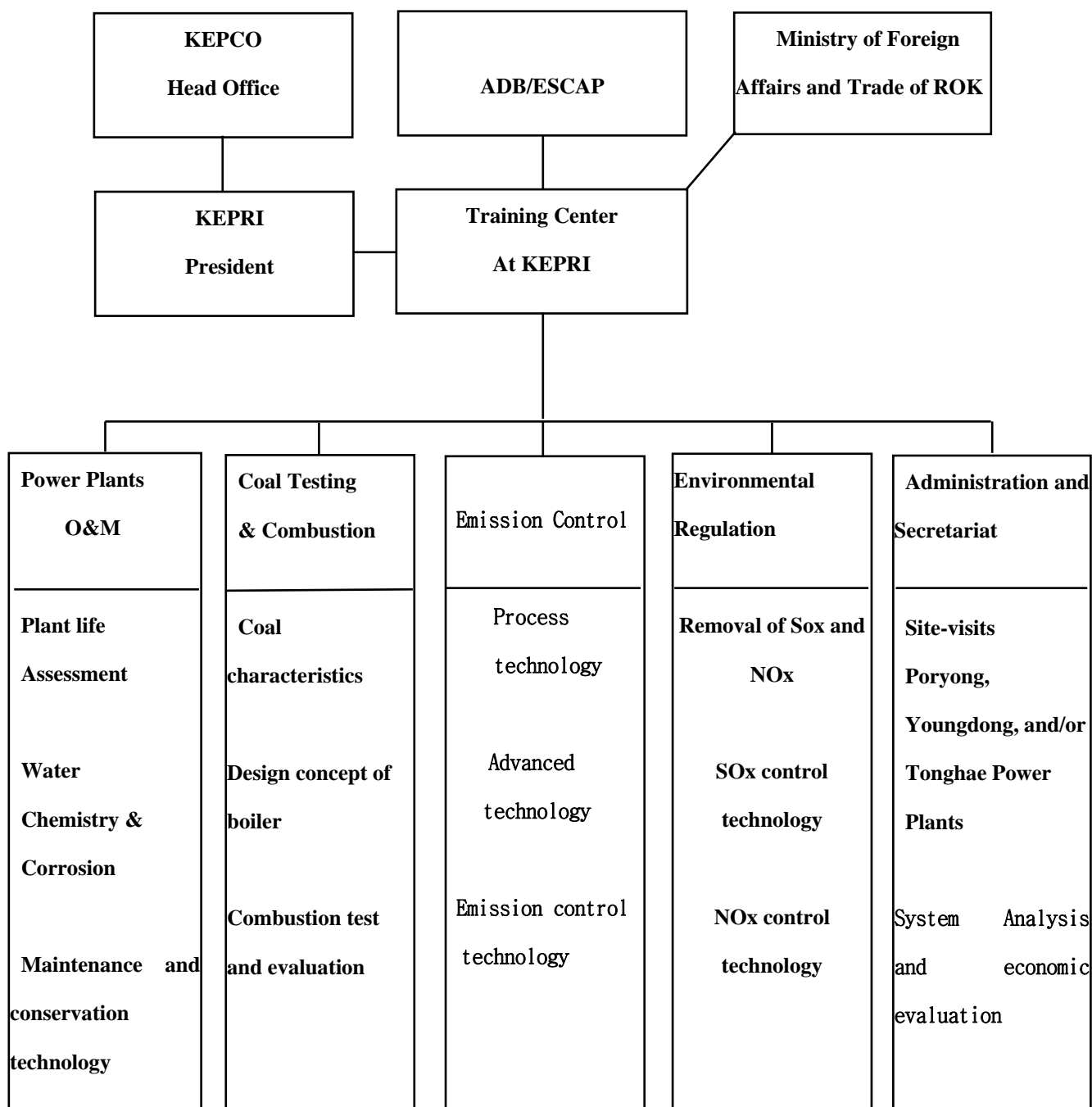
The training center will implement the training programs and project concerned under the overall supervision of the ESCAP secretariat and general guidance of ADB and the Korean Ministry of Foreign Affairs and Trade.

