



Arnaud Lefevre

## That happened in March: China First Heavy Industries

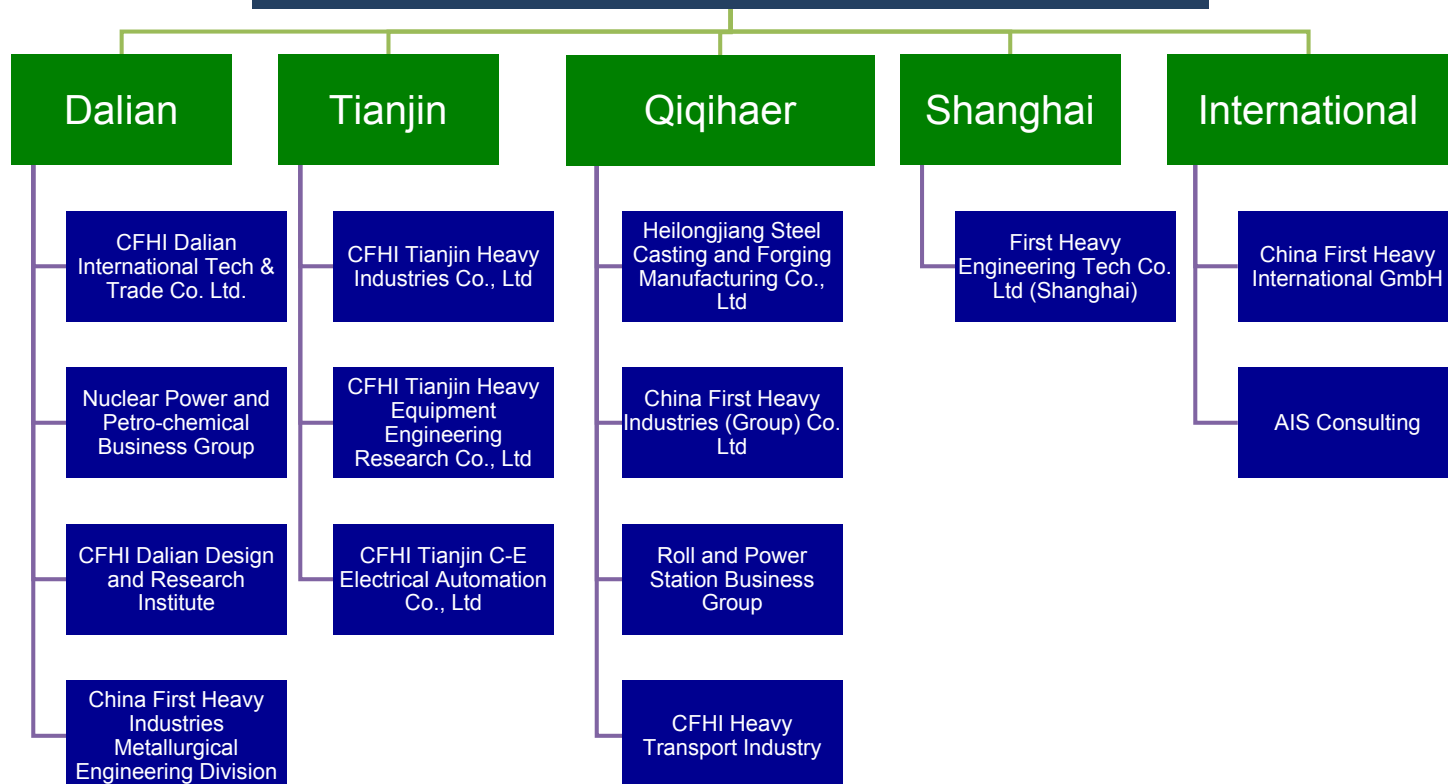
### Have you heard about China First Heavy Industries?

It's a group which was incorporated in 2008 with revenue of 9.6 billion CNY in 2011, a net income of 375 million CNY and 12,000 employees.

The group is the Chinese leader in nuclear forgings and its goals are:

- To own the largest domestic market share
- To compete against foreign manufacturers in the international market.

## Overview of the group



China First Heavy Industries (CFHI) is one of the fifty-three backbone enterprises under the management of the Central Government that are directly related to the national security and economy.

Since 2006, CFHI has been manufacturing pressure vessels, reactor internals, braces, pipes and pipefittings for the nuclear industry.

It controls 90% of the forging market in this industry and has revitalized the industry in the Northeast of the country.

CFHI is one of these SOE Champions that must control the domestic market, improve their technology to break the monopoly of foreign products and finally export and compete against Mitsubishi Heavy Industries, Japan Steel Works, Doosan and Areva.

To understand CFHI, we will look at how the company is **structured**, who are its **investors** and which **projects** the group handles. Major hurdles such as the **profitability** of the company and the need for a new type of **human resources** will be described as well.

