



Transfer of Knowledge and Technology on the Examination and Inspection of Dams for the Lao People's Democratic Republic (Lao PDR)

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ABSTRACT:

The Government of Lao PDR (GOL) requested technical assistance to acquire practical examination and inspection knowledge and skills to the Japan International Cooperation Agency (JICA). In response to the request, JICA started the technical cooperation project entitled "The Project for Improvement of Power Sector Management (IPSM) in Laos" commenced in October 2010 with a period of two and half years. It is expected that the regulatory capacity of the Department of Electricity (DOE) will be enhanced at the end of the Project, scheduled in March 2013. This Paper highlights the first-half of the IPSM (Phase 1) on practical knowledge and technology transfer of the examination and inspection of hydropower facilities, specifically dams. The Japanese Experts prepared the On-the-Job-Trainings (OJTs) at existing and hydropower project sites under construction for the staff of the DOE as the national-level regulatory authority. Also the Experts started assisting the DOE staff to carry out actual examinations, such as flood and dam stability analyses during the feasibility study (FS) stage, and carry out inspections, such as a rock foundation inspection, an inspection before first impounding and an inspection before operation during the construction stage.

Keywords: Laos, Dam, Hydropower, Technical Standards, Inspection

1. BACKGROUND OF THE IPSM

In the Lao PDR (Laos), the power sector plays an important role in the nation's socio-economic development. Many independent power producer (IPP) hydropower projects are being planned and implemented for such an agenda, including the improvement of the transmission and distribution network. Based on a request from the Government of Laos (GOL), the Japan International Cooperation Agency (JICA) provided technical assistance to the GOL to develop the Lao Electric Power Technical Standards (LEPTS), Guideline and Safety Rule from 2000 to 2008.

The GOL requested further technical assistance to acquire practical examination and inspection knowledge and skills for the power facilities utilizing the LEPTS and Guideline. The new technical cooperation project entitled "The Project for Improvement of Power Sector Management (IPSM) in Laos" commenced in October 2010 with a period of two and half years funded by JICA. A joint venture from Japanese electric power companies such as Chubu Electric Power Co., Inc. and the Kansai

Electric Power Co., Inc. was selected as an implementing organization of the IPSM after a competitive bid. The IPSM includes 10 Japanese Experts with various backgrounds, such as hydropower, civil and electrical engineering, transmission, substation, distribution and training.

This paper focuses on the activities in the field of hydropower civil engineering, specifically dam issues from the beginning of the IPSM (October 2010) to the first-half (end November 2011) as the report of the 1st Phase.

2. OUTLINE OF LAOS AND ITS POWER GENERATION

Laos is an inland country and located in Indochina surrounded by Thailand, Cambodia, Vietnam, China and Myanmar. Its population is 6 million twelve thousand as of 2009 and its area is approximately 236, 800 square kilometers (km²). Around 70% of its terrain is mountainous. The

rainy season is from the beginning of May to the end of September, and the dry season is from October through April. Annual average temperature is about 28 degrees Celsius, rising to a maximum of 38 degrees Celsius during April and May. The average precipitation is the highest in Southern Laos, where the Mountains receive over 3,000 mm annually. In Vientiane, the Capital rainfall is about 1,500-2,000mm, and in the Northern provinces only 1,000-1,500mm. Most of the power source is hydro in Laos and the installed capacity for the domestic use is 385 MW as of 2009 and 1,450MW for exportation.

The country's precious hydropower potential is considered to be utilized for exportation and Laos has signed an the Memorandum of Understanding (MOU) to provide 7,000MW of energy to Thailand after 2015 and 3,000MW of electricity to Vietnam until 2020. For the reason, many hydropower projects are being developed by independent power producer (IPP) developers.

3. OUTLINE OF EXAMINATION AND INSPECTION BASED ON THE LEPTS

3.1. LEPTS

In Laos, the Electric Power Management Division (EPMD), the Department of Electricity (DOE) of the Ministry of Energy and Mines (MEM) is in charge of the regulatory work and it has been conducting examinations and inspections based on the LEPTS.

The LEPTS is contemplated to meet the 4 principles:

- Power facilities shall not harm the human body and damage any object,
- The power facilities shall be installed so as not to cause any electrical and magnetic interference that may affect other electrical facilities,
- There shall be of no significant effect on power supply despite of the power facilities being broken down or damaged, and
- Installation of the power facilities shall not have an adverse effect on the surrounding environment.

It basically consists of the combination of required loads and required performances (e.g. "A waterway shall be stable against expected loads and shall not be damaged by a landslide or flood").