The personal management resources for project activities could be as follows:

- (a) Project Manager at KEPRI
- (b) Staffs for each technology group at KEPRI
- (c) Administration assistant at KEPRI

The provisional organization of this training center would have five functional divisions, such as power plant O&M, coal testing and combustion, emission control, environmental regulation, and secretariat and administration as shown in figure 1.

Fig 1. Provisional Organization for the KEPRI-ESCAP Training Center



### C. Future functions and prospective of the training center

It would provide regular training in the field of power plant O&M and environmentally sound power generation including pollution abatement and new power generation technologies with the assistance of ESCAP and/or ADB and Korean Government in terms of expenses and operation.

And the training center would have the capacity to process and to analyze information on power plant operation, O&M, and new power generation technologies that would be received from various countries and to communicate with them periodically. The center would also provide information of the updated technologies and monitoring methodologies. The sharing of knowledge is an important component of cooperation among member countries.

The center would encourage technology transfer by developing a regional network of experts and expertise that would be known throughout North-East Asia region.

#### **2. Programs for the training courses to be provided by the Center and on-site assessments in the participating countries and related meetings;**

The objective would be achieved through three primary types of activities;

- 1) Training plant managers and operators
- 2) Organizing on-site assessment workshop for technology demonstration and technology assessment
- 3) Organizing project review meetings

Basic training classes would be conducted twice with two-week period each at North East Asia Training Center in KEPRI Korea. And the Training Center will organize on-site assessment workshop for two weeks in participating countries and hold three times of meeting during project period at appropriate time and places. The on-site assessment workshop and meetings would be organized by KEPRI with the cooperation of

participating countries and organizations concerned such as China, DPRK, Mongolia, Russia Federation, ESCAP and ADB.

Tentative schedule for these activities is shown in Table 1.

Table 1. Tentative Schedule for the Project.

<b>Time (tentative)</b>	<b>Activities</b>
<b>Sep. 2001</b>	<b>Development of project implementation plan by international consultant</b>
<b>Oct. 2001</b>	<b>Complete the development of draft training manual and material by KEPRI staffs</b>
<b>Nov. 2001</b>	<b>Finalization of the training materials</b>
<b>Nov. 2001</b>	<b>Hold the first training program at KEPRI</b>
<b>Dec. 2002</b>	<b>The first project review meeting in Korea</b>
<b>April 2002</b>	<b>Hold the 2<sup>nd</sup> training program at KEPRI</b>
<b>June 2002</b>	<b>the 2<sup>nd</sup> project review meeting at Mongolia with SOM</b>
<b>Sep. 2002</b>	<b>On-site assessment workshop in China, DPRK, Japan, Mongolia and Russia</b>
<b>Feb. 2003</b>	<b>Final project review meeting for project evaluation including on-site assessment workshop and for future plan</b>

## A. Technical and Managerial Training

### 1) The first training program

- a) Time : November 2001
- b) Participating country: China, DPRK, Mongolia and Russia
- c) Number of participants from each country : two or more
- d) Training Courses : coal testing and combustion, pollution control, power plant O&M, economic analysis theory for alternative technology selection, etc.
- e) Participant qualification : plant manager level who can make

decision of new technology adaptation to their plant or who can influence to the decision maker of their company

Training center would initiate training courses for a selected group of managers from the participating countries. These participants would share their knowledge of modern O&M practices and retrofit technologies at their own or similar plants. For the first training program, the participants should be plant manager level who can make decision or who can influence the decision maker so as to adapt a new technology to improve the plant efficiency and to reduce pollution emissions. In many countries, not necessary just in North-East Asia, coal-fired power plant management has traditionally concerned itself only with producing power, electricity and/or steam without caring environmental concerns. And it is necessary to enhance the decision-making capacity of power plant managers and operators with respect to proposed improvements to increase plant efficiency and implementation of environmental protection measures. Power plant managers must be committed to environmental protection, or else it is easy to sacrifice the environment in favor of increased power production. They must also be aware of the important issues, such as the annualized cost of pollution abatement technologies, regulatory compliance, the plant's impacts on the local environmental health, the effects of pollution abatement systems on the energy efficiency of the power plant, and so on. All of these factors should be presented to plant managers so as the environmental initiatives should receive the attention from them.

