Small Hydropower Contributes to Poverty Reduction and Rural Integrated Development in China

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1. Briefing of Small Hydropower (SHP) development and demand of poverty reductions in China

Over the past 50 add years, outstanding achievements have been made in the development of rural small hydropower (SHP) and electrification in China. By the end of 2003, 42,221 SHP plants with a total installed capacity of 28,489 MW have been constructed and under operation. Half of the country's territory, and one quarter of population of the whole nation are now accessible to SHP. The role of SHP in the whole hydropower industry and even in the whole electricity section has become increasingly indispensable as evidently shown in the following figures:

—Percentage of SHP capacity in hydropower section > 30%.

—Percentage of SHP capacity in electricity industry, about 7%.

These figures are much higher than that of the average value (5% and 1% respectively) of the world.

As a unique case in the world, a new independent SHP industry has been formed in China, combining economic, social and environmental benefit for the whole rural area and contribute considerably to the rural development as a whole.

Another salient feature of SHP development in China is that numerous local grids have been established either operating independently or further inter-connected into the national grids. The scale of the local grid is usually 30-80MW or even greater than 100MW where inter-counties or trans-regional local grids have been formed. By now, around 68% of SHP installed capacity in China is connected to local grids. This figure depicts a fully different situation with other developing countries.

With the above peculiarity of China's SHP development in mind, I would thereby explain the contribution of SHP to poverty reduction in China by several stages with emphasis on the early 1950-60s which seems to be more similar with the present situation of SHP development in the developing countries in East Asia. Experiences and lessons from closer situations may be more conducive to our neighbor countries. These will be given in the next section.

Referring poverty-reduction, it is important to clarify the standard of poverty and actual demand of poverty relief in the country.

As stated by Chinese present premier Went Jiabao, "There are 900 million farmers out of the 1.3 billion population in China, of whom, 30 million still have not lifted out of poverty, with an annual income of 625 Yuan (RMB) per capita. The poor population would be raised to 90 million if 200 Yuan per capita should be added to the standard." According to the UN's Millennium Development Goals, the standard for poorest people's income is less than $1 USD per day, or $365 USD/year, which is equivalent to 1,095 Yuan if international USD rate 1:3 is adopted for calculation. Then, the poor population in China would be increased to 145 million. Whether 145 million or 30 million is to be taken in counting poverty reduction committement, the tasksof which are all very tough.

Although great achievement has been made in the rural electrification work in China, the electricity consumption in rural area is only about 500 kWh/capita/year by end of 2000, still far below that of urban area, and less than half of the nation's average. Furthermore, by end of 2000, there are still 30 million people in the whole nation not accessible to electricity, in spite of the 98.03% high accessibility of electricity for the rural household in the country. The above figures show that energy-poverty also exists in China, especially in the rural area.

2. Contribution of SHP service in different stages of rural development in China

SHP service in China has been developed in step with nation's overall, especially rural area's, social and economic progress during the past 5 decades.

(1) In early 1950s, SHP construction started on a backward economic and technical basis with a total SHP

installed capacity of about 6,000 kW in the whole country. The main consumption of electricity is for domestic lighting and primary agro-based product processing. The strategy of SHP development adopted at that time was "to get the ball rolling first, and proceed on with two steps," that is, firstly set up hydro mechanical station with simple equipment and technology for water pumping and rice-processing. Then, expanded and upgraded it to the electric power station after fund raising from the income of the original station. Other measures in addition to the above "two-step" strategy include:

—Strengthening technical guidance and on-site training of local people;

—Running the station industriously and thriftly;

—Requesting planning for development;

—Consolidating management of SHP stations.

Take Sichuan Province as example, both hydro-mechanical and electrical power stations were developed simultaneously during 1957-65. The average installed capacity of SHP station in the whole nation in 1950s was only 26.9kW.

The contribution of SHP service during 1950s-1960s was mainly for liberation of labor force and improvement of agro –labor productivity. As per statistics of that period, 5-labor force could be replaced by 1 kW electric capacity in pumping irrigation and agro-product of processing. The unit area production in Zhejiang province was doubled after being irrigated from electric pumping stations. For construction of SHP stations, the input of labor force was about 200 per kW installation while the annual output of each kW could replace about 1500-labor-day This is evidently much justified economically.

The contribution of electricity supply from SHP during this period could be simplified in the following road map:

Liberation of labor by SHP — Furthering development of local electric supply — Further transference of surplus labor to non-agro sectors.

On the basis of initial development of SHP in many places, a SHP-program called "preliminary electrification for 5 county /100 commune," in a province was launched in 1958, with a low standard of 100-150W per household for easy achievement. By end of 1959, number of SHP stations and total capacity in the country were greatly raised from 562/20,200 kW in 1957 to 5,586/150,000 kW.

(2) In early 1960s, for strengthening the agricultural production in the country, the central government set up the policy of establishing stable and high grain production systems by construction of a number of base ground for grain and cotton. For serving this purpose, the national rural electric supply should comply with the following strategy: "Focus on commercial grain and cotton bases, with electric service mainly for irrigation and drainage, mostly supplied by the national grid combined with rural SHP".

Thus, from 1969-73, the annual growth of new SHP installation successively kept at 50,000 kW/year.

Then, the growth rate consecutively increased as shown in the followings:

400,000 kW/year for early 1970s

800,000 kW/year for late 1970s

1,000,000 kW/year for 1979

By end 1979, the total number and capacity of SHP in China jumped into 80,000 and 6.38 million kW.

In the mean time, local grid of SHP was gradually formed, which not only supplied electricity locally, but also sent electricity into the national grid.

The approach of SHP-RE and economic development in the past several decades was summarized by the local people into the following formula:

—Water for electricity.

—Electricity promotes industry and agriculture.

—Industry backs up electricity.

— "To get the hilly regions changed, build small hydropower ahead."

That is a sound cycle way of development.

The structure of electricity demand or composition of rural electricity consumption at various stages varies considerably, which could be roughly categorized as follows:

Period	Percentage of various load (%)					
	Irrigation & Drainage	Agro/sideline processing	Township Industry	Household Lighting	Others	Total
1960s	65	25		10		100
1970s	41.8	22.9	15.8	19.8		100
1980-85	23-38	20-23	19-32	17-21	4.1-4.5	100
1989	19.8	13.7	38.9	17.9	9.7	100
1990s	9.3	13.7	44.7	23.3	8.8	100
2000	7.7	12.0	44.2	27.0	9.1	100
2001	7.1	11.4	42.3	30	9.2	100

It is evident that the load of irrigation/drainage and agro-processing dropped sharply during the past 50 years while the town-ship industry and household lighting grew quickly in the same period.

(3) During the period of 1980s-1990s, SHP service was mainly for poverty relief in poor areas.

The State Council initiated the program of SHP-based rural electrification (SHP-RE) since early 1980s, requesting for establishment of 653 "SHP-RE" counties over 18 years up to the end of 20th century. 82% of the counties are located in central and west part of China, which cover 252 million people and 2.74 million sq.km, where the economic development was backward to the nation's average. Completion of the program enables the above counties to attain a great achievement as illustrated by the following figures:

GDP value, fiscal income, farmers' net income per capita and electricity consumption per capita were all doubled over the past 5 years and quadrupled over the past 10 years. The growth rates were all much higher than the nation's average.

The SHP service further played on important role in the poverty-reduction and socio-economic development of broad remote, old-revolutionary and minor-ethnic poor hilly areas.

(4) After entering the 21st century, SHP is used mainly for protecting and improving ecological environment and boosting the local economy.

Started from this period, the Central government has paid great importance to poverty reduction, environment protection and realization of harmonious development between human beings and nature as well. SHP, with its prompt and evident effect of improving farmer's income, has been documented as important medium and small infrastructure in the rural area by the central Government in 2002 and 2003. Two large scale SHP-program: the pioneer project of using SHP in replacing firewood and construction of the 4th batch of SHP-RE 400 counties were further initiated. 80% of the 400 counties are located in central and west part of China and 85% of them are in hilly, poor areas. This program is aiming at construction of higher level of rural electrified counties complying with the demand of well-off society and improved ecological environment as well as overall social and economic development in the rural area. The SHP replacing fire wood program will take 14 or more years to solve the long-term stable supply of living fuel and rural energy demand for 28 million households with 104 million people in the whole country. Further details will be described in section 4 of this paper.

It should be noted that the contribution of SHP service in different stages were different. Taking reference of the above experience, corresponding stage should be selected for effectiveness of the experience.

3.Integration of SHP construction with comprehensive economic and social development

SHP development in China has always been integrated with overall economic and social development in the rural area notwithstanding differences of various stages of SHP development. China's experience in this respect further proves the significance of the statement raised in the Report 《Linking Rural Electrification with Rural Development in Asia》 published by UN-ESCAP, Bangkok on 1990 that:"Energy (including electricity) is only one element of an effective integrated rural development strategy. With availability of electricity in an under-developed rural area, further input is needed for setting up agricultural, industrial and cultural, educational end-users, Otherwise, the actual impacts of electricity would be limited or hampered." In China, this is called "simultaneous development of energy with local industry and agriculture." The successful implementation of this strategy in China usually attributes to the following factors:

(1) Unified leadership and co-ordination of local government usually at county level was insisted (there are about 2,400 counties in China as a basic administrative set up). In each SHP-RE county, a leading group was usually established headed by a county mayor or his deputy. Any type of ownership for SHP development was put under co-ordination of the leading group for multi-sectoral development. This measure greatly overcame the barriers of both SHP and overall rural development not only financially, technically but also for all issues related to regulatory and policy arena.

(2) With a master plan for the whole county development, load forecast for SHP-RE was not only a predication but also a part of integral plan of the overall development of the county. Thus the market problem was no more constraints to the SHP development.

