

# A NUCLEAR MILESTONE IN CHINA





**The Tianwan Nuclear Power Plant is the largest Chinese-Russian joint venture ever. A decade in the making, it will help China reduce greenhouse gas emissions and produce cheaper energy. Safety lies at the very heart of the project.**

TEXT: PAN HAIXIA, GONG FEI PHOTO: TIANWAN NPP, LIANG LIANG

**TO SATISFY EXPLODING** demand for electricity while minimizing pollution, China has embarked on a nuclear-plant construction binge. In September 2008, China had 11 nuclear power reactors in commercial operation, six under construction and several more about to start construction.

Two of the most recent reactors belong to the Tianwan Nuclear Power Plant (NPP), located in the beautiful port city of Lianyungang in Jiangsu Province on China's east coast. Lianyungang, dubbed the "East-West Freight Corridor," was one of the first 14 cities the Chinese government permitted to open to foreign trade in 1984, and it has since developed into a transport hub and a popular tourism destination.

The plant provides power mainly to the country's most developed area, southern Jiangsu, close to Shanghai, which has become a hot spot for foreign investments.

When the two Tianwan reactor units went into commercial operation, in June 2006 and August 2007 respectively, they were the result of the largest-ever technological and economic cooperative project between China and Russia, with investment for the first phase standing at 3.2 billion US dollars.

Russia and China first signed a nuclear cooperation agreement in 1990. In 1997 they signed a milestone contract regarding the Tianwan NPP. As defined by the agreement, the Russian side is responsible for technology, the design of the nuclear island and the turbine island as well as the supply of set equipment. The Chinese side is responsible for construction management, construction and supply, partial designing and most of the installation.

Construction work kicked off in October 1999. The two reactors involved in the first phase are Russian AES-91 pressurized water reactors (PWR). The reactors are an

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The two reactors at the Tianwan Nuclear Power Plant are part of China's extensive investment programme in nuclear power and the result of the largest-ever technological and economic cooperative project between Russia and China.

“Compared with the coal-fired power plants, the Tianwan project can reduce carbon dioxide by 16 million tonnes a year.”

SHI LING, deputy director, JNPC's maintenance branch



Yan Weifeng (left) and Shi Ling of Jiangsu Nuclear Power Corporation, which operates the Tianwan NPP.

improved concept based on the Russian standard reactor type VVER-1000/392 to be in line with internationally proven nuclear and radiation safety standards as well as with China's relevant regulations and standards on nuclear safety.

**SECURITY CONCERNS** have long dogged the nuclear industry, and the devastating accidents at Chernobyl in Ukraine and Three Mile Island in the United States

are still fresh in the minds of many people. However, the Chinese government has emphasized a commitment to safety.

“Safety is the most important issue for nuclear power plants,” says Shi Ling, deputy director of the maintenance branch of the Jiangsu Nuclear Power Corporation (JNPC), which was established in 1997 to operate the Tianwan plant. “There are international organizations working as nuclear watchdog inspectors. The Tianwan NPP has joined as a member, welcoming their inspections.”

At the Tianwan NPP some advanced measures have been taken to better ensure safe operation. Its reactors have two protective layers, including an internal hermetically sealed cover that prevents radiation leakage into the environment and an external cover to protect it from any environmental impact.

Fifty-five bundles of steel rope help support the pre-stressed protective layers, which are designed to withstand earthquakes, floods, tornadoes and storms. The reactors were also designed to be protected from falling objects.

“What makes the Tianwan plant unique globally is a reactor trap that can hold and cool the reactor core in the

event of a meltdown,” Wu Xiujiang, deputy general manager of the JNPC, recently told *China Business Weekly*. “Tianwan is the first in the world to use it.” The trap prevents the reactor core from melting the concrete workshop slab and causing leakage of radioactive material.

The Tianwan plant also relies on equipment from Alfa Laval. “We use a total of 46 Alfa Laval gasketed plate heat exchangers in five different models,” says Yan Weifeng, JNPC maintenance engineer.