## 2) the second training program

- a) Time : April 2002
- b) Participating country: China, DPRK, Mongolia and Russia
- c) Number of participants from each country : two or more
- d) Courses : coal testing and combustion, pollution control, power plant O&M, economic analysis theory for alternative technology selection, etc.
- e) Participant qualification : plant manager or operators who is taking charge of plant O&M, who can cooperate with plant manager to adapt new technologies for improving energy

efficiency and environmental improvement.

A concerted effort should be made to raise the awareness of power plant managers on such as environmental issues, pollution abatement system availability, and new pollution reduction technologies so that environmental protection matters receive priority attention from high management levels in the organization.

#### B. On-site assessment workshop

- 1) Time : Sep, 2002
- 2) Period and duration : two weeks (two days in each participating country)
- 3) Site selection : Japan, China, DPRK, Mongolia and Russia
- 4) Participants : All participants who participated classroom training in KEPRI Korea and regional country members
- 5) Topics to be discussed : Observation of the plant with explanation by the plant manager, finding possibilities of upgrade and retrofit for pollution control systems and efficiency improvement and development of recommendations, etc.

The on-site assessments will function both as a training activity for country participants, and as a mechanism for developing detailed recommendations to remedy pollution problems and achieve best practice operations at each plant studied. One or more coal-fired power plants which have serious pollution problems and remedy actions needed, may be identified by each participating country. The selected facilities will become on-site training and demonstration sites for the workshop. An on-site training workshop will be organized at each of these power plant sites in the participating countries. As part of this workshop, the participant trainees will identify remedial actions needed at each power plant and recommendations could be developed as a report by KEPRI staffs with the assistance of the country representatives participating in training.

The workshop would focus on implementation of best-practice O&M and installation of retrofit technologies that will lead to either efficiency improvements, enhanced air pollution abatement, or some combination of

these measures.

Selection of sites for on-site assessment workshop in each country would be made at second project review meeting of the program. The KEPRI staff will have reviewed the potential sites and the review meeting will offer recommendations on each site and make the final decision. The site for on-site workshop would be selected more than one site in each participating countries for the technology demonstration and technology assessment. At least three power plants including Japan will serve as on-site locations for technology assessment and new pollution reduction technology demonstration.

Recommendations may include estimating capital expenditures for upgrade and retrofit of pollution control equipment and efficiency-enhancing technologies. On-site assessment workshop in every participating countries would be conducted by the experts who attended on the classroom training program in KEPRI Korea, and regional experts in each hosting country for two days on each site. Additional participants from the host country may also be welcome to attend. Training participants would assist to KEPRI experts in conducting an assessment of the power plant to identify potential remedial actions to improve efficiency and to reduce pollution emissions.

A sample on-site assessment and training could be hold in Korea, visiting Poryong Power Plant and/or Donghae Power Plant during training in KEPRI to see what remedial actions are undertaken. Similarly, on-site assessment in Japan, the participants would find new pollution reduction systems and environmentally sound technologies installed and on operation. Keeping the information on the remedial actions in mind, participants will conduct the assessment of remedial actions needed at their own power plant in the future.

### C. Project review meetings

Members of the project review meetings will consist of senior representatives of each participating countries. The project review meetings will review the progress of the project, provide recommendations, and input on the future directions of the project and make important decisions

for the project. The meeting will review training program performed and make decisions regarding next training in terms of selection training participants and reviewing curriculums, etc. The meeting will meet three times over the course of the project. Each meeting will be for two or three days period.

The first meeting will be hold after the first training program for reviewing the training program and curriculum and recommending next program. The second project review meeting will identify a site each participating country for on-site assessment workshop. The final project review meeting will review activities conducted and identify follow-up activities needed for future plan and visions of center.

1) The first project review meeting :

- time and period : December for two days after or before the expert group meeting on environmental cooperation mechanisms in North-East Asia
- place : Korea with expert group meeting
- representatives : senior representatives from each participating countries
- topics to be discussed : review the progress of the project, evaluate the first classroom training program conducted, and discuss on the second training program and candidates for second training program

2) The Second project review meeting :

- time and period : June or July 2002 for two days after the second classroom training in KEPRI
- place : Mongolia with SOM
- representatives : senior representatives from each participating countries
- topics to be discussed : review the progress of the project, evaluate the second classroom training program performed, and discuss on the on-site assessment workshop for site selection, workshop

arrangement and participants required, etc.