(3) SHP development in conjunction with irrigation and drainage of farmland in early 1950s. Later, since 1980s, the town-ship industry has boomed tremendously, especially in coastal provinces, where the annual increase rate was kept at 15-20% or

even higher over the past 2-3 decades. A serious, shortage of electricity supply both in urban, peri-urban and rural area has thus been emerged in the long run, notwithstanding of the high growth rate of 7-10% of the power generation sector. Therefore, electric market has persistently been kept on the seller side, which strongly promoted the SHP development together with rapid economic growth in the whole country.

(4) Transference of self/semi-self-sufficient economy to commodity economy and from traditional agriculture to modernized one in the rural area starting from 1980s further step up the salient function of electricity during the transition. Electricity had promoted the agricultural and industrial production, popularized the household users, and decreased deforestation by utilizing surplus seasonal energy in replacing the firewood.

4. SHP replacing firewood

(1) General description of the energy consumption in China's rural areas

The energy consumed in China's rural areas includes that used for the village, agriculture and farmer's production and living. Of which, the latter occupies a very important place in the rural energy. According to statistics, in 2000 the total energy which rural residents spent on living equals to 370 million tons of standard coal in China, among which firewood is 21.76%, straw 33.41%, coal 31.9%, electric power 9.31%, finished oil product 2.04%, and liquefied gas and methane 1.58% etc. The firewood consumed by rural residents in whole China is actually up to 141 million tons annually, and equivalent to about 188 million m^3 of timber if 750 kg of firewood amounts to $1m^3$ of timber.

UNEP has ever reported that, farmers burning the firewood for cooking and keeping warming is an important reason for the Asian Brown Cloud which results in serious natural disasters in South Asia and threatens the health of local people there.

(2) The general target of SHP Replacing Firewood

SHP is a kind of clean and renewable energy, and the SHP Replacing Firewood is aiming to, in a long run, reliable supply of farmer's fuels for living, thus radically preventing forests and vegetation from being destroyed further. By this means, the forest resources can be protected and the emission of GHG such as carbon dioxide etc. and the poisonous gas as sulfur dioxide etc. can be also mitigated.

In 2002, the Ministry of Water Resources compiled a Program of "SHP Replacing Firewood Ecological Protection Project" in China. According to the project scale, the central government's input and the local government's capability, it is planned to basically accomplish the targeted task in 14 years or a little longer from year 2003, that is in a long run, to reliably supply living fuels and rural energy for 28.3 million households (104 million rural residents). Based on this program, a consumption of 189 million m^3 timber can be saved each year, and 340 million Chinese mu (one ha. is 15 Chinese mu) of forests can be preserved, thus RMB36 billion yuan of ecological benefit can be achieved. The eco environment is also protected and improved, farmers' income increased and an overall socio-economic development is speeded up in the local regions.

(3) Implementation of the SHP Replacing Firewood

— Fund mobilization

For providing living fuels for a total 28.3 million households of rural residents, 24.038 million kW of SHP capacity needs to be newly increased for replacing the fuel. This will cost an investment of RMB122.605 billion yuan which is to be mobilized from the central government, the local government and bank loans etc. The investment composition is, 50% from the central government, 20% from the local government and 30% from the bank (the annual interest rate is 6.21%).

—The power tariff of SHP replacing fuels

Whether the SHP Replacing Firewood Ecological Protection Project can be smoothly implemented, mainly relies on the end users' affordability of the power tariff of "SHP replacing fuels".

It is estimated that, when the national capital is 50% of the total investment (which needs not turn-back in the same period of cost/benefit calculation and only annual discount is to be counted on), the local capital is 20%, the bank loan occupies 30%, and if the mean annual utilization hour of power generation amounts to 3,250 hours, the tariff of power for replacing fuels could be kept at RMB 0.17 yuan/kWh to the end user, while the tariff of marketable power is RMB 0.316 yuan/kWh. In 2000, the per capita net income was RMB 2,253 yuan/year for the rural residents in China, and RMB 1,632yuan/year in western regions. If on the average, each household consumes 1,200kWh annually in the planned areas, and the power tariff of SHP replacing fuels is taken as RMB 0.17 yuan/kWh for the end user, each household shall spend RMB 204 yuan on electric power annually on the average, and RMB 53 yuan/ per capita per year, which amounts to 2.4% of the yearly per capita net income of rural residents in the whole country, and 3.3% of that in western areas. Both are far less than the current proportion of expense for various kind of living fuels by the rural residents (according to a typical survey, the non-farmer households spend 5.5%, the farmer households spend 7.2% and in some typical counties it is 9.16~15.68%). With the development of rural economy, the expense proportion of this power consumption to the net annual income of each household shall be further decreased, and it seems acceptable to the farmers.

— Administrative system of the SHP Replacing Firewood Project

The "SHP Replacing Fuel" Project shall adopt an administrative system of "3-rights Separation", that is, the ownership, the using right and the management right are separated from each other. The station ownership belongs to the central government. As the representative of investors, the provincial administrative sector of water resources shall supervise and manage the state assets of SHP Replacing Firewood Project to maintain and increase its value, such that long-term, effective operational and ecological benefits can be guaranteed in the station for replacing fuels, as well as the social benefit and farmers' profit can be achieved. The juridical person of the project is responsible for its construction, marketing management and employing managers. The juridical person shall also sign a PPA (power purchase agreement) with the power-supply sector for providing electric power to the grid, and formulate the regulations of measuring power quantity, fees collection, and power-use safety management. The using right belongs to farmers who replace the fuel with SHP, and have their rights to consume the ecological power according to specified tariff and quantity of the electric power for replacing fuels. They are also responsible and obliged to protect forests and vegetation, and stop deforestation. This administrative system effectively restricts all sorts of short-term behaviors, as to ensure the supply of long-run electric power and electricity quantity to farmers for replacing the fuel, which also safeguard a long-term, effective benefit of the SHP Replacing Firewood Project.

(4) The initial effect of SHP Replacing Firewood Project

At the end of 2003, the SHP Replacing Firewood Projects were formally initiated for 26 pilot projects located in 26 counties (or cities) of Shanxi Province, Guangxi Zhuang Autonomous Region, Sichuan Province, Guizhou Province and Yunnan Province. After that, a national working conference was held on the experiment of SHP Replacing Firewood Project by the Ministry of Water Resources. The "Notice on Strengthening the Construction and Management of SHP Replacing Firewood Project", the "Directory on the Management of SHP Replacing Firewood Project" and the "Notice on the Summing-up Work of the SHP Replacing Firewood pilot project" were issued on the meeting, and the "Acceptance Regulations on the SHP Replacing Firewood Project" was also published. All these effectively instructed the nationwide pilot work on the project. Presently these pilot projects have entered the stage of acceptance, and anticipated targets of the SHP Replacing Firewood Project have been achieved which is deeply welcomed by farmers. After accomplishing the overall task of the pilot construction, the scale will be further expanded, as to push forward the construction of SHP Replacing Firewood pilot project in full swing and benefit the nation and the people ultimately.

5. Financial, technical and regulatory standpoints on which the transition to small hydropower enterprises have been handled

In recent years, Chinese private investment in SHP has been booming. Many other developing countries, in the meantime, have also formulated a series of incentive policies to encourage the mobilization of private capital for SHP. Therefore, a trend of public-private-participation (PPP) in SHP development seems to have been started. But, so far as we know, the recent enforcement of PPP in most developing countries is far from meeting expectation.

In China, the construction of rural hydropower mainly counted on central and local governments in a state-owned manner before 1990s. Since then, the central government has put forward the economic development strategy as follows:

"With the public sector remaining dominant and diverse sectors of the economy developing side by side".

This strategy has brought a far-reaching influence to SHP development. All social sectors are encouraged to construct SHP through different means such as share holding etc., as to balance power demand and supply as well as meet the government shortage of fund. Over the past 10 years, many private enterprises have taken part in the SHP development in rural area. The fund ratio for SHP has gradually changed from the government-oriented to the private-oriented.

Take Zhejiang Province as an example, during 1994-2002, 70% of the total investment US $133 million for the newly established SHP installation 1,058 MW was from private enterprises. Of course, up to now, the state-owned SHP stations are still in a dominant position, which is briefly shown in the following table (on the top):

State-owned and non-state-owned SHP stations (year 2001)

Ownership		State-owned	Non-state-owned (including private-funded)	Total
Stations	Number	8,244	34,783	43,027
	Ratio (%)	19.2	80.8	100
Installed capacity	MW	17,500	8,762	26,262
	Ratio (%)	66.6	33.4	100
Annual output	GWh	62,954	24,187	87,141
	Ratio (%)	72.2	27.8	100

In a nationwide scale, 66.6% of the SHP installed capacity is still state-owned.

The current tendency of PPP in SHP development has exerted deep influence on various aspects in the economic development in China. The transition of investment from medium and small enterprises to SHP development has also handled on the financial, technical and regulatory standpoints as well. Some brief explanation will be given in the followings:

(1) Financial issues, including investment structure and profit availability, are most sensitive to the stakeholders, either from public or private sectors. In China, it is recognized that the following modes of PPP are all permitted or encouraged for SHP development:

— *Cooperative development between enterprises from water resources sector and electric power sector (Public-public).*

— *Cooperative development between provincial & county level investment companies and private enterprises (Public-private).*

— *Development with investment from private enterprises (private).*

— *Foreign invested or joint venture for SHP development (Private-private).*

Any one of above modes can be registered as a limited liability company or share-holding company limited.

Besides capital investment, the right of land use, labor force, equipment, technology and construction fund etc. can all be taken as shares of the investment company. Even water right can be used for shares as to alleviate the water-use conflict between SHP station and downstream villages.