## The origin of CFHI development: the “863” program

The “863” program can be considered as the trigger of CFHI’s expansion. The State Council assigned the major SOE’s the task of developing the country’s infrastructure and technology, including nuclear power. CFHI was assigned to develop a technology to manufacture the fast breeder reactor vessel.

In 2002, the State Council and the Central Party Committee assigned to CFHI the responsibility of developing a large hydraulic press and to become the national champion for nuclear forgings.

Four years and 150 million CNY of investment later, CFHI unveils the 15,000 ton hydraulic press which can forge a 600t-class giant ingot.

Its purpose is to manufacture the conical shell of the nuclear power steam generator, top closure head, whole head of the nuclear power pressure vessel and other giant forging parts. This press is considered to be one of the most advanced in the world in terms of structural design, control system, product specifications and performance.

The eleventh five-year plan in 2007 clarified the intentions of the government to break the monopoly of foreign companies. Zhang Guobao, the head of the NEA, declared in 2008 that the nuclear forging is a critical infrastructure for nuclear power equipment manufacturing and the construction of nuclear power plants. As the peak of China’s nuclear power construction would be between 2020-2030, it is essential that China becomes the world’s leader in nuclear Forging.

### Major Milestones

2002

The state council announces that CFHI will develop a large hydraulic press for forging.

2005

August: Contract for the China Experimental Fast Reactor (parts of the reactor vessel and reactor components)

September: Contract for Qinshan NPP Phase II (reactor pressure vessel)

2006

December: Contract for Hongyanhe(reactor pressure vessel)

2007

June: CFHI unveils its 15,000 tons free forging hydraulic press

July: Success of the Reactor Vessel strength and leak test for the CEFR

2008

August 2008: Contract for Fangjiashan and Fuqing units 1&2 (pressure vessel)

2009

August: CFHI developed the 580 tons steel ingot

December: CFHI becomes a qualified supplier by SNPTC for the AP1000

2010

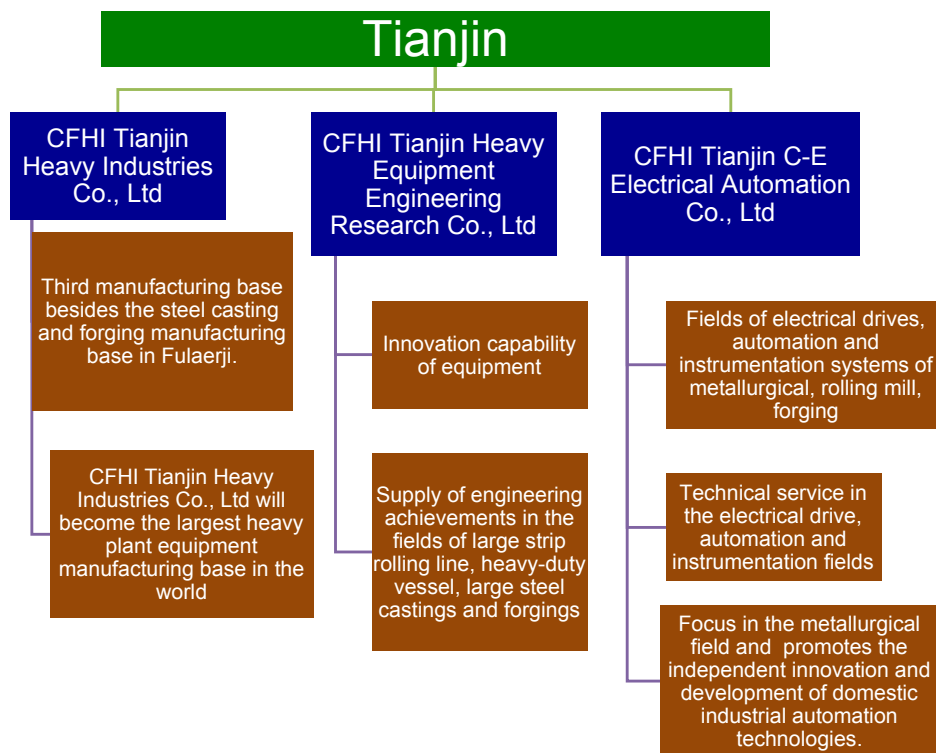
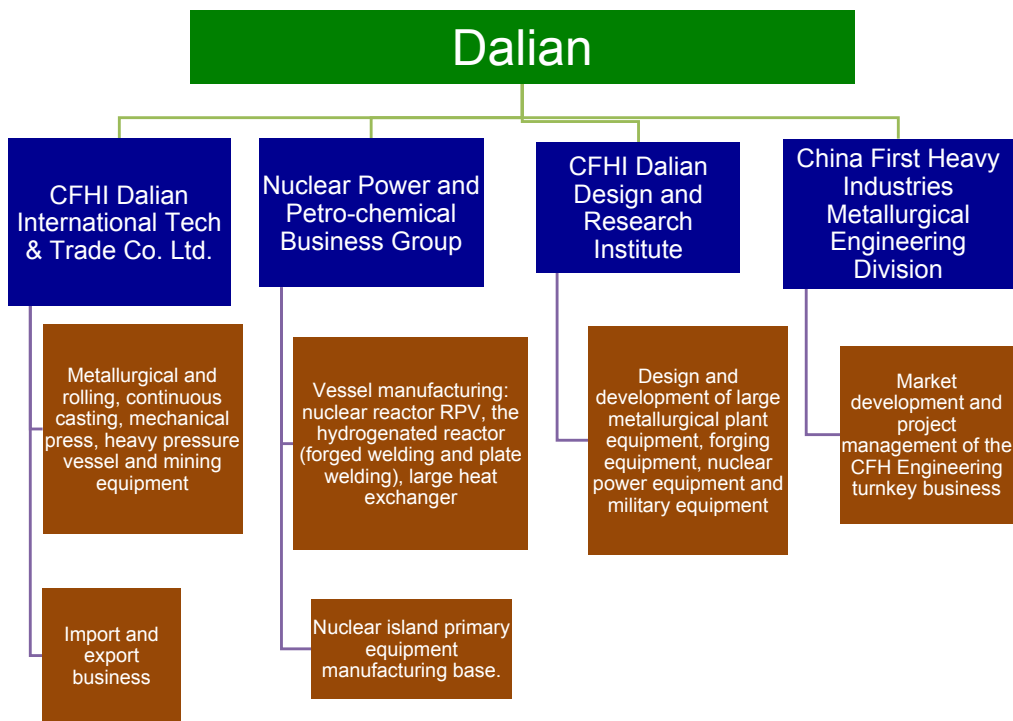
January: Success of the hydrostatic test for Qinshan NPP Phase II reactor pressure vessel

