Opportunities And Challenges To Launch New Power Programmes

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Abstract. The large majority of the current fleet of nuclear power plants are water-cooled reactors. Their efficient and safe operation is a key factor in assuring that nuclear power will meet both the current and the future energy needs. Refurbishment and life extension, as well as power up-rating of existing plants will be a major activity.

In order to promote the peaceful utilization of nuclear energy, in 1970s, China made a decision to develop nuclear power and further determined the technical direction of water cooled nuclear power plants. After more than 30 years' effort, in December 1991, the self-designed water cooled nuclear power plant-Qinshan Nuclear Power Plant was established and started power generation, which ended the history of no nuclear power plant on China mainland and achieved a new breakthrough. Since then on, the nuclear power plant in our country gradually developed and achieved certain accomplishment. However, if comparing it with the advanced nuclear power technology in the world, the development nuclear power in China still lagged to some extent.

China is now facing an important strategic opportunity for further development and this much needed strategic forum convenes at the right time. Actively developing nuclear power is the most practical measure for China to realize energy diversification, ensure energy security, optimize power structure and enhance environmental protection.

1. ACTUALITY OF WATER COOLED NUCLEAR POWER PLANTS

Up till now, there are totally 11 sets of nuclear power generators under operation, all of which are water cooled nuclear power plant. The Installed Capacity is 9124 Megawatt. In 2008, the nuclear power generation reached 69.22 billion KW/H, occupying 1.3% of the total power generation in China. CNNC holds the controlling shares of 7 units with an installed capacity of 5.1 GWe. In addition, 8 units under CNNC with an installed capacity of 8.12 GWe have been approved by the government.

2. DEVELOPMENT OF WATER COOLED NUCLEAR POWER PLANTS CNNC

CNNC (China National Nuclear Corporation) is a super-large conglomerate with a complete nuclear industrial chain incorporating uranium exploration, mining and milling, nuclear fuel production, research and development of nuclear energy technology, engineering test, engineering design, equipment design and manufacture, engineering construction, project management, operation and maintenance, nuclear facility decommissioning and treatment, etc. Nuclear power is one of the three pillar industries and a major economic growth engine for CNNC's development.

The 300 MWe PWR NPP of Qinshan Phase I was connected to the grid on December 15, 1991, which realized the breakthrough of no nuclear power in the mainland of China. China became the seventh country in the world capable of designing and building nuclear power plants by itself.
Qinshan Phase II NPP was an important stride forward towards independent design and construction of commercial NPPs, which marks that China had mastered Generation II nuclear power technology. The project was awarded the 1st Class *National Awards for Science and Technology Progress* and *the Special Commend of China Industry Awards* in 2004. Its localization rate of equipment manufacture reached 55%. Among the 55 key equipments, 47 were produced domestically.

Based on these experiences, CNNC has been carrying out self-design and scientific research activities of China's 1000 MWe second-generation plus nuclear power plant, which filled the gap of independent design of 1000 MWe-class nuclear power plant in China.

At present, CNNC has two institutes qualified as general nuclear power engineering designer, which are equipped with professional teams specializing in scientific research and engineering design. We have also put into place large-scaled nuclear power research and test bases with complete and highly modernized nuclear engineering research and test facilities.

In addition, the two 1060 MWe Russian AES-91 PWR units in Tianwan Phase I NPP built were completed and put into operation in 2007.

The first unit of Pakistan's Chashma NPP constructed by CNNC in a "turn-key" mode was put into commercial operation in September 2000.

The second unit of the Chashma NPP Project has entered the installation stage in 2008.

3. OPPORTUNITIES FOR WATER COOLED NUCLEAR POWER PLANTS

3.1. During the occurrence of present financial crisis, the government has increased the input in infrastructure facilities and adjusted the structure of energy. It also proposed to develop nuclear power energetically. In accordance with the Plan on Sustainable and Long-term Development of Nuclear Power, by 2020 in our country, the installed capacity of nuclear power under operation will reach 40 million KW and the nuclear power capacity under construction will be up to 18 million KW. At present, the plan is still being revised and the final numbers may even exceed the current ones.

3.2. Presently the operation performance of water cooled nuclear power plant in China is fair good. In 2008, 4 of the 7 power units in our company were listed as advanced level in the world nuclear power industry, which lays a foundation for better development of water cooled nuclear power plan in China.

3.3. The projects under construction are carrying on smoothly. Currently, totally there are 18.92 million KW of water cooled nuclear power plan units are under construction along with many units with permit of implementation and potential plant addresses. The first AP1000 in the world is also in process now.

3.4. The core competitive strength of self-innovation was improved. In our country, the engineers are capable to design 2nd -generation improved water cooled nuclear power plant with million KW nuclear power unit. At the same time, based on the constant improvement of 3rd generation nuclear power technology.

3.5. The degree of self-determination was reinforced, the equipments are gradually manufactured domestically, which helps to decrease the cost efficiently. To build a nuclear power plant, the investment in equipment may take about 45% of the total investment. As the equipments are gradually manufactured domestically, the cost for building a nuclear power plant is deducted greatly. The rate of domestically made equipment among all equipments in the project of Qinshan Ⅱ is 55%, increased to 77% in the expansion project of Qinshan Ⅱ. In other projects like Fuqing, Fangjiashan, the rate of whole domestically made equipments will reach 75%. In Sanmen project, the rate of conventional island and BOP will also reach 50%.

3.6. EPC(Engineering Procurement and Construction) mode was adopted in the sub-contract of nuclear power plant to finish the construction of plant. Such mode was initially used in Fuqing and Fangjiashan Project. CNPE is the only subcontract company of nuclear power plant led by design with the most powerful strength, and the most complete equipments.