Referring financial benefit of the investment, it could be mentioned that the profit was very encouraging in the past several years, but is now gradually lowered due to various reasons. Usually the investment turnback is estimated by the input and expected outcomes. The situation in China is mostly that where private enterprises favor SHP investment, there is generally short of electric power and the off-take tariff is relatively high, often above US $0.03-0.06 per kWh, which is justifiable with the capital investment of construction if the latter could be controlled within US $730-970 per kW. When the plant factor could be run at 35-45%, the rate of investment return is mostly above 10%, which is usually acceptable to most private enterprises.

In addition to the benefit potential, other two factors are also basic conditions that effect private enterprise funding the rural hydropower, i.e., macro economy and power market.

① The potentials of private fund in China is growing quickly over the past several years. Up to now, the production value of private enterprise in the whole country amounts to USD 447.4 billion, equivalent to 1/3 of total GDP. During 1980-2000, an investment of USD 91.9 million was from private enterprises, covering 33% of the fixed assets investment for the whole society in this period. In recent years, a lot of private capital is mobilized domestically for constructing almost 1 million kW capacities annually. In addition, following the call of "Go global" from the central government, private enterprises are preparing to invest in abroad if there are appropriate opportunities in neighboring countries.

② Currently, electric power is deadly deficient everywhere in China, as a result of continuous and quick development of economy. In many regions, especially coastal developed provinces, the demand for electricity is like “a hungry person not choosy about his food”, and even small diesel generators are extensively used again after long time abandon just as “drinking poison to quench thirst” without concerning the cost and environmental pollution. Thereby, SHP certainly becomes a highlight to investors.

(2) Regulatory issues

There are two significant points that should be of serious concern:

— Market admittance and approval system

As de-regulation policy has been adopted in most countries including China, there is no obstacle in principle for SHP accessing the power market as an independent power producer (IPP). But PPA is still not easy to be reached with respect to the application for grid connection, off-take quantity and tariff. Not like free application and transfer for water right in many developing countries, policies of paid transfer and competitive winning of the use right of small rivers are prevailing in China. For approval of the SHP project construction, the procedure in China is comparatively simple.

— Incentive policies

Although SHP is profitable in places where electricity is in serious shortage and the selling price to the grid could be reasonable for ensuring the profit, SHP in many places is still not competitive with traditional electric power sources. Incentive policies are thus necessary for encouraging private enterprises to finance SHP. Various policies and regulations have been stipulated in some province, such as “Decision on Quickening the Development of Medium and Small Hydropower in Yunan Province”, “Regulations on Strengthening Development & Management of Hydropower Resources in Zhejiang Province”, etc. Similar regulations for favorable off-taking tariff, taxation, discount loans and other governmental support were included. These favorable policies are the basic requisites for rapid SHP development.

(3) Technical issues

The technology of SHP construction is matured and proven in China and world widely. For small hydro, water diversion type project is usually adopted without high dam and complicated headwork for lowering the cost. For electro-mechanical equipment supply, China is fully self-sufficient and is able to export to other developing countries upon request. A lot of Chinese consultant intermediary, including many design institute and HRC are able to offer technical service for all stages of SHP development such as planning, site-selection, design, construction and operation.

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Letter from HRC

Dear participants of TCDC workshops,

In the auspicious Chinese Year of Rooster, we would like to extend you and your family our heartfelt wishes for happiness and prosperity.

Entrusted by the Ministry of Commerce of P. R. China, by now HRC (Hangzhou Regional Center for Small Hydro Power) has already hosted 38 TCDC international training workshops on SHP, and nearly 700 international engineers or technicians from around 70 countries participated. It is believed your stay in China offered you valuable experience through the classroom presentation, discussions, study tours and various contacts with the local friendly Chinese people. It is meanwhile expected that we could continuously carry out all-round exchange and cooperation in the field mutually concerned.

Thereby, HRC’s homepage ***(www.hrcshp.org)*** was set up years ago for dissemination of SHP information, and it has already been browsed by hundreds of thousands of SHP professionals for it is informative, applicable and rewarding. Now a new column called ***“HRC Alumni”*** is open especially for the participants of TCDC SHP training workshops, inside which the personal details of each former TCDC participant will be online, and participants can also log-in for raising any comments or suggestions, as well as get acquainted with other friends for exchanging experience and technology to consolidate friendship and SHP cooperation. In such a way, all of us can work closely with each other, regardless of the geographical distance, and share valuable information and further strengthen co-operation among us. You, as our friends, are expected to timely provide us the SHP-related information in your countries (such as policies & regulations, project cooperation, project bidding, international meetings, training and etc.) by means of giving introductions, reports, brief news, business opportunities or with vivid pictures. We will put the relevant information on HRC’s homepage, and possibly select some to distribute internationally through our periodical ***“SHP NEWS”***.

Besides, should there be any change of your personal contact details or other information concerned, never hesitate to contact us directly, since HRC, as the family of global SHP, is the home for all of you.

Thank you for your attention. Looking forward to hearing from you.

Yours faithfully

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A Visit of Small Hydropower Stations in Australia

Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power

Regarding SHP (small hydropower) design and equipment manufacture, Australia differs much from China. In Australia, SHP design is simple and more attention is paid to the environmental protection. In respect of the manufacture, priority is given to the reliability of equipment with new technology adopted such as the unmanned control system, which improves the stability and reduces the cost of SHP. This deserves to be taken by us for reference.

To introduce the technology of Australia containerized SHP station, in March 2005, a delegation of 4 HRC engineers visited Australian containerized SHP stations and other three conventional SHP plants with the accompany of Tyco Tamar. These stations, no matter in the design of powerhouse, main equipment or auxiliaries, differ significantly from those ones in China. Here, a briefing is presented as follows.

1 Brief of the stations

1.1 Mt Stromlo SHP station

This SHP station is located beside the inlet pipe of a water supply plant, with an installed capacity of 770kW. It provides electricity for 500 households in a village nearby. Water remains a high pressure before pouring into the water plant from a reservoir. So the water pressure is utilized to drive a Francis turbine besides. The parameters of this station are shown as below:

- *Gross head: 68m*
- *Net head: 77m(Maximum),55m (Minimum).*
- *Discharge: 2200L/s(Maximum), 1000L/s(Minimum).*
- *Unit output: 770kW.*
- *Type of turbine: Francis with the runner diameter of 0.62m and speed of 750rpm.*
- *Generator: Synchronous type.*

The main powerhouse covers an area of about 15m^2,where is arranged a horizontal-shaft turbine, a governor, a switchgear cubicle, an excitation system, a PLC controller and a microcomputer protection set, etc. The governor is of hydraulic operation with a nitrogen vessel, and the inlet valve is hydraulic butterfly kind. There is no crane erected inside the powerhouse, and in case of maintenance, the roof could be opened to make a truck crane outside work conveniently. No auxiliary powerhouse is built, and all the control and supervision activities can be achieved in the control room of water plant far away.

1.2 Bendora Dam Hydro containerized station

This is a containerized SHP station at the dam-toe with an installed capacity of 20 kW. As the water-supply source for Canberra, the reservoir is some 30km away from the downtown. To reserve some flow to the downstream river, an existing penstock under the dam is releasing water to the downstream. So this penstock is also adapted to supply water for generation. This station is mainly used as a power source for the water-quality testing device in the reservoir. Due to the long distance between downtown and the dam area, it is not economical for this region to acquire electricity from the grid. Before the installation of this station, electricity for the water quality inspection instruments relies on a diesel generator set. Its parameters are as below:

- *Gross head: Maximum 32.4m, Minimum 23.3m.*
- *Net head: Maximum 31.6m, Minimum 22.5m.*
- *Discharge: Maximum 86.5L/s, Minimum 73.0L/s.*
- *Output: Maximum 19.4kW, Minimum 11.0kW.*
- *Turbine: Reaction type with the runner diameter of 0.62m and turbine model of 150χ25-250.*
- *Generator type: Synchronous generator with brushless excitation system.*

With an area of about 8m^2, the powerhouse is actually a standard container for installing equipment and weather-proof. Manual hoist fixed on the top serves for unit maintenance. A hydraulic counterweight valve is adopted with an electronic load adjuster equipped for adjustment.

1.3 Googong hydropower station

Occupying about 16m^2,its powerhouse is equipped with two sets of vertical shaft Francis turbines with the unit capacity of 300kW. The generator is connected directly with the turbine instead of being set on the concrete pier, just like the configuration of a compact micro-hydro. The governor also adopts the oil-pressure type with a nitrogen vessel equipped. Spring and pressure oil coming from oil pressure unit supply power to the inlet valve. Noticeably, one set of oil pressure unit is shared by two governors and two inlet valves. Meanwhile, the switch cubicle, PLC controller and micro computer protection system are also arranged in the main powerhouse. Just like the station mentioned above, there is no crane or auxiliary powerhouse in this unmanned station. Parameters are just as below:

- *Net head: 48(Maximum),33 (Minimum).*
- *Discharge: 700L/s(Maximum), 400L/s(Minimum).*
- *Output of generator: 300kW.*
- *Type of turbine: Francis with the runner diameter of 0.44m and speed of 1000rpm.*
- *Type of generator: Asynchronous motor.*

Close to the powerhouse stands a containerized substation, inside which is equipped with transformer, high-voltage switchgear, DC devices and capacitors etc.

1.4 Parangana Dam SHP station

With a set of vertical-shaft Francis turbine of 750kW, Parangana Dam SHP station is located in Tasmania State. The inlet penstock is arranged in line with the tail-water canal, over which a metal container is built as the powerhouse covering 8m^2. In respect of the connection of turbine and generator, the type of inlet valve and the configuration of the powerhouse, there is no great difference between this station and Googong Hydro SHP station except that the oil pressure device, along with the switchgear equipment, is located in the auxiliary room that is higher than the powerhouse and faces the containerized substation. Its parameters are:

- *Net head: 36m.*
- *Discharge: 1.05-2.7L/s.*
- *Output of generator: 750kW.*
- *Type of the turbine: Francis turbine with speed of 750rpm.*
- *Type of the generator: asynchronous generator.*

The peculiar design lies in the installation method of this plant. The powerhouse, a metal container, is directly erected on the tail water canal which is connected with the inlet penstock tunnel.