Concrete figures are applied only for a few items such as the return period of the design flood and dam stability analysis (e.g. "The safety factor against sliding calculated by the following formula shall be three or more under usual conditions...."). Table 1 shows the outline of table of contents of LEPTS hydropower civil engineering part.

Table 1 Outline of LEPTS (hydropower civil engineering)

Items	Outline
2-1 General	Definition
2-2 Fundamental Requirements	Fundamental requirements for stability of dams, waterways, etc.
2-3 Dam 2-3-1 Common Rules 2-3-2 Concrete Dams 2-3-3 Fill Dams 2-3-4 Other Types of Dams 2-3-5 Spillways and Other Discharge Facilities	Design loads, stability analyses, materials, conditions of rock foundation, etc. for concrete dams, fill dams and discharge facilities
2-4 Waterways	Design loads and stability conditions of civil facilities from intake to outlet
2-5 Powerhouses and Other Facilities	Stability and safety of powerhouses and temporary facilities
2-6 Reservoirs	Stability of reservoirs
2-7 Downstream	Flood control to protect downstream lives and facilities

3.2. Guidelines

The purposes of the Guidelines are to operate and manage the LEPTS, specifically for civil engineering facilities in hydropower stations. It includes the procedures and requirements in the planning, design, construction and operation stage of power facilities with necessary forms and technical documents and drawings to be submitted by the project owners, which shall conform to LEPTS.

In the case of hydropower IPP projects, examinations of technical documents on feasibility study (FS) and detailed design (DD) are conducted in planning stage and approved by the GOL. Then 3 steps of inspections such as the Inspection of Dam Foundation, Inspection Prior to First Impounding and Inspection before Commercial Operation are conducted for the projects with dams of more than 15m height in construction stage and the GOL issues the Certificate of Completion to the project owners.

In operation stage, regular reports e.g. Monitoring Inspection Report of Dams (including deformation of dam body, leakage water and uplift), Monitoring Report of Sedimentation in Reservoir and Reports of Accidents and Damages must be submitted by the project owners. Outline of the contents for examinations and inspections in line with development stages is shown in Table 2.

Table 2 Outline of contents for examinations and inspections

Stage	Outline of examinations/inspections
FS	Examination of items (table of contents) and preliminary design for flood analysis and dam stability
DD	Examination of design for civil facilities such as dams, waterway structures, etc. based on the LEPTS
Rock Foundation	Inspection of rock foundation immediately after finishing and clearing excavation surface before concrete placement
Prior to First Impounding	Inspection before first impounding for the results of concrete placement, foundation treatment, installation of monitoring equipment and impounding plan
Before Commercial Operation	Inspection before commission (after impounding) for the results of measurement, appearance, leakage water, etc. of civil facilities including dams
Regular Reports	Regular reports of operational records, results of measurement, sedimentation in reservoirs, etc.

4. ISSUES OBSERVED

Operational issues on the regulatory works such as examination and inspection were clarified in the beginning of the IPSM through interviews with the EPMD/DOE and relevant organizations, and through the confirmation of the past examination and inspection records.

4.1. Procedure for Examination and Inspection

IPP developers exchange MOU on the exclusive right for feasibility study and the Project Development Agreement (PDA) in planning stage, and the Concession Agreement (CA) before starting construction works.

The Department of Energy Promotion and Development (DEPD) is the window to receive the applications from the project owners as the one-stop service department in the MEM. DOE as the regulatory department receives the application Forms on examination and inspection through the DEPD. However, DOE could not receive the applications on time because of lack of communication between the both Departments.

As a result, it was not easy for DOE to prepare the concrete schedule of examination and inspection on annual basis. Moreover, it was still difficult to adjust the two procedures such as FS - DD- construction (regulatory procedure) and MOU - PDA - CA (development procedure). Fig. 1 shows the flow of development of hydropower IPP in Laos.

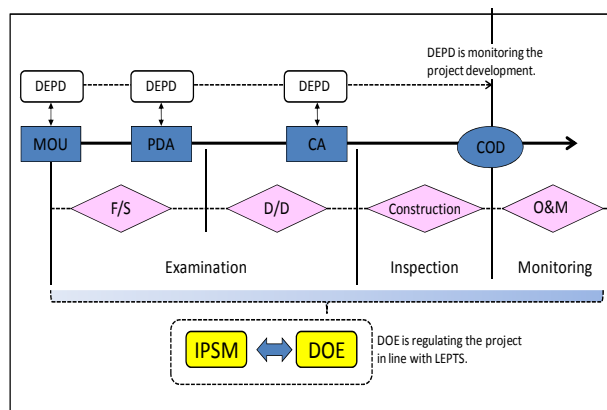


Fig. 1 Flow of development of hydropower IPP in Laos

4.2. Preparation of Examination and Inspection

It was observed that concrete and practical contents of the technical documents with relevant drawings attached to the application Forms were not clearly defined yet even if the Guidelines showed the lists of them. The developers and GOL could not make proper preparation before the examination and inspection due to the reason above.