February: Completion of Phase II expansion project of Qinshan Nuclear Power Plant Unit 4 reactor pressure vessel

April: Beginning of the AP1000 pressure vessel manufacturing

June: Agreement with Shenyang Blower Works, Haerbin Electric and SNPEC for the AP1000 main pump shell.

December: Shipment of the reactor pressure vessel for Hongyanhe 1



2011

March: Shipment of the first AP1000 head regulator

May: SNPTC signs the agreement of sub-licensing for the AP1000 Technology with CFHI

May: CFHI signs a supply agreement for thirty reactors pressure vessels

August: Shipment of the generator shaft forgings for Ningde Unit 3

September: Success of the hydrostatic test for Fangjiashan1 pressure vessel

September: CFHI completes its new equipment-testing center in Dalian

December: Success of the hydrostatic test for Yangjiang II reactor pressure vessel

2012

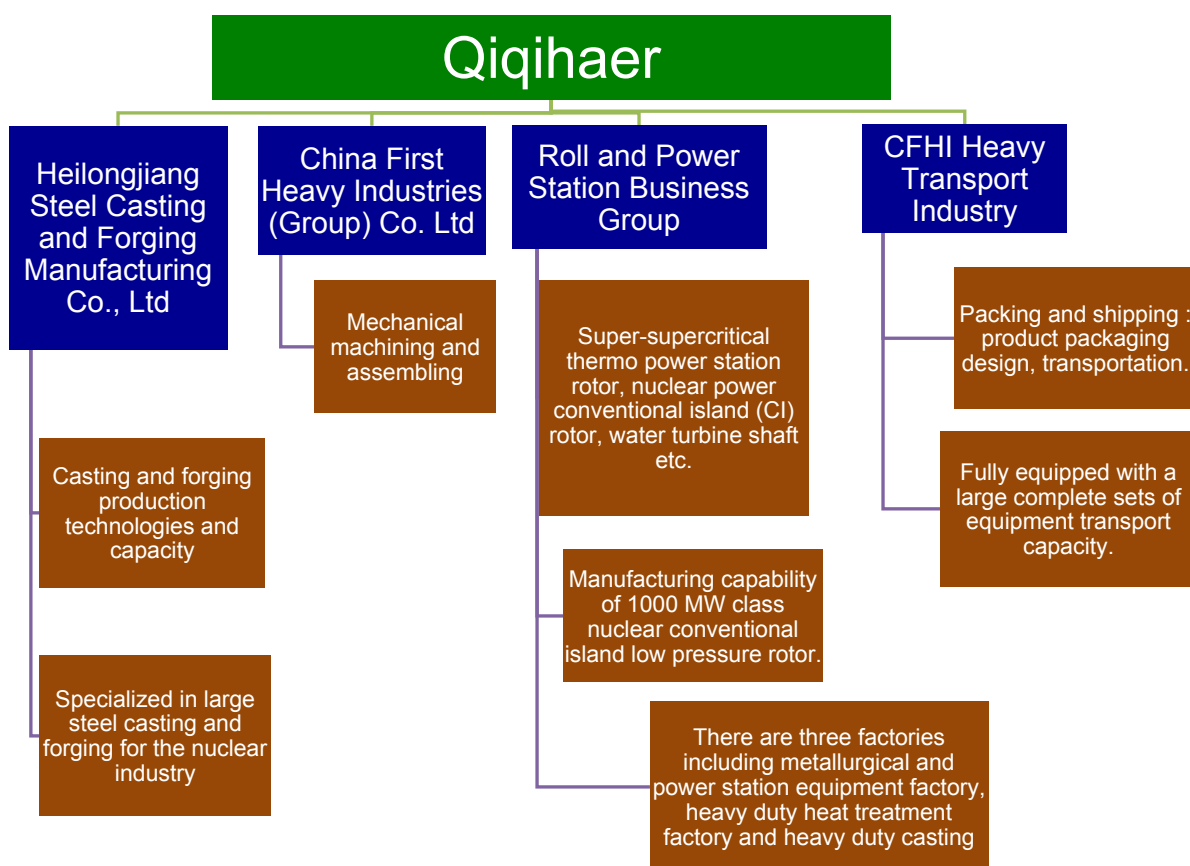
June: CFHI developed the world's largest 715 tons steel ingot.