2 Features of stations

2.1 Powerhouse design

In general, powerhouses of these 3 conventional SHP stations all look like a container. The inner space is limited, with an aisle reserved only. There is no crane inside and a truck crane could work for maintenance as the removable roof opens. There is no window and a fan on the roof is used for ventilation.

2.2 Energy recycle

Another design characteristic is that the station utilizes the energy originating from the reduction of water pressure. For example, before the installation of Mt Stromlo hydropower station, water usually flows, with very high pressure, into the water plant through the penstock. The installation of this station not only recycles the energy, but also mitigates the danger of water pressure to the water pond.

2.3 Inlet valve

To ensure the reliable shutdown under any emergency such as unit accident or power failure, either counterweight valve or spring plus servomotor pressure-oil vessel is adopted as the inlet valve. The closing time is decided by adjusting the oil pore of servomotor. As mentioned by Tyco Tamar engineers, such kind of inlet valve has been widely used in Australia. This technology for the containerized SHP station that we will soon import still has rare application in China.

2.4 Governor

Governors in these 3 conventional SHP stations all adopts the hydraulic operation type with a pressure nitrogen tank, among which in Googong SHP station two governors and two inlet valves share one set of oil pressure device, thus reducing the cost. This approach of two or even three units sharing one oil pressure set have been prevailing in Canada and Europe.

2.5 ELA (Electronic load adjuster)

For SHP stations, the optimal choice for adjusting of turbine output suggests the appropriate utilization of inlet valve responsible for a rough adjustment and electric load adjuster for a precise adjustment. For instance, a set of butterfly valve with springs serving for approximate adjustment of the turbine output is installed in Bedora Dam containerized SHP station, which is also equipped with a set of electric load adjuster for balancing the turbine output and the load after the inlet valve's performance.

2.6 Generator and containerized substation

Among these 4 SHP stations, two belongs to isolated system with synchronous generators and the other two are equipped with asynchronous generators for connecting with grid. In Europe or the United States, all the power stations linking to grid always adopt asynchronous generators, and Australia is not an exception.

3 Summary

From this station visit, several aspects can be wrapped up: firstly, thanks to complete safety precaution and high-level automation, reliable shutdown of units £¨although unattended£©can be achieved even in case of accident and power failure. Secondly, to reduce the front cost, simple auxiliary equipment and small powerhouse have been adopted during the installation of small hydropower system in Australia, which represents the combination of SHP with ecological protection.

The key conclusions are as follow:

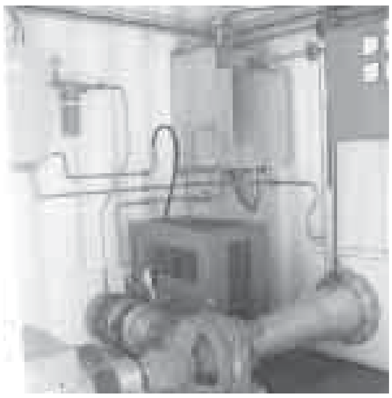
- *The sustainable development of SHP dwells in the continuous reduction of cost and adherence to pragmatism and simplicity. Furthermore, more energy and attention should be dedicated to the adoption of the advanced technology and station's reliability. Just as discussed above, small hydropower stations in Australia work very well in these terms.*
- *Ecological protection has attracted great attention in the exploitation of small hydropower in Australia, and lots of methods have been launched, such as using less land and preserving vegetation. Recently much more concern is going to the ecological protection in the SHP exploitation. Though SHP is considered as a green and renewable energy, some SHP stations would be developed to endanger the environment if not considering the ecological protection. In a word, Australia hold many merits worthy to be followed by us in this regard.* ■

(Written by Li Guang)







25 YEARS EXPERIENCES OF CHINA MADE SMALL HYDRO-ELECTRIC UNITS WITH USA MADE DIGITAL TECHNOLOGY INSTALLED IN USA AND CENTRAL AMERICA

BY DR. ALEXANDER A. TSENG, PE. PRESIDENT ORENCO
251 HIGH STREET, PALO ALTO, CALIFORNIA, USA

1 Background

Twenty-five years ago America's small hydroelectric power generations were reactivated by private, municipal, and local governments to utilize the renewable energy from the small hydro sties available 10,000 existing dams, small rivers and/or streams, and energy recovery facilities at many water transmission and delivery systems.

The catalyst which touched off this usage of renewable energy reactivation was the 1976 oil crisis caused by OPEC, increasing the crude oil price from $ 6.00 per barrel to $ 40.00. Prior to this time many coal burning plants converted to the oil fueled thermal power plants to meet environmental clean air requirements. In 1978 the US National Energy Act was established. This further encouraged the development of SHP as the Energy Act provided the key provision mandating utilities to buy power from anyone who could product it at the rate determined by the principle of "Avoided Cost," i.e., the cost at which a utility could generate power itself or purchase it from another utility.

During the same period many existing thermal plants converted from oil fuel to natural gas with added combined cycle features providing higher efficiency. Natural gas or coal bed methane gas interconnected to existing gas transmission pipe lines which provided adequate gas supply. The large scale gas burning power plant reduced the installed cost to $ 750.00 per W. Usually Small Hydro Power(SHP) had an installed cost over $ 1200.00 per W, even the fuel cost is free. Under these conditions, it was difficult to compete when the gas was selling at $ 1.25 to $ 3.00 per 1,000,000 BTU. To induce individual entrepreneur's participation and allow reasonable profit, resolve SHP's problem of meeting the firm power requirement, and accomplish the nation's need for swift, effective, renewable energy, the Public Regulatory Policies Act(PURPA) was formed. The new policy requiring utilities to pay the small power producers a handsome sum, often as much as eight cents a kWh, made SHP investment viable.

2 Steps Taken

In 1979, at the International Conference on Small Scale Hydropower sponsored by the US Army Corp of Engineers and US Department of Energy held in Washington D.C., I presented a paper entitled "The Role of Small Hydroelectric Generation in the Energy Mix Development for PRC". In this paper I reported since 1958, China has already constructed over 30,000 small and micro hydroelectric power stations with total installed capacity of 5400MW (by end of 2001, there were 43,027 small hydropower stations with a total SHP installed capacity of 26,260MW representing 31% of PRC installed hydropower).[1][2]

The turbine generator equipment made in China has standardized the selection of the turbine units from low head, medium head, to high head as shown on the Fig. 1 and Table 1.

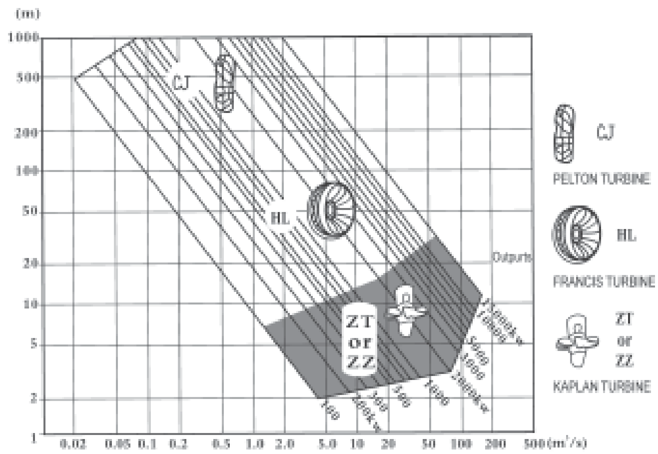


Figure1 APPLICATION DIAGRAM OF THE VARIOUS TYPE SMALL SCALE HYDRO-TURBINES 100kW~15, 000kW

The selection of the proper type and size to fit the specific small hydro site conditions can be easily determined. After the choice of the turbine with its associated generator, the required dimensions for the powerhouse is determined and the civil, mechanical and electrical field installtion costs can be made.

There is a definite advantage in the United States to build new small hydro plants because most of the new SHP plants can be interconnected to the existing electrical distribution lines. This provides the immediate market by signing the power purchase agreement(PPA) with the nearby utility under the Public Regulatory Policy Act.(PURPA) as mentioned above. The electricity supplied to the network from these SHP plants have benefited the network with added voltage loss compensation and reactive power supply which forms as a part of the distributed generation.

Chinese-made small hydroelectric units can be equipped with compatible US made digital controls and built for remote non-attended stations with SCADA system. This enables SHP plants can compete with large scale power generating units. Most of these SHP units were supplied with a Water to Wire package and installed by Engineering Purchase and Construction (EPC) contract. The SHP cost was reduced to near $1000.00 per kW.

The successful use of automation-SCADA on SHP plants have improved the unit reliability, efficiency, and custom service through the effective application of the automation technology. The principle of this application are shown on the attached four flow charts, (A) Unit Start Sequence, (B) Unit Stop Sequence, (C) Unit Shutdown Sequence Generator Problem and (D) Unit Stop Turbine Problem.