### 3) Final project review meeting

- time and period : February 2003 for two or three days
- place : KEPRI in Korea
- representatives : senior representatives from each participating countries
- topics to be discussed : review the results of the project, evaluate classroom training program and on-site assessment workshop conducted, and discuss on future program and visions of the Center

### **3. Development and finalization of the draft training manual to serve above training events**

- a) Modifying training manual and training materials could be completed by October and finalized by November 2001 by KEPRI

The development of the curriculum, manual, and training materials was completed and approved by participating countries but it could be modified so as to appropriate to the high level participants and to shortened period. Developing and modifying the training materials by KEPRI staffs are expected to complete by November 2001.

- b) Training curriculum : in addition to the technical subjects, economic analysis subject would be included

The training could be offered on this manual, including particulate abatement SO<sub>x</sub> and NO<sub>x</sub> reduction, plant O&M, boiler O&M, coal testing, plant management, power generation system expansion technologies and techniques. An economic analysis subject could be included to improve

managers economic mind for alternative technology selection and investment analysis.

Evaluating technologies includes extensive economic and financial analyses, so that a life-cycle costing of the proposed technology can be systematically accomplished. And if the analyses are standardized, then multiple proposals can be evaluated against each other in a systematic, non-arbitrary manner.

Table 2. Training Curriculum Recommended

Area	Subject
Coal Testing & Combustion	Coal preparation and analysis
	Combustion experiments by using combustion test facility at KEPRI
	Design concept of furnace
	Pollution control experiments
Pollution Control	Simultaneous Removal of SO <sub>x</sub> & NO <sub>x</sub> by Using Plasma (Electron Beam or Pulse Corona)
	Nox control technology
	SO <sub>x</sub> control technology
Power Plant O&M	Life Assessment and management technology
	Maintenance and conservation technology
	Performance management technology
	Boiler supporting system technology
	Boiler operation simulation
	Generator and motor technology
	Water chemistry
Dust Collection Technology	Emission control in KEPCO power plants
	Process description
	Advanced technology
Economic Evaluation	Economic analysis
	Comparative analysis for alternative selection

As shown in the table 2, the whole training comprises five subject areas, and basically each area is supposed to be covered over a two-week training program. However, the Power Plant O&M area is emphasized, and thus

new technologies can not be included because of the training period shortage. In addition to classroom lecture, laboratories and forums could facilitate to exchange of hands-on experience and knowledge of the participants.

#### **4. Facility and equipment requirements for the Center**

In addition to KEPCO power plants that could be utilized for this training, the KEPRI currently operates several facilities either in demonstration scale or in pilot scale, which can be used for the training as follows;

- a) pilot scale (200kg/hr) coal combustion test facility at KEPRI.
- b) boiler operation simulator at Poryong Power Plant.
- c) 200MW FGD(flue gas desulfurization) demonstration facility at unit 2 of Youngdong Power Plant.
- d) pilot scale (3,000Nm<sup>3</sup>/hr) SCR(selective catalytic reduction) facility at Poryong Power Plant.
- e) pilot scale (3,000Nm<sup>3</sup>/hr) electron beam and plasma facility for simultaneous removal of SO<sub>x</sub> and NO<sub>x</sub> at Poryong Power Plant
- f) 200MW CFBC(circulating fluidized bed combustion) facility at Tonghae Power Plant.

The pilot scale coal combustion test facility has capabilities to study all of coal-related impacts on thermal power plant operation. Some bench scale apparatus that may be employed for the training include atmospheric and pressurized drop tube furnaces, etc,. There are also numerous diagnostics and test equipment, for example, thermogravimetric analyzer (TGA) for coal tests. In addition to these, many lecture equipment such as note-book computer, beam projector, overhead projector, blackboard, white board, paper board would be prepared with stationery.

## 5. Estimation of the associated costs

The project cost would be in categories of cash and in-kind contributions to be provided by the donors and the participating countries.