Alfa Laval's heat exchangers were specified in the nuclear power plant design in 1998. “We introduced our heat exchanger technology to the Russian Design Institute in St Petersburg in 1994,” says Carl Zhang, nuclear power sales manager at Alfa Laval in China. “Four years later, Alfa Laval supported the institute in writing all the specifications for the plate heat exchangers.”

Says Shi, explaining the choice of Alfa Laval equipment, “As a world-leading plate heat exchanger manufacturer, Alfa Laval boasts advanced production techniques, a full set of service systems and high-quality products. A large number of service technologies have been developed in terms of plate heat exchanger cleaning and maintenance, such as online chemical cleaning and the automatic backwashing filter.”

**THE TIANWAN NPP** has proved both efficient and reliable. With a single-unit capacity of 1,060 megawatts, by far the largest in China, as of August 2008 the plant had generated more than 19 billion kilowatt-hours (kWh) of electricity, of which 18 billion kWh were connected to the national grid.

The two reactors have also set a national record for continuous operation during the nuclear fuel cycle, and emission of the three wastes, nuclear wastewater, gas and residue, was also successfully kept under the national standard, says Yan.

Apart from the hardware, trained talent is another



Carl Zang, sales manager, Alfa Laval China.

#### ► Nuclear power in China

## China invests in nuclear power

**Moves to build** nuclear power in China began in 1970. As of September 2008, China had 11 nuclear power reactors in commercial operation: five in Qinshan in Zhejiang Province, four in Daya Bay in Guangdong Province and two in Tianwan. There are also six under construction and several more about to start construction.

Technology has been drawn from

some of the world's largest nuclear power exporters, France, Canada and Russia, with local development largely influenced by French design.

At the end of 2007, China's installed power-generating capacity rose to a record high of 713 gigawatts (GW): 145 GW belong to hydropower, 554 GW to fossil fuel, nine GW to nuclear power and four GW to wind power. About three quarters of China's electric power is

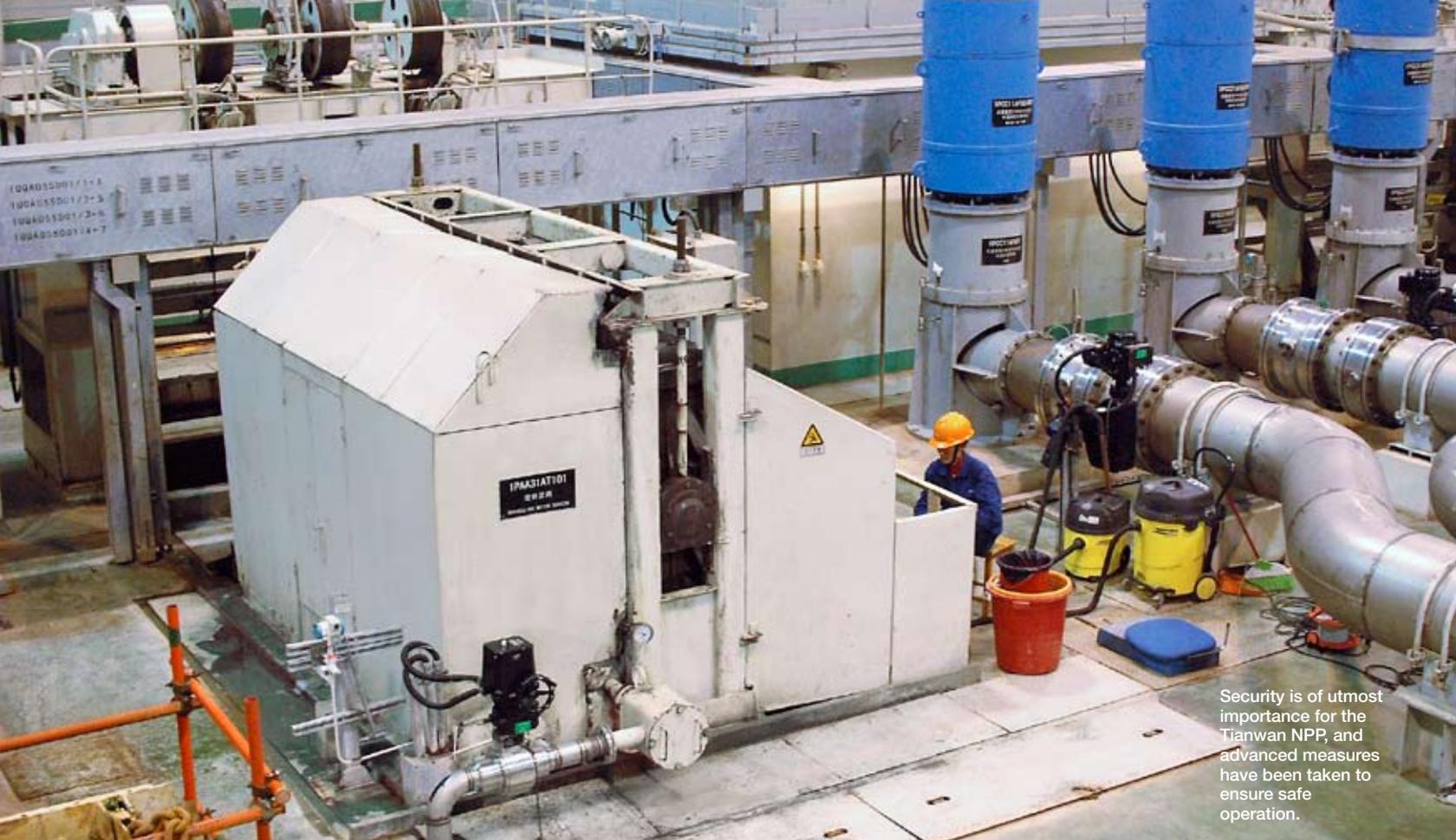
consumed by the industry. This can be compared with the European Union, where industry's share of total energy consumption is around 40 percent.