STANDARD SMALL HYDROELECTRIC GENERATING UNITS BY ORENCO FOR U.S. INSTALLATION

Table 1 **Specification of water Turbine Generator Sets 18~3000 kW**

Item No	Turbine				Generator		
	Type	Model	Head (m)	Flow (m^3/sec)	Capacity of Generator (kW)	Speed (rpm) 60Hz	Voltage (V) 60Hz
1	Axial-flow reactiont type	ZD760-LM-60	2~6	0.8~1.64	18.30.40.55.75	1200	460
2		ZD760-LM-60	2~6	1.4~3.54	30.40.55.75.100.125 160	1200 514	480 460
3		ZD760-LM-100	5.5	4.174	160	450	460
4		ZD760-LM/LMY-120	2.6~6.6	4.17~6.58	75.100.125 160.200 250.320	900 300 (360) 360	460 460 (6300) 6300
5		ZD760-LH-200	4.2~5.7	16.4~18.7	500.600 800	189.5 211.7	3150 6300
6		ZD560-LMY-60	9.3~12.7	1.21~1.35	75 100.125	900 900	460 460
7		ZD560-LH-60	7.8~12.7	1.41~1.85	75.100.125.160	720 (900)	460
8		ZD560-LMY-80	6.3~13.5	1.77~2.97	75 200.250 160.200	1200 600 600	460 460 460
9		ZD560-LH-80	8~14	2.9~3.99	160 250 400	450 514 (600) 600	460 460 6300
10		ZD560-LH-100	12~15	5.53~5.5	500.630	514	6300
11		ZD560-LH-120	8~14	5.1~8.5	500.630	360 (450)	6300
12		ZD560-LH-180	10	16.5	1250	257	6300
13	Mixed-flow Reaction type (Francis type)	HL110-WJ-35	38.5~50	0.27~0.33	75.100.125	1200	460
14		HL110-WJ-42	49	0.44	160	1200	460
15		HL110-WJ-50	33.3~92	0.51~0.91	125.160.200.250 320.500.630	720 (900) 900 (1200)	460 460 (6300)
16		HL110-WJ-60	55.5~80	0.97~1.10	400.500 630	720 (900) 900	6300 6300
17		HL220-WJ-50	30~47	1.51~1.83	320 400.500 630	600 720 900	6300 6300 6300
18		HL220-WJ-60	47	2.81	1000	900	6300
19		HL220-WJ-71	33~44	3.32~3.90	800.1000.1250	600	6300
20		HL230-LJ-134	35.2	12	3000	276	6300
21		HL240-WJ-59	32.6~34	2.38~2.5	630	720	6300
22		HL240-WJ-71	20~45	2.9~4.19	500.630 800.1000.1250	514 (600) 600	6300 6300
23		HL240-LJ-84	15~31	3.8~4.65	500.630 1000	360 514	6300 6300
24		HL240-WJ-100	16~30	5.6~6.4	800.1000.1250	360	6300
25	Impulse type	C/-w-55/1×58	100~260	0.12~0.19	75.100.125.160	720	460
					200.250.320.400	900	460
26		C/-w-65/1×72	100~260	0.18~0.29	125.160	600	460
					200.250.320.(400)	720	460 (6300)
					500	900	6300
27		C/-w-92/1×11	138~145	0.50	500	514	6300

3 Types of SHP Application

The first Chinese made SHP was built by diverting water from two upper streams, Bailey Creek and Bear Creek. It is located near Redding, California. The unit is 680kW with a rated head of 148 ft. and a flow of 60cfs. At its dedication on July 1, 1980, The Honorable Hu Dinyi, first Consul General for China in San Francisco, referred to this “baby plant” as born in China, reared in California with US digital technology, and parented by Texans. Now twenty five years later, the plant is still in successful commercial operation. (See Photos 1,2)

The thirty six small hydroelectric plants built in USA and C.A. are identified by the type of application as follows: (for detailed listing see Chart E)

1) New on the stream plants using diverting structure to tap a portion of the stream water flow out and returning it back to the river to meet the local requirements and regulation. (Bailey Creek, Rio Bravo, Macal-Mollejon in Belize CA. and etc). (Photo#1&2)

2) Bypass the existing pressure reducing valves with on-line turbine generating units recover the energy yet meet the back pressure requirement for water sub transmission and distribution. (Vallejo, Sunshine, E1 Sigundo and etc.) (see Photo #3 presented by HRD & (Photo #4)

3) Generation of power by using fish ladder water supply without inhibiting the fish to complete its natural journey cycle from upper streams to the sea or lakes. (The Dalles, & McNary Fish Water Releasing Projects along Columbia River)

4) Using released water from existing dam for irrigation and industrial usages while at the same time removing previous sediment deposited near the dam. (Camp Far West for SMUD, Camanche for EBMUD). (See Photo #5)

5) Retrofit existing units with standard higher efficiency units which uses existing water way. (Navajo units for City of Farmington, New Mexico)

6) Stand alone plants, black start without station battery. (Finca San Francisco, Guatemala, Indian Point & etc.) (See Photo #6)

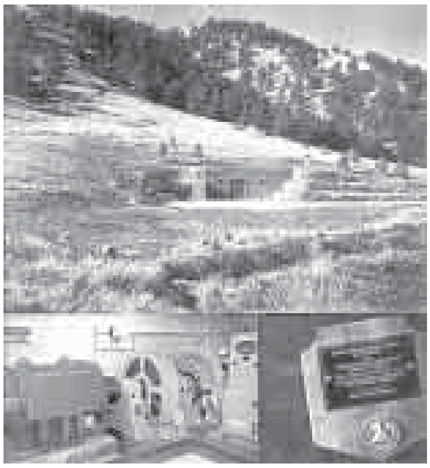
The experiences we have learned from these new generating small hydro electric plants can serve as a guide to minimize the future world wide concerns of removing existing old dams and generating equipment. The implementation of small hydroelectric project usually takes multi-disciplinary efforts. Few individuals have the depth of knowledge of each aspect of hydropower to perform all the tasks. The use of standardized packages provide the essentials that the planner and decision maker needs to overcome the constraints and cost requirement.

4 Summary

With energy needs risings and ever growing need for cleaner energy sources, ORENCO is dedicated to extracting renewable energy from our environment cleanly, efficiently and appropriately. Dams create electricity by holding back water and then running it through turbines. Many dams, including the Dalles Dam, McNary Dam located along the Columbia River, use turbines to tap the earth's nature resources. For the humans these dams have created clean, cheap electricity. However, for fish, such as Northwest salmon, dams are more of a trouble obstacle. Migrating past the dams and through the wheeling turbine is a difficult and often deadly task. To help the salmon along heir journey, we took many environmental precautions and have created unique mechanisms to assist the salmon's return to their spawning grounds. Screens along bypass pipes were added to the existing fish ladder as in the Dalles Dam. For the McNary fish water bypass, the slower speed turbine was used allowing the fish to safely navigate the blades. Since 1994, the US gov-

Photos 1

Photos 2



Photos 3

Photos 4

ernment has spent over USD$60 million dollars devoted to fish passages associated with other dams.

To strengthen the cooperation on the cost shared program funded by the US Congress through its Advance Hydro Power Turbine System (AHTS), two hundred and seventy million dollars has been allotted for research and development.

We should all be aware the most sophisticated small hydro power plant would be worthless if it does not include the feature to satisfy environmental regulations or ignore the constraints resulting from downstream water usage. Twenty first century is here. The old hydro plants (See Photo #7) can now be replaced with newer digital technology to generate electricity essential to the economic and social developments. Let us share our SHP experiences on a world-wide basis.

References:

[1] *Waterpower '79 Proceedings October 1-3 1979.*

[2] ***SHP NEWS*** *Published by HRC Vol.21,2004*

[3] *Energy Recovery From Water Treatment Plants and Water Distribution Systems, By A.A. Tseng, International Energy Conference Proceedings, Beijing China September 1993.*

Brief Resume of the author:

Alexander A Tseng, President Oriental Engineering and Supply Company, Palo Alto, California, USA. Chief Electrical Engineer (retired) Stanford Linear Accelerator Center. Lecturer at UC Berkley on How to Build and Operating Small Hydro Electric Plants. Consulting Engineer for Large Energy Converting and Generating Plants in USA, Canada, Korea, China, Philippine, Brazil, Belize and Guatemala. B.S. Electrical Eng. National Central University, China. M.S. Electrical Eng. Illinois Institute of Technology. B.S.Industrial Eng. Illinois Institute of Technology. Engineer Stanford University. PHD Electrical Eng. Stafford University.

Registered Professional Engineer in 7 States of USA. ■

Photos 5

Photos 6

The Chinese "Small Hydropower", a magazine that National Research Institute for Rural Electrification (NRIRE) and Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power has edited and published for 123 issues (bimonthly), was allocated with the International Standard Serial Number ISSN 1007-7642, and China Standard Serial Number CN33-1204/TV. It was published in Chinese attached with title of articles in English. Its special features are technical experience of SHP development in China. Information of international SHP activities and important events in the field of SHP have also been widely included.

This magazine carries news, views and articles on all aspects of small hydro power. It is useful to those who are intersted in technical experience of SHP development in China.