The costs of the training center would mainly consist of cost for meetings with travel, costs for training materials and printing reports, and overhead of the training center during whole period of the project.

It is assumed that training expenses for KEPRI, US\$40,840, would be covered by ESCAP/ADB and training manual modification expenses would be charged to Korean Government, Ministry of Foreign Affairs and Trade. All other expenses would be paid by ESCAP/ADP according to UN regulations except KEPRI overhead charges that would be covered by KEPRI in kind.

Table 3. Training Expenses Estimation

Description	Expenses (US \$)	Fund sources	Remark
Training expenses at KEPRI (Facility and equipment operation, instructors, and office supply etc.)	40,840	ESCAP/ADB	KEPRI
Training manual development (Manual modification)	15,000	Korean Gov.	KEPRI
Travel expenses for trainees (Training and on-site workshop)	65,700	ESCAP/ADB	Trainees
Review meetings (3 times)	20,000	ESCAP/ADB	Delegates
Consultant (including trip expenses for meetings and on-site workshop)	30,550	ESCAP/ADB	Consultant
Over head cost (persons, utilities etc.)	180,000	KEPCO in kind	
Grand Total	352,090	ESCAP/ADB 157,090 Korean Gov. 15,000 KEPCO 180,000	Cash  Cash  In Kind

\* see attachment for detail calculation estimated

**6. Linkage with other subprograms of the NEAESPEC project- in particular, development of an action plan for improving the efficiency of particular abatement systems existing power plants.**

Generally speaking, energy technology projects, such as clean coal technology projects; low-NO<sub>x</sub> burner replacements, electrostatic precipitators (ESP) upgrades, flue gas desulfurization (FGD) system installation, selective catalytic reduction (SCR) system installation, etc. involve large amount of capital expenditures, substantial planning, and the involvement of several departments within a power plant. Therefore, it is useful to develop a careful planning approach that will be appropriate for a given plant's situation.

The development of an action plan of existing power plant for improving the efficiency of particular abatement systems can not be included in this training program and it should be considered as an independent project to be acted. There are also involved a lot of important factors to be counted such as the technology in place at the plant, the expertise of the plant operators, the applicable environmental regulations, the financial standing of the plant, public perceptions and pressures.

**7. Recommendations for the future development**

There is a strong need in the region for dissemination of information on dust abatement technologies and the latest FGD technologies, clean coal technologies, research projects and technical papers. Therefore, it is necessary to develop a common technology data base especially in the field of coal fired power generation with the cooperation of member countries so as to be operated this data base by all member countries through the internet.

An Internet home page on air pollution technologies for coal-fired power plants could be developed cooperatively, with research organizations such as KEPRI and KIER (Korea Institute of Energy Research) with taking charge of coordinating role. At the present time KEPRI (<http://www.kepri.re.kr>) and/or KIER ( <http://www.kier.re.kr> ) home pages could be used to support such an effort. Several countries in the region already maintain important national information and technology centers located at prominent research institutions. These centers possess significant expertise and experience in the field of environmental monitoring, power plant operations and maintenance, and clean coal technology. Examples include NEPRI in the Peoples Republic of China, CRIEPI, MITI and the Environment Agency in Japan, as well as the all Russia Center for Nature Protection.

The coal technology is presently undergoing extensive and widespread research and development. It is strongly recommended that meetings for technical information exchange and opening training programs on new and improved techniques and coal related technologies should be organized regularly in the future to stay up with the developments.

Promoting inter-country cooperation in analysis and modeling of long-range air pollution transport is also recommended. To promote inter-country cooperation in air pollution analysis and modeling, a series of workshops on focusing on the science and policy of long-range air pollutant transport and environmental impacts could be conducted. These workshops could involve information dissemination, training, and case studies using simulation models like the Regional Air Pollution Information and Simulation Model for Asia (RAINS-ASIA) developed by IIASA with funding of the Asian Development Bank and the World Bank.