4. CHALLENGES FOR WATER COOLED NUCLEAR POWER PLANTS

4.1. Although the 3rd generation nuclear power technology (AP1000) is developed and advanced, there is no whole-process check and inspection from construction to operation in the world. Neither the equipments owners nor the suppliers are capable to provide any valuable experience for reference. Therefore, the model project of the 3rd generation nuclear power technology is inevitably at certain risk.

4.2. Challenge of nuclear safety. Nuclear safety is the lifeline of nuclear power industry. Ensuring safety during rapid development is the prerequisite for rapid nuclear power development.

4.3. Nuclear power entered the construction period of large scale. Therefore, how to optimize the project management, integrate group resources and improve construction efficiency become the main problems of nuclear power plant construction. An industrial system and development mechanism fitting in with specific Chinese situations—shall be established to effectively ensure the rapid development.

4.4. R&D and technical renovation on key technologies— are the core competitiveness for rapid development.

4.5. As the construction of nuclear power entered the period of large scale construction, nuclear power market gradually raises higher and higher demand on the capability of nuclear power equipment and its technology.

4.6. Uranium exploration and exploitation and nuclear fuel supply—secure the resources for rapid development.

4.7. The construction of nuclear power entered the period of large scale construction. With the increase of newly established nuclear power plants, more professional staff is required to be trained. At the same time, the flow of work staff may weaken and reduce the experience and skills of nuclear power plant operation, which brings large negative influence on the operation of nuclear power station. Therefore, the human resource in nuclear power industry needs to be managed reasonably and thoroughly. Cultivation of technical personnel— provides the source of power for rapid development.

4.8. How to deduce the cost is also one of the challenges for the future development of water cooled nuclear power plant. The project of Qinshan, which is self-designed by Chinese, costs 1330 USD/KW, while the other construction of nuclear power plant at the same time costs 2000 USD/KW as the equipments and technology are introduced from foreign countries.

4.9. Challenges raised by constant increase of nuclear power performance. WANO has put forward the Six Major Lessons for the operation of nuclear power in 1990s in combination with the assessment experience.

4.10. Risks of nuclear power under financial crisis. Under the background that the world economy is fluctuated greatly, risks of investment control and cost control caused by changes of exchange rate in the introduction and export of nuclear power project and import & export of equipment also exist.

4.11. The loss of experience on nuclear power and the urgent demand of knowledge management.

4.12. Standardization and normalization of nuclear power—shall be strengthened to adapt to rapid development.

5. THOROUGH PREPARATIONS MADE BY CNNC FOR RAPID DEVELOPMENT

5.1. Supporting development of Generation III technology

CNNC supports the development of Generation III technology, and actively takes part in the transfer and assimilation of AP1000 technology.

5.2. Consciously promoting nuclear safety culture

CNNC has consciously advocated the nuclear safety philosophy of defense-in-depth. We have put into place a complete nuclear power plant quality assurance system. Much attention has been given in order to promote nuclear safety culture. Experience exchanges have been carried out and effective safety control measures have been adopted, so that all scientific research and production activities are safely under control in nuclear power system to ensure the safe and stable operation of nuclear power plants. Several performance indicators of the seven operating power plants under CNNC have kept abreast with world advanced level. Radioactive wastes have been safely managed, and staff and public safety been protected to ensure the sustainable nuclear power development.

5.3. Strengthening human resource development

First priority was given to personnel development in CNNC's development strategy. Focusing on introduction and cultivation of high-level and much needed personnel, we have made great efforts to implement specialized personnel securing programs to introduce, cultivate and utilize nuclear professionals. Introduction and cultivation programs have also been implemented for highly qualified and urgently-needed personnel. An effective personnel development mechanism has been established, and abundant training funds been secured to provide effective services to the development of nuclear science and technology and support major projects undertaken by CNNC.

With the favorable opportunity of rapid development of nuclear-related industries and the construction of key scientific and production projects, personnel development has been well planned. Introduction and cultivation of high-tech and innovative personnel have been strengthened to improve the overall personnel development and the self-reliant and innovative capability.

5.4. Strengthening efforts in natural uranium exploration, fuel element fabrication and reprocessing

Greater efforts have been devoted to uranium exploration and the development of both international and domestic markets. Advanced fuel cycle techniques have been developed to meet the need of closed cycle strategy. New techniques for uranium exploration, mining and milling have been developed to secure the strategic reserve of uranium resources.

As the exclusive nuclear fuel supplier in mainland China, we are actively increasing our production capacity in order to meet up with the demand of rapid nuclear power development. Spent fuel reprocessing has been implemented to achieve closed fuel cycle and increase the resource utilization rate. New and high techniques have been adopted to reduce cost and increase benefit.

5.5. Actively promoting specialized and group-based operation

To adapt to the rapid nuclear power development, CNNC has devoted major efforts to promote EPC mode as the general contract mode for nuclear power projects. China Nuclear Power Engineering Co., Ltd. was established in early 2008, and the first general engineering contract in the true sense was achieved in Fuqing project.

Meanwhile, CNNC is also actively exploring a specialized operation and maintenance mode.

To sum up, China's nuclear industry has entered an important phase of accelerated development. The Chinese government has attached great importance to the development of nuclear industry, and actively advanced nuclear power construction. In support of nuclear power development, key projects

in all sectors of nuclear fuel cycle industry have been in full swing. The water cooled nuclear power plant in the 21st century faces both opportunities and challenges. But we are confident that water cooled nuclear power plan will illuminate the future of China soon.CNNC will seize this favorable opportunity to ensure that its major business will also usher in a new stage of group-based, large-scaled and all-round development.