In 2007, nuclear power in China provided 62.86 billion kWh of electricity – 2.3 percent of the total – and there is now 8.6 electric gigawatts (GWe) installed.

The government plans a sixfold increase in nuclear capacity to at

least 50 GWe or even 60 GWe by 2020 and then a further increase to 120–160 GWe by 2030.

The move is a sign of China's determination to develop more recoverable energy to ease the energy shortage created by its rapidly expanding economy. It is also intended to improve environmental protection by decreasing the country's dependence on coal-fired plants. ■



Security is of utmost importance for the Tianwan NPP, and advanced measures have been taken to ensure safe operation.

►► [www.alfalaval.com/here/power/tianwan](http://www.alfalaval.com/here/power/tianwan)

important aspect in ensuring the safe running of a nuclear power plant. “All 1,100 JNPC employees have a college-level or above education,” Shi says. “All operators are sent to Russia for a 17-month training before they start working. And here at Tianwan, we also have regular training for them.”

**NUCLEAR POWER** is seen by the Chinese government as the answer to reducing greenhouse gas emissions and producing cheaper energy. The country’s need for electricity has soared in past decades with its rapid economic growth. In the summer, for example, air conditioners devour electricity at such alarming rates that the national grids can’t cope. The most common way to satisfy this demand has been for local governments and entrepreneurs to throw up coal-fired power plants, which are inefficient and spew greenhouse gases, soot and toxins into the air.

According to the World Nuclear Association, about 80 percent of China’s electricity is produced from fossil fuels (mainly coal), and China has become the second largest contributor to energy-related carbon dioxide emissions after the United States.

To slow down the development, the Chinese government has decided to invest in cleaner energy and has initiated an extensive nuclear power investment programme that aims to give a sixfold increase in nuclear capacity by 2020.

In Jiangsu Province, the Tianwan project has already changed the overall energy structure, says Jiang Guoyuan, general manager of JNPC. The province is now closing down many small highly polluting coal-fired power plants and has plans to further develop clean energy sources, including nuclear power.

“Despite the higher construction costs, which are usually 30 to 50 percent higher than coal-fired ones, with the same installed capacity, nuclear power plants have a longer life span and lower fuel costs,” says Shi. “Including expenses for protection of the environment, the costs for a nuclear power plant are 15 to 30 percent lower than those for coal-fired plants.”

The two Tianwan reactors use some 50 tonnes of nuclear fuel a year. Coal-fired power plants with the same installed capacity would require 6 million tonnes of coal. “This means an enormous reduction in emissions,” Shi says.