"Small Hydropower" is the only professional publication on small hydropower in China, which is issued domestically and abroad. It is widely circled in all corners of China concerning SHP, and getting more and more popular in over 600 rural counties which is primarily hydro-electrified, more than 2,300 counties with hydropower resources, more than 50,000 small-sized hydropower stations, thousands of colleges or universities, research institutes and other administrative authorities on SHP. Advertising is welcome for any equipment manufacturer to target Chinese market on SHP construction, equipment purchasing or other businesses. ■

Chart A

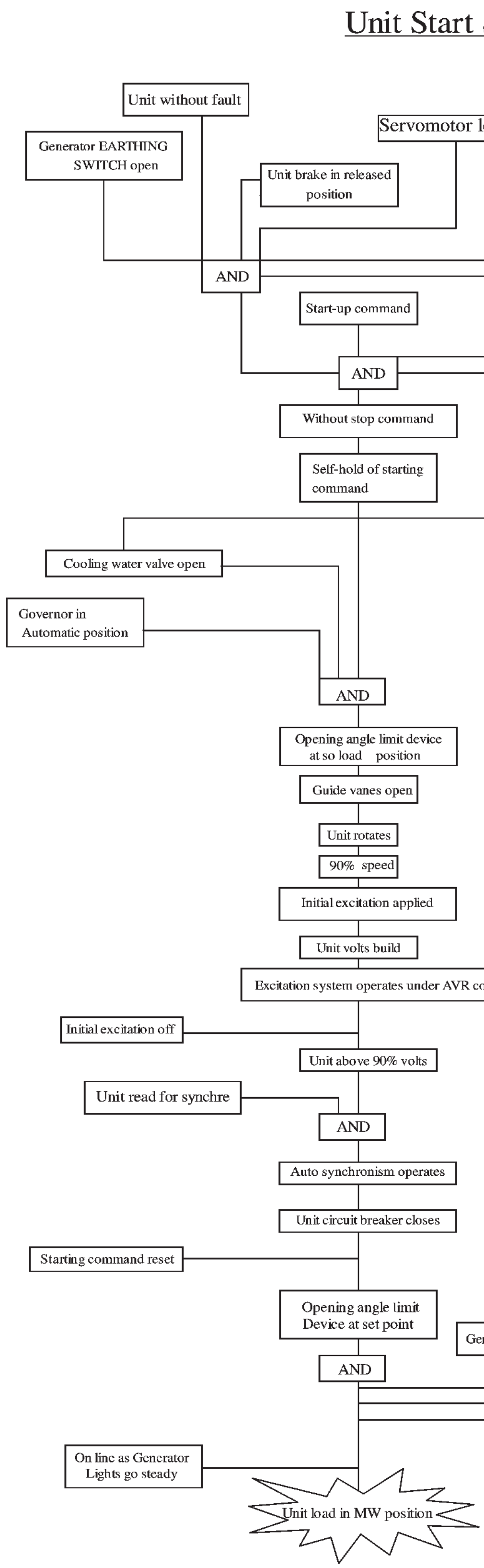

Unit Start Sequence
Unit without fault
Generator EARTHING SWITCH open
Servomotor lock off
Unit circuit breaker open
Unit brake in released position
Unit intake gate fully opened
AND
Start-up command
Preselect generator
Select start
AND
Without stop command
Self-hold of starting command
Cooling water valve open
Governor in Automatic position
On time as generator fights flash
Off line lights go out
AND
Opening angle limit device at so load position
Guide vanes open
Unit rotates
90% speed
Initial excitation applied
Unit volts build
Excitation system operates under AVR control
Initial excitation off
Unit above 90% volts
Unit read for synchre
AND
Auto synchronism operates
Unit circuit breaker closes
Starting command reset
Load change rate set point
Opening angle limit Device at set point
Generating load set point
Load limit set point
AND
On line as Generator Lights go steady
Unit load in MW position

Chart B

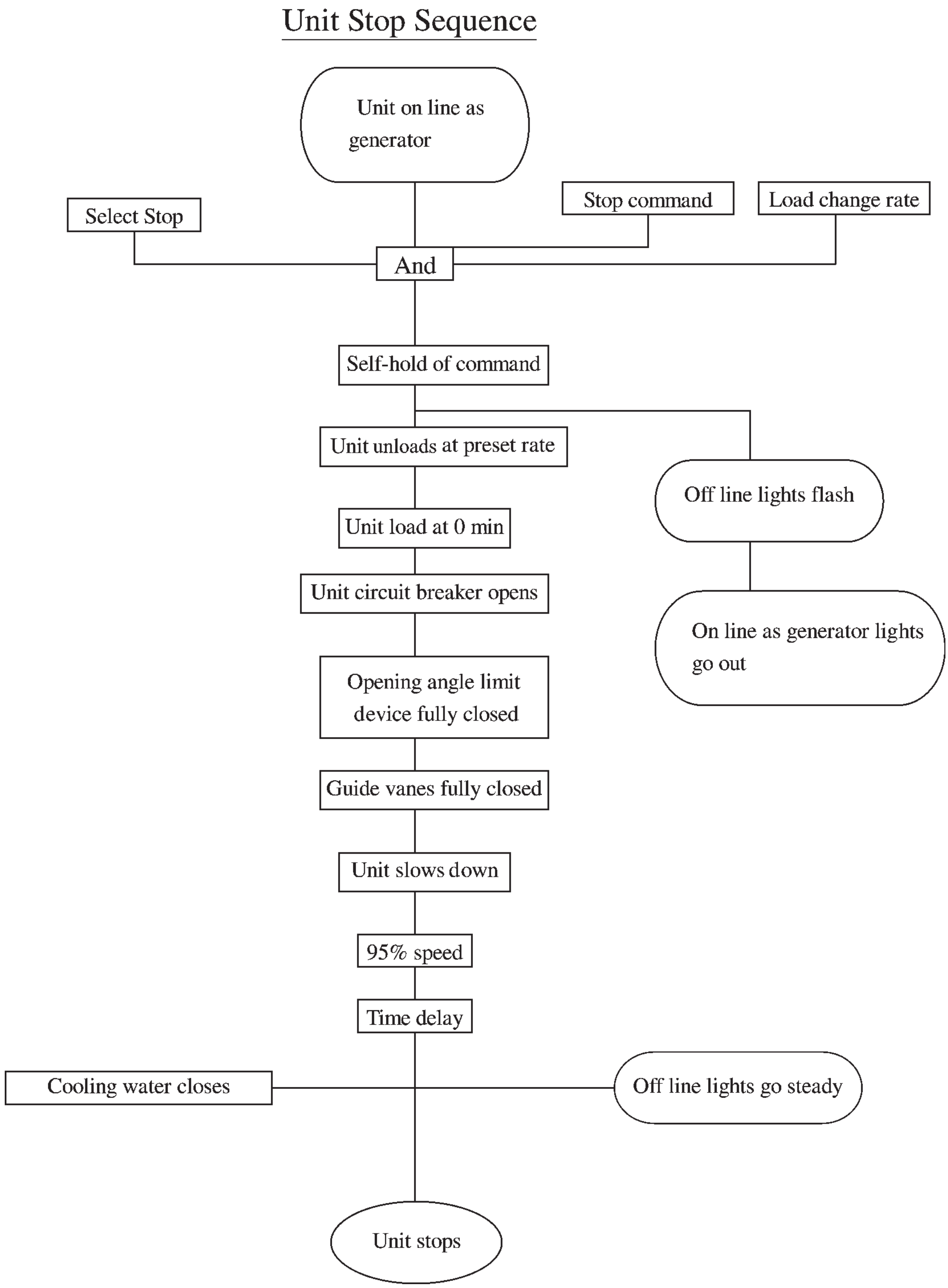
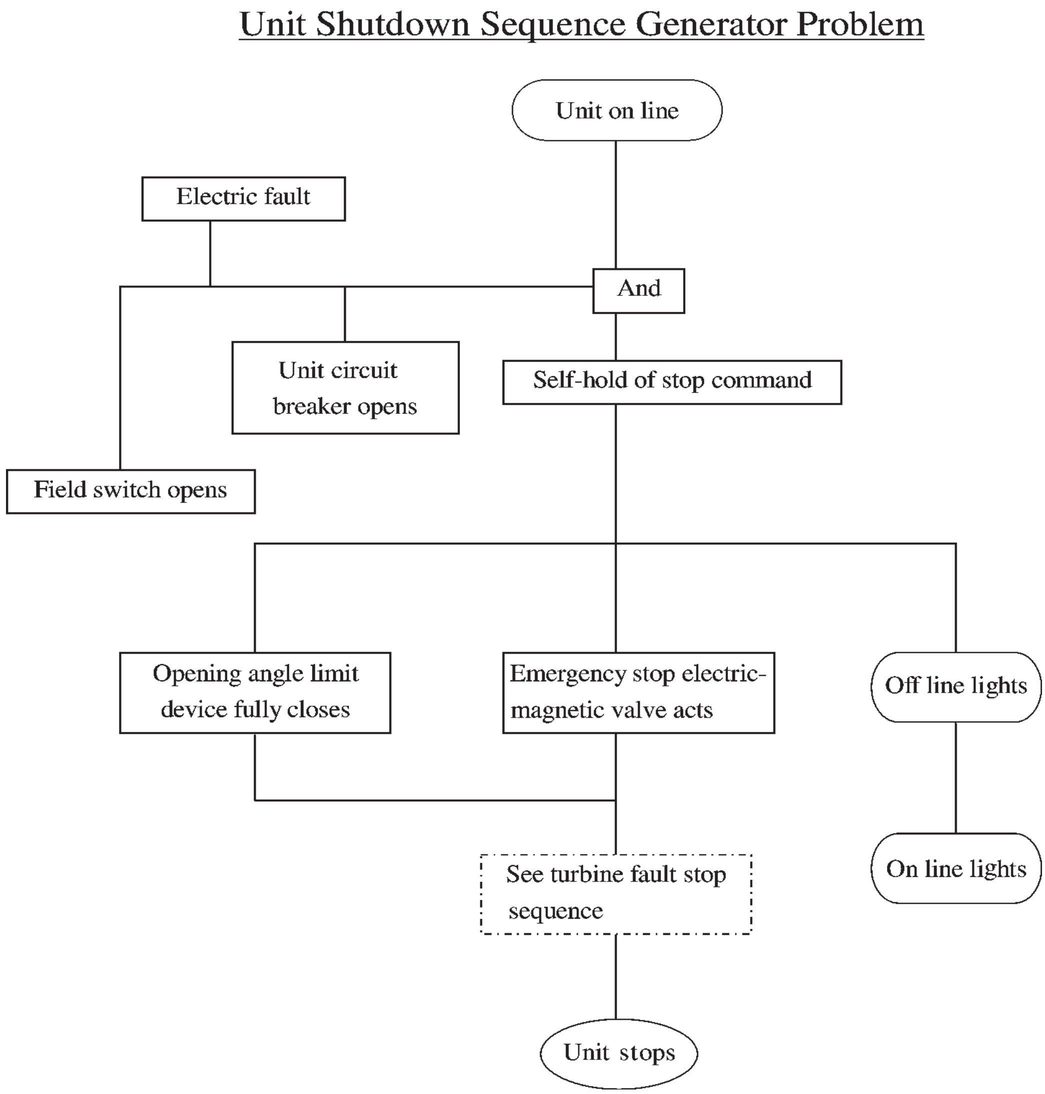

Unit Stop Sequence
Unit on line as generator
Select Stop
Stop command
Load change rate
And
Self-hold of command
Unit unloads at preset rate
Off line lights flash
Unit load at 0 min
Unit circuit breaker opens
On line as generator lights go out
Opening angle limit device fully closed
Guide vanes fully closed
Unit slows down
95% speed
Time delay
Cooling water closes
Off line lights go steady
Unit stops

Chart C



Pakistan Guest Visit HRC

Companied by CMEC Beijing representative, Dr. Eng. S.M.Bhutta, a technical advisor of Alternative Energy Development Board (AEDB) in Pakistan, paid a visit to HRC during June 3-5, 2005. Both sides exchanged ideas on micro & small hydropower development, and intended to further strengthen the cooperation in micro & small hydropower fields as to push forward the rural electrification program in Pakistan. Dr. S.M. Bhutta also visited the SHP New-tech Laboratory set up by HRC and showed an intense interest in HRC's new technical products such as SHP-applied TC operator, governor, automatic control system and micro hydropower generating units etc.