Attachment 1. **Total expenses estimation in detail (US dollars)**

1. Training expenses at KEPRI : 40,840

- Upgrading test facilities (1,500 x 3 areas + 2,000 x one area)	6,500.
- Machinery and equipment operation (including on-site operation) (4,000 x 2 times)	8,000
- Training material development (1,500 x 2 times)	3,000
- On-site visiting arrangement (bus rental and others ) (2,000 x 2 times)	4,000
- Instructor lecture fees (3,120 x 2 times)	6,240
- Review meetings arrangement (700 x 3 times)	2,100
- Report printing and copy (1,000 x 3 times)	3,000
- Training assistant (2,000/person/month x 2 times)	4,000
- Miscellaneous for two years (2,000 x 2 years)	4,000
Sub- total	<u>40,840</u>

2. Training manual modification and development : 15,000.

3,000 x 5 subjects area = 15,000

3. Travel expenses for trainees : 65,700

1<sup>st</sup> training (estimated for 3 countries 6 persons): 15,600  
air ticket :  $500 \times 6 \text{ person} = 3,000$ .  
Staying allowance :  $150 \times 14\text{days} \times 6 \text{ person} = 12,600$

2<sup>nd</sup> training (estimated for 3 countries 6 persons) : 15,600

On-site assessment workshop : 34,500.

- Trainees : 3 countries, 6 persons  
air ticket :  $1,500 \times 6 \text{ persons} = 9,000$   
per-diem :  $150 \times 14\text{days} \times 6 \text{ persons} = 12,600$
- KEPRI expert and center manager : 3 persons  
air ticket :  $1,500 \times 3 \text{ persons} = 4,500$   
per-diem :  $200 \times 14\text{days} \times 3 \text{ persons} = 8,400$

4. Review Meetings : 20,000.

1<sup>st</sup> project review meeting in Korea : 7,500  
(6 delegates from three countries )  
air ticket :  $500 \times 6 \text{ persons} = 3,000$   
per-diem :  $150 \times 6 \text{ persons} \times 5 \text{ days} = 4,500$

2<sup>nd</sup> project review meeting in Mongolia with SOM : 5,000  
(4 delegates from 2 countries)  
air ticket :  $500 \times 4 \text{ persons} = 2,000$   
per-diem :  $150 \times 4 \text{ persons} \times 5 \text{ days} = 3,000$

3<sup>rd</sup> project review meeting in Korea : 7,500  
( 6 delegates from 3 countries)

5. Consultants : 30,550.

- consultant fee for two years : 20,000.
- attending 2<sup>nd</sup> project review meeting in Mongolia : 1,750.  
(air ticket – 500, per-diem : 250 x 5 days = 1,250)
- attending on-site assessment workshop : 5,000.  
(air ticket – 1,500. Per-diem : 250 x 14 days = 3,500)
- domestic trip in Korea for two years including on-site visit :  
(1,400 x 2 years = 2,800.)
- final report printing : 1,000.

6. KEPRI training center staffs salary : 180,000

- center manager annual salary : 60,000.  
(60,000 x 50% x 2 years)
- project assistant (one person) : 80,000  
( 40,000 x 1 person x 2 years)
- manager secretary : 40,000  
(20,000 x 1 person x 2years)

\* others : public utilities, spaces are not counted

Grand total U\$352,090.

**Attachment 2. Basic assumptions for expenses estimation to be paid by ESCAP**

- a. Number of participants and countries for training :
  - 6 persons from 3 countries
  
- b. Number of participants for on-site assessment workshop
  - 6 persons from 3 participating countries
  - 3 experts from KEPRI including training center manager
  - 1 consultant
  
- c. Number of delegates for review meetings
  - 1<sup>st</sup> meeting in Korea : 6 person from 3 countries
  - 2<sup>nd</sup> meeting in Mongolia : 4 person from 2 countries except Mongolia
  - 3<sup>rd</sup> meeting in Korea : 6 person from 3 countries
  
- d. Training and meeting periods;
  - Training in Korea : 2 weeks each
  - On-site assessment workshop : 2 weeks
  - Project review meetings : 5 days each
  
- e. Daily allowances :
  - US\$ 150/day per person for trainees for training and delegates for meeting
  - US\$200/day per person for expert of KEPRI for on-site assessment
  - US\$ 250 per day for consultant
  
- f. Air ticket fares:
  - US\$500 per person for training and meeting (trip to one country)
  - US\$ 1,500 per person for on-site assessment trip (trip to three countries)

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