“Our statistics show that, compared with the coal-fired power plants, the Tianwan project can reduce carbon dioxide by 16 million tonnes a year,” he says. This equals almost half of Hong Kong’s total annual carbon dioxide emissions. “It can also reduce waste residue by 400,000 tonnes annually, as well as significantly reduce sulphur dioxide and nitrogen oxide emissions,” Shi adds.

An agreement has already been reached between China and Russia to jointly work on a second phase at the Tianwan NPP. The agreement was part of a joint communiqué signed by China premier Wen Jiabao and his Russian counterpart at the time, Viktor Zubkov, in Moscow in November 2007,

► Facts

### Tianwan Nuclear Power Plant

- Owned by China National Nuclear Corporation (50 percent), China Power Investment Corporation (30 percent) and Jiangsu Guoxin Group (20 percent)
- Operated by the Jiangsu Nuclear Power Corporation
- Located in the Tianwan, Lianyungang City, Jiangsu Province, China
- Employs 1,100 people
- Is the nation’s third-largest nuclear-power generating complex after the Qinshan complex in Zhejiang Province, also on the east coast, and the Daya Bay complex in Guangdong Province in the south
- Has a capacity of two times 1,060 MWe and a design life span of 40 years
- Has produced (as of 16 August 2008) 19.4 billion KWh of electricity, of which 18 billion KWh were connected to the national grid.

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As of 16 August 2008, the Tianwan NPP has contributed 18 billion kWh of electricity to the national grid.

>>> which said that increased cooperation on nuclear energy is a priority in the two countries' relationship.

According to the feasibility report, the second phase will contain two more one gigawatt (GW) nuclear power-generating units. The construction area is prepared for another four, which means the Tianwan NPP can contain altogether eight one GW generating units with a total installed capacity of eight to 10 GW. It will generate 60-70 billion kWh of electricity annually, which equals more than three times the total wind energy installations in the United States, which is the world leader in wind energy generation. The annual output value from the total eight units will

reach well over 25 billion Chinese yuan (USD 3.6 billion).

China is also developing third-generation nuclear power technology through agreements with US-based Westinghouse and the French company Areva to use their latest technologies to build six nuclear reactors.

According to Shi, the biggest problem faced by the Tianwan NPP, and China's nuclear power industry as a whole, is the heavy reliance on foreign technology. "It makes cultivating and training more nuclear professional talents a pressing task for China, which is looking forward to having more self-designing, self-constructing and self-managing nuclear power plants," he says. ■

► The Alfa Laval solution

## A cost-effective choice

– Plate heat exchangers ensure efficient heat transfer

**The Tianwan Nuclear** Power Plant uses 46 Alfa Laval gasketed plate heat exchangers in five different models. "They are used to remove heat from different systems in the plant, such as turbine and reactor equipment cooling," explains maintenance engineer Yan Weifeng of the Jiangsu Nuclear Power Corporation (JNPC).

He says Alfa Laval heat exchangers have a compact design, occupying far less space than traditional shell-and-tube heat exchangers, as well as good performance, easy maintenance and a long operating life. "A reason for choosing Alfa Laval's plate heat

exchangers is their cost-effectiveness," says the deputy director of the maintenance branch of JNPC, Shi Ling. "Their titanium plates eliminate risk of seawater corrosion, and the plate corrugations promote fluid turbulence, resulting in efficient heat transfer."

To achieve the same heat transfer effect, shell-and-tube heat exchangers require a heat exchange area twice or three times as large as plate heat exchangers do. Shi says another advantage is that the plate heat exchangers need less cooling media than shell-and-tube, saving water and reducing the cooling pump's design volume. In addition,

**"The advantages of Alfa Laval products lie not only in their high quality but also in their service-oriented designs."**

plate heat exchangers make maintenance and plate replacement convenient and easy.

"The advantages of Alfa Laval products lie not only in their high quality but also in their service-oriented designs," says Yan.

According to Yan, similar products will be used during phase two of the Tianwan NPP. ■



The Tianwan NPP uses a total of 46 gasketed plate heat exchangers from Alfa Laval.