The Alternative Energy Development Board (AEDB) was established in May 2003, which is a governmental organization for promoting the development of renewable energies. The Chairman is Air Marshal (Retd.) Shahid Hamid.

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Source: SHP NEWS Editorial office, http://www.hrcshp.org

Chart D

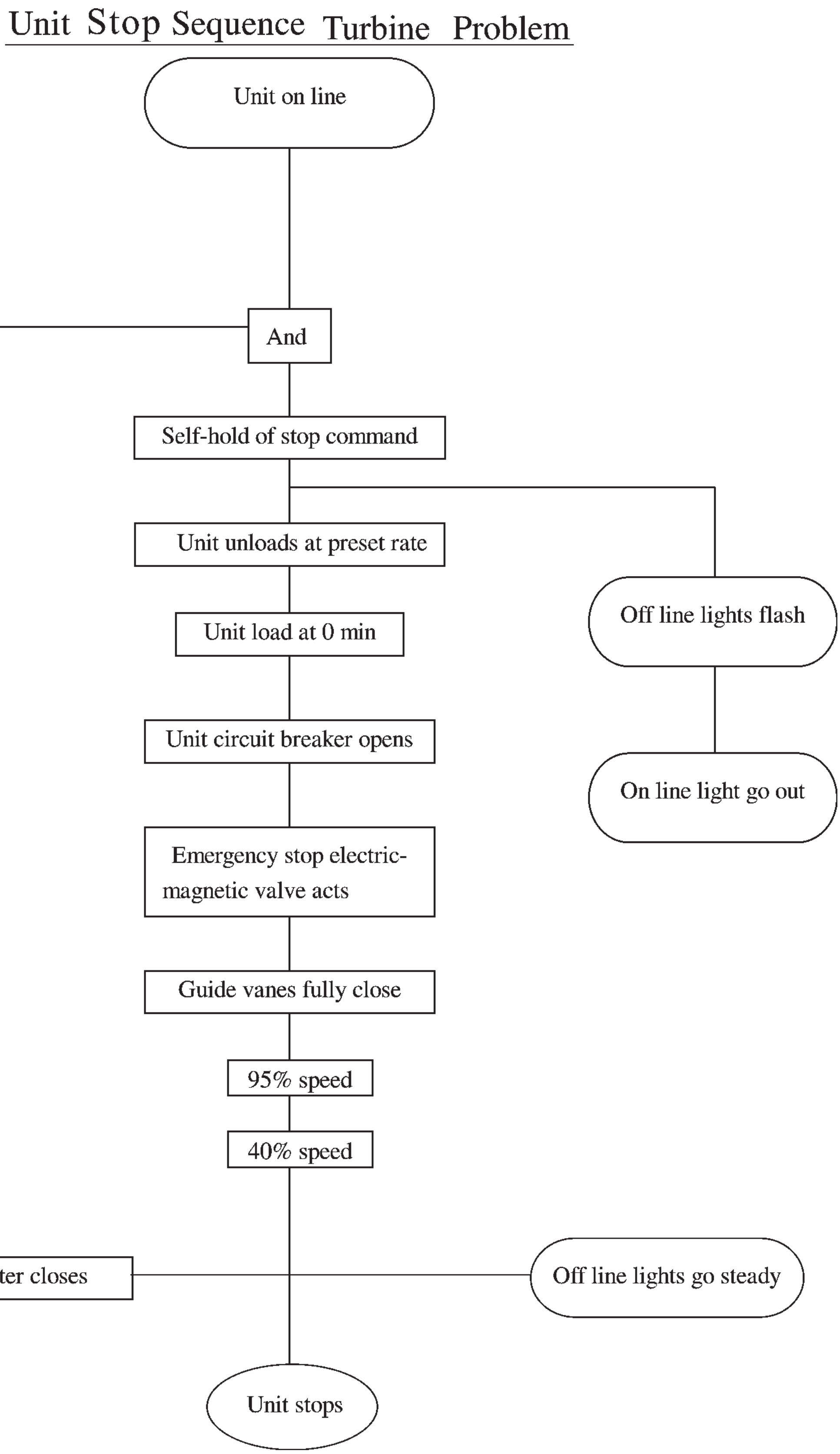
Unit Stop Sequence Turbine Problem
Unit on line
Turbine fault
And
Self-hold of stop command
Unit unloads at preset rate
Unit load at 0 min
Unit circuit breaker opens
Emergency stop electric-magnetic valve acts
Guide vanes fully close
95% speed
40% speed
Off line lights flash
On line light go out
Cooling water closes
Off line lights go steady
Unit stops

Chart E

SMALL HYDROELECTRIC PLANTS BUILT IN USA AND C.A. BY ORENCO FOR INSTALLATION

Customer	**Project**	**Type**	**kW**
Atkinson Construction No. WASCO PUD	MCNARY DAM	Vertical Fixed Blade	10 MW
Axel Johnson	Yolo County	Torgo	150
Baccarat Development Corp.	Isabella	Vertical Francis	2-5975
Brol Bros. Guatemala	San Francisco Finca	Horizontal Francis	150
C. Keller	Potter Valley	Vertical Turgo	5
Catalyst Energy Development Corp.	Rio Bravo	Kaplan	2-6120
Chris Difani	Shasta River Hydro	Fixed Blade Propeller	100
Church Camp	Viola	Pot Form Horizontal	55
City & County of San Francisco	MOCCASIN	Horizontal Francis	3000
City of Boulder, Colorado	Sunshine	Horizontal Francis	750
City of Boulder, Colorado	Boulder	Horizontal Pelton	3100
City of Farmington, New Mexico	Navajo	Generator Only	2-16500
City of Soda Springs, Idaho	Soda Creek	Horizontal Francis	300
City of Vallejo	Fleming Hill	Horizontal Francis	300
Consolidated Hydroelectric, Inc.	Bailey Creek	Horizontal Francis	650
County of Los Alamos, New Mexico	Abiquiu	Vertical Francis	2-6876
Dominion Energy Inc./BECOL	Macal/Mollejon Belize	Vertical Francis	8.4 MW
East Bay Muncipal Utility District	Camanche	Kaplan	3562.5
F & H Construction	Virginia Ranch	Horizontal Francis	950/1386
F & H Construction	Virginia Ranch	Horizontal Francis	50/75
Farmer's Irrigation	Hood River	Horizontal Pelton	1800
Finca San Francisco	Gautamala	Horizontal Francis	120
Finca San Francisco	Gautamala	Horizontal Francis	250
Hirschkind Estate	Ecuador	Vertical Francis	10
Levan Town, Utah	Cobble Rock	Horizontal Pelton	110
Levan Town, Utah	Pigeon Creek	Horizontal Pelton	240
Maher Wissa, P. E.	Portneuf	Horizontal francis	900
North WASCO PUD	Dalles Dam	Vertical Francis	5850
Pheiffer, Wisconsin	Ozga	Kaplan	22
Placer County Water Agency	Hell Hole	Horizontal Francis	800
South Sutter Water District	Camp Far West	Vertical Francis	7500
U.S. Burea of Reclamation	Mcphee	Horizontal Francis	405
U.S. Burea of Reclamation	Mcphee	Horizontal Francis	809
William Ingran	Ingram Ranch	Horizontal Francis	350

■

HRC's SHP Consultation Mission in Rwanda

Invited by Kigali Institute of Science, Technology and Management, four specialists from Hangzhou Regional Center for small Hydro Power (HRC), China, have conducted study tour in Rwanda to provide consultation service to Kavumu and Rutongo sites as well as several other hydropower sites for potential construction from 11 to 22 May 2005. The team leader of the group is Prof. Liu Heng who is Vice Chairman of UNESCO-IHP Intergovernmental Council Bureau and Vice President of Nanjing Hydraulic Research Institute. The other members include Mr.Pan Daqing, Deputy Secretary General of HRC secretariat, Mr. Wu Weiguo, Deputy Chief of HRC Design Institute and Mr.Rao Dayi, a senior engineer of HRC. During the stay in Rwanda, a total of seven hydropower site visits have been conducted in seven provinces of Rwanda.

Rwanda has indigenous energy resources of hydropower. The terrain of Rwanda is mostly grassy uplands and hills declining from west to east. The precipitation is high, with numerous rivers crossing around and flowing with abundant water resources which are appropriate for small or micro hydropower development. The annual rainfall ranges from 1200 to 1800mm.

As the fund is limited, the harnessing of hydropower is only limited to the development of micro hydropower so as to resolve the energy issue of the local farmers. In the short period of time, it is realistic. In the long run, however, sites with larger hydropower potential and even with reservoirs may be selected for exploitation, as the micro has less economic benefit. Meanwhile, it is necessary to form a national grid of a comparatively larger scale for power transmission.