As a result, the EPMD staff had to visit the project site for inspection without technical documents and inputs from the project owner in advance. Otherwise DOE has to receive all technical documents and data from them without selection.

4.3. Technical Knowledge and Understanding

It was also observed that deeper technical knowledge and understand were necessary for the EPMD staff to implement examination and inspection smoothly with confidence.

5. ACTIVITY RESULTS

Recently, many developers from various countries such as Thailand, China, Vietnam, etc. started hydropower development in Laos and the number of applications of examination and inspection has been increasing. Specifically, it was treated as one of the urgent issues for the DOE to regulate dam construction works for the sake of public safety.

Therefore, the technology transfer of a series of inspection procedures for dam construction i.e. receiving application forms with necessary technical documents, conducting inspection at the sites and issuing the letter of completion became one of the urgent activities for the IPSM. Technology transfer was conducted through preparing the OJT at the project sites and participation in the actual inspections

5.1. Preparation of Inspection Check-sheets

In the beginning stage of the IPSM, the Experts prepared some check-sheets for dam inspection with drawings and relevant LEPTS articles. They were prepared for 3 stages of inspections such as the Inspection for Dam Foundation, Inspection Prior to First Impounding and Inspection before Commercial Operation. Fig. 2 shows a sample of the check-sheet for gravity dams Prior to First impounding and Fig. 3 shows the detailed check-sheet supporting the check-sheet in the Fig. 2.

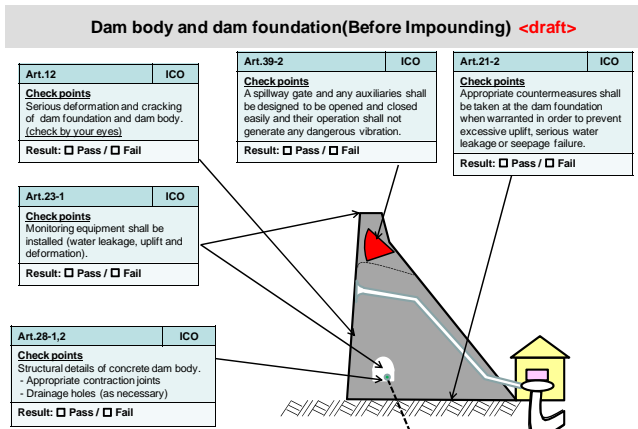


Fig. 2 Check-sheet (Gravity dam prior to first impounding)

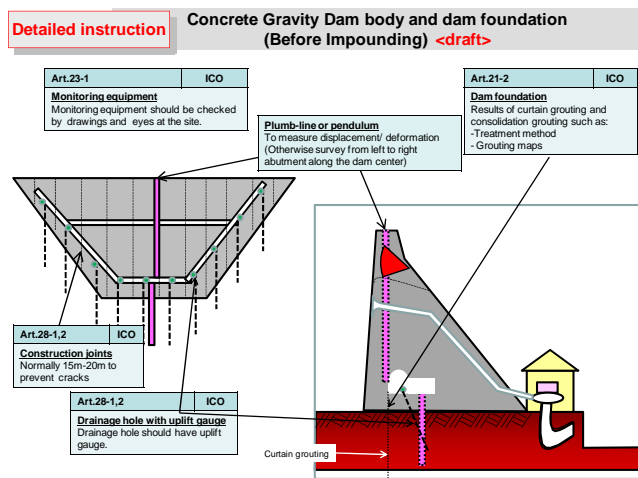


Fig. 3 Detailed supporting check-sheet

5.2. Field OJTs and Actual Inspection Results

The Experts conducted some field OJTs using the check-sheets. Also the Experts assisted the DOE to conduct actual inspections from receiving forms, conducting inspections to issuing the letter of completion. Table 3 shows the results of OJTs and inspections assisted by the Experts.

Table 3 Outline of contents for examinations and inspections

No.	Activity	Capacity (MW)	Name and Status
1)	OJT	60 (Expansion)	A HPP (Construction)
2)	OJT	615	B HPP (Operational)
3)	Inspection Prior to Impounding	60 (Expansion)	A HPP (Construction)
4)	Inspection before Operation	3.2	C HPP (Construction)

*HPP: hydropower project

1) and 3): A HPP Expansion (60MW)

A HPP is an expansion project with additional 60MW with a concrete gravity dam with approximately 70m height (Roller Compacted Concrete: RCC). The Inspection of Dam Foundation was conducted in 2010. The DOE staff with Experts visited the site twice (OJT and actual inspection) during the dam concrete placement period in 2011 (Figs. 4 and 5).