Surveying work should be done at the areas with large catchment and large flow. Master-planning should be carried out for those large catchment areas.

The consultation group is grateful for all the arrangement and kindness demonstrated by Kigali Institute of Science, Technology and Management as well as the Ministry of Energy during the stay in Rwanda. The consultation group would also like to express the gratitude for the long-term and powerful support and guidance by the officials of the Commercial Office of the Chinese Embassy in Rwanda.

As one of the follow-ups, HRC's second group of expertice will be sent to Rwanda in June to help accomplish the topographical survey for the design of several hydropower sites in Rwanda. ■

(Written by D.Pan)

Chinese Commercial Counselor at the Embassy Mr.Fang received the specialists

Discussion with Rwandan Minister of Water Resources

On-site study

Flow measuring

2005 Training Course on SHP for Asia-Pacific Region

<Prospectus>

"2005 Training Course on Small Hydropower for Asia-Pacific Countries" is specifically for developing countries under the list of aid to foreign countries by the Chinese government. Entrusted by the Ministry of Commerce, Hangzhou Regional Center for Small Hydro Power (HRC) will undertake the mission.

Sponsored by the United Nations and Chinese government, Hangzhou Regional Center for Small Hydro Power (HRC) was created in 1981, aiming at promoting the SHP development in the world. China has most SHP stations, with much experience in SHP development. In order to disseminate SHP technology, HRC has already held with success 38 training workshops for nearly 700 participants from 70 countries.

1. Objectives: To master the basic theory and principles of SHP development, to know more about the serialization and standardization of Chinese SHP equipment, and to master the method of equipment selection, operation and maintenance, etc.

2. Date: From 20 Oct. to 28 Nov. 2005, Hangzhou, P.R. China.

3. Venue: Hangzhou Regional Center for SHP，Hangzhou, China.

4. Course Contents: Procedures of SHP development, SHP Hydrology, civil structure and economic evaluation, SHP equipment selection, operation and maintenance, electrical design and automatic control technology for SHP station, etc.

5. Training Methods: Lectures, experiments, practice, discussions, field trips & seminar.

6. Medium of Instruction: English

7. Methods for Evaluation: Certificates will be issued to those qualified participants who present the country report on SHP and perform well during the training.

8. Participant's Qualifications and Requirements for Admission:

a. Recommended by the governmental organizations concerned.

b. The applicants should be under 50 years old.

c. At least two years working experience in the hydropower sector.

d. Be in good health with no infectious diseases or handicapped.

e. Be proficient to listen, speak, read and write in English.

f. Prepare a review paper or report on SHP development of the participants' country so as to exchange among the participants.

g. Not to bring family members to the training course.

h. To observe the laws, rules and regulations of P. R. China and respect the Chinese customs during the training.

9. Training Expenses:

a. The Chinese government will bear the expenses of training, boarding and lodging, local transportation, pocket money of RMB 30 Yuan per person per day for those from developing countries during the training period.

b. The expenses of international airfares (including transit fees), medical care, insurance for the participants are covered by the participants themselves.

10. Application and Admission:

a. Nominated by their respective governments, applicants are requested to fill up the Application Form, which should be endorsed by the departments concerned of their respective governments, and submit with valid Health Certificate provided by authorized physicians or hospitals to the Economic or Commercial Counselor's Office of Chinese Embassy (ECCOCE) for examination and endorsement.

b. If endorsed after checking, Admission Notice will be signed and issued to the accepted participants by ECCOCE through the related government departments. With Admission Notice, participants should go through all necessary formalities with all the mentioned documents to China on the registration date.

11. Insurance: The training course organizer dose not hold any responsibility for such risks as loss of life, accidents, illness, loss of property incurred by the participants during the training period.

12. Liaison Address:

a. Economic or Commercial Counselor's Office of Chinese Embassy (ECCOCE).

b. Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power.

1. 中国大使馆经济商务参赞处

2. 亚太地区小水电研究培训中心

地址 Add：中国 杭州市学院路 122
122, Xueyuan Road, Hangzhou, China

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FORMATION 2005 Pour L'AFRIQUE SUR LA TECHNIQUE DES PETITES CENTRALES HYDRO-ELECTRIQUES

<PROSPECTUS>

"Le stage de formation 2005 pour l'Afrique sur la technique de petites centrales hydro-élèctrique" est subventionné par le Gouvernement Chinois specialement pour les pays en voie de developpement, dans le cadre de l'aide aux pays en voie de développement. Chargé par le Ministère chinois du Commerce,le centre de formation et recherche sur les petites centrales hydro-élèctriques de la Région d'Asie et d'Océan Pacifique, organise ce stage de formation à Hangzhou, Chine.

Le centre de formation et de recherche sur les petites centrales hydro-élèctriques de la Région d'Asie et d'Ocianie Pacifique a été crée conjointement par le Gouvernement chinois et le département du Programme de Développement des Nations-Unies en 1981, en vue d'accélérer le développement de petites centrales hydro-élèctriques du monde entier. La Chine est un pays exploitant de petites centrales hydro-élèctriques(P.C.H.E) le plus du monde. Chargé par UNDP, UNIDO, FAO, le Ministère Chinois du commerce et le Ministère Chinois de la Science et de la Technologie, le Centre a tenu avec succès, 38 stages internationaux depuis sa création. Près de 700 représentants venant de 70 pays d'Asie, d'Afrique, d'Europe et d'Amérique latin y ont participé.

1 Objectif de formation

Par le moyen des enseignements,visites, explorations et activités pratiques, le stage a pour objectif d'aider les stagiaires à assimiler la théorie et la méthode fondamentale de la mise en valeur d'une petite centrale hydro-élèctrique, à maitrîser les connaissances élémentaires sur le choix des types, le fonctionnement, l'entretien et la maintenance des équipements de P.C.H.E, et à connaître la sériellisation et la normalisation des matériels de P.C.H.E de Chine ..

2 Date du stage: du 2 Septembre au 26 Septembre 2005.

3 Lieu du stage: Le centre de formation et de recherche sur les petites centrales hydro-élèctriques de la Région d'Asie et d'Océan Pacifique, Hangzhou, Chine.

4.Thème de formation

Procédure de la mise en valeur de P.C.H.E , hydrologie,construction et évaluation économique de P.C.H.E, choix des types ,fonctionnement et maintenance des équipements de P.C.H.E, conception de l'élétricité et l'automatisation des centrals,etc.

5 Méthode de formation: Les cours en classe, des exercices sur des themes, stage, demonstration,des études et visites sur place, des cours donnés au chantier, des manoeuvres pratiques du fonctionnement, en vue de consolider les connaissances théoriques et les savoir-faires appris du stagiaire.

6 Langue: français

7 Méthode d'examens: Les certificats seront distribués aux participants qualifiés en tenant compte de leurs rapports sur le développement de PCHE du pays d'origine et leurs performances pendant le formation.

8 Candidat au stage

a. Recommandé par le département compétant du gouvernement de son pays.

b. Agé de moins 50 ans,

capable de terminier les cours concentrés et les études sur terrain, durant le stage de formation.

c. Ayant plus de 2 ans de travail pratique en hydro-élèctrique.

d. Sain, sans maladie contagieuse, non infirme.

e. Possédant le français écout é, parlé, lu et écrit.

f. Preparant un rapport sur le développement de PCHE de son pays et un rapport concernant de son travail en vue d'effectuer des é changes des experiences parmi les stagiaires.

g. Non accompagn é des membres de famille

h. Respectant les lois et les règlementations chinoises ainsi que les moeurs et coutumes de la Chine pendant le formation.

9 Frais:

a. Le gouvernement chinois prend en charge les frais de formation, circulation locale , nouriture et hébergement, ainsi que l'argent de poche égal à 30 yuans RMB par jour par stagiaire au cours du stage.

b. Les frais du voyage international aller et retour des stagiairs entre le pays d'origine et le lieu de stage (y compris ceux de transit) sont à la charge du stagiaire.,

c. Les frais d'assurance et de soins médicaux ainsi que tous les frais à l'intérieur du pays d'origine sont à la charge du stagiaire.

10 Demande et approbation

a. Sélectionné par son pays,le stagiaire doit remplir le formulaire de demande de l'inscription qui,à la suite de la signature du département compétant du gouvenement de son pays est remit à l'Ambassade de Chine pour l'examiner.

b. Le bureau du conseiller d'économie et commerce de l'Ambassade de la République Populaire de Chine, après examiné et signé le formulaire de demande et le certificat de santé,par l'interm édiaire du département compétant du gouvernement du pays du demandeur,expédie la notification d'admission au candidat admis. A la presence de la notification d'admission le stagiaire remplit toutes les formalités pour venir en Chine et avec la notification d'admission, la formulaire de demande et le certificate de santé s'inscrit à temps au centre de formation et de recherche de petite centrale hydro-élèctrique de la Région d'Asie et d'Océan Pacifique.

11 Assurance:

Accident corporel, dommage de proprité et les autres risques des stagiaires au cours de la formation ne sont pas de la responsabilité du Centre de formation et de recherche sur les petites centrales hydro-élèctriques de la Région d'Asie et d'Océan Pacifique.

12 Etablissement des inscriptions:

— Bureau du conseiller économique et commercial de l'Ambassade de la République Populaire de Chine, accréditée dans le pays du candidat.

—Centre de formation et de recherche sur les petites centrales hydro-élèctriques de la Région d'Asie et d'Océan Pacifique.

Adresse du centre de formation:

122, Rue Xueyuan, Hangzhou , R.P. de Chine. (杭州学院路 122 号)
Centre de formation et de recherche sur les petites centrales hydro-élèctriques de la Région d'Asie et d'Océan Pacifique
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