< Major activities >

- Receiving application forms with technical documents before inspection properly after the preparatory discussion among the DOE, project owner and Experts.
- Conducting inspection before impounding; checking dam body, reservoir, discharge facilities and monitoring equipment in and around the dam body using the check-sheet some field OJTs.
- Issuing the letter of completion of the inspection with minutes of meetings (M/M) signed by both parties in the end of the inspection at project site.

< Achievement >

- Practically it became the first opportunity for DOE staff and project owner to conduct an inspection from preparation to issuing/receiving letter of completion.

< Issues >

- DOE would continue monitoring the progress of the impounding and prepare the next inspection (before Commercial Operation) on timely basis.



Fig. 4 A project site



Fig. 5 A project site

2): B HPP (615MW)

B HPP is an operating project with a concrete facing rock-fill dam (CFRD) with approximately 180m height. The DOE staff with Experts visited the site as the OJT (Figs. 6 and 7).

< Major activities >

- Confirming operational conditions of power and dam monitoring results.
- Confirming the gate operation with consideration of the damage to downstream and the Flood Management Rule.

< Achievement >

- DOE staff could deeply understand the operational activities including reservoir control and monitoring system for the CFRD dam.

< Issues >

- DOE would also have to receive the Regular Reports including dam monitoring result from the project owner on timely basis.



Fig. 6 B project site



Fig. 7 B project site

4): C HPP (3.2MW)

C HPP was a small scale project just before commission with a concrete gravity dam with less than 15m. The DOE staff with Experts visited the site to assist the Provincial Department of Energy and Mines (PDEM) to conduct the Inspection before Commercial Operation because PDEM is responsible for hydropower projects with less than 5MW (Figs. 8 and 9).

< Major activities >

- Assisting the PDEM to prepare the inspection and necessary documents such as draft letter of completion and M/M.
- Assisting the PDEM to carry out the inspection from the intake weir to the power house.

< Achievement >

- DOE staff could give the appropriate guidance to the PDEM technically and non-technically (procedure).
- DOE could also get a good opportunity to teach PDEM (teaching is learning).

< Issues >

- PDEMs as the regulators for local and small projects have to increase their capabilities for examination and inspection.

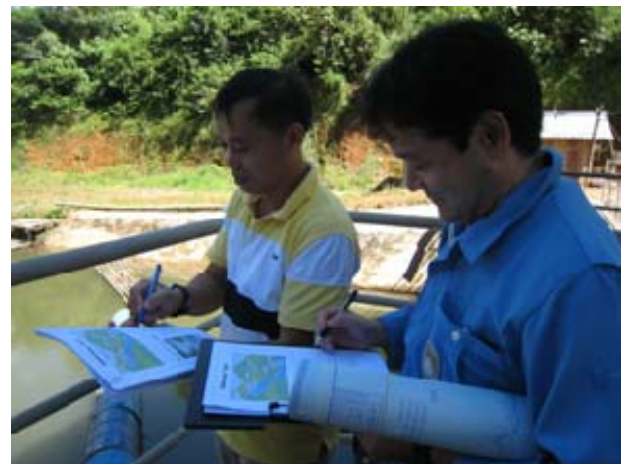


Fig. 8 C project site



Fig. 9 C project site

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5. WAY FORWARD

In the first phase of the IPSM, the Experts assisted DOE to organize a series of inspection procedures including technical aspects in the field. However, there are more issues remaining institutionally, organizationally and technically to be solved as pointed out in 4. ISSUES OBSERVED.

The JICA, GOL and Experts held the Joint Coordinating Committee (JCC) on IPSM in November 2011 and discussed the activities for the second phase from January 2012 to February 2013 and agreed that:

- 1) The Experts would assist DOE to clarify the procedures of approval process in line with LEPTS in the GOL;
- 2) Guidelines and relevant documents shall be updated and modified by GOL with the Experts' assistance;
- 3) The primary focus of the technical activities in the 2nd phase of the project shall be to deepen the understanding of technical matters related to LEPTS and its procedures for examination; and
- 4) The regulatory capabilities of PDEM shall be strengthened.

Regarding the hydropower civil engineering field, combination of loads and calculation methodologies will be the major technical skills to be acquired through the OJTs and actual examinations.

ACKNOWLEDGEMENT

It has been a big pleasure for us to have been given such precious opportunity to implement the technical cooperation "IPSM" funded by JICA working with the officials of the GOL (DOE) as our counterparts. We will continue our best efforts towards the end of the IPSM to achieve the project goal "enhancing the regulatory function of the GOL".