June, Assessment of the forgings for the CAP1400 low pressure rotor

June: Shipment of the reactor pressure vessel for Fuqing Unit 1

July: CFHI gets the HAF 601 manufacturing certification for the steam generator

August: CNPEC and CFHI sign R&D agreement on the ACPR1000+



## First Heavy Engineering Tech Co. Ltd (Shanghai)





## Revitalizing the industry in the Northeast

CFHI spreads its activities among four major cities:

- Qiqihaer (Heilongjiang) focuses on casting, forging, machining, assembling and the transportation of heavy equipment.
- Dalian (Liaoning) specializes in manufacturing the pressure vessels, the R&D of nuclear equipment and project management.
- Tianjin is dedicated to the manufacturing of heavy nuclear equipment, an R&D center of 150 experts, automation and instrumentation in the metallurgical field.
- Shanghai concentrates on the design and manufacture of mechanical products and innovation.
- The offices in Germany and the agent in Moscow support the international expansion of CFHI.

## Two major poles of R&D and support from the Government

The National Development and Reform Commission, the Ministry of Science and Technology, the Bureau of Energy, the National Nuclear Safety Administration and other ministries combined their resources with CFHI and gradually allocated strong funds in technical research: from 200 million CNY in 2006 to 400 million in 2011.

The company's strategy to improve its technology is based on:

- Internal R&D,
- International cooperation and acquisition,
- Investment in standards and certifications.

By 2009, CFHI moved its R&D to Dalian and Tianjin in order to benefit from the numerous universities and colleges. CFHI also hires experts with international experience focused in large-scale iron and steel casting and forging products (turbine rotor, metallurgy

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roller, pressure vessels) as well as stainless steel and nickel-based super alloy and other special materials and products. Today, the R&D Centers have 900 experts and 2,400 technical personnel.

A few years later, in September 2011, the group opened its world-class set of domestic first-class welder training, detection, and experiments on heavy equipment and large castings. This testing center was equipped with advanced testing equipment to become the national testing center in nuclear power for Generation 2+ and 3, including the CAP1400.

On the international side, CFHI cooperates mainly with SMS Demag (Germany), Mitsubishi Heavy Industries and Hitachi Shipbuilding (Japan), General Electric and P & H mining equipment (USA), Framatome and Le Creusot (France) and Doosan Heavy Industries (South Korea). In particular, Doosan brought extensive know-how for the forging of the pressure vessel in the first AP1000 plants.

This transfer of know-how helped the company to acquire several HAF 601 nuclear manufacturing certifications between 2006 and 2011:

2006: Pressure Vessel/Reactor Internals/Brace

2010: Casting and Forging

2011: Pipe and Pipefittings

In 2012, the NNSA expanded the HAF 601 range for the steam generator.

## **The Management of CFHI**

Wu Shengfu is the chairman of the board and General Manager of CFHI. He joined the Communist Party in 1985, and in April 2007, was elected at the 17th National Congress of the Communist Party of China.

The top management spent the essential parts of their careers in the company and many of the actual members of the board have been in place since 2008. Still some members, such as Chen Tianlin, Liu Zhangming and Wang Ling have had different experiences (China Shipbuilding Industry/DongFeng Motor/and Wuhan Iron and Steel respectively).

This board illustrates a steadily management, which is not common in SOEs where the decision makers change every three to four years. The company decided to go public in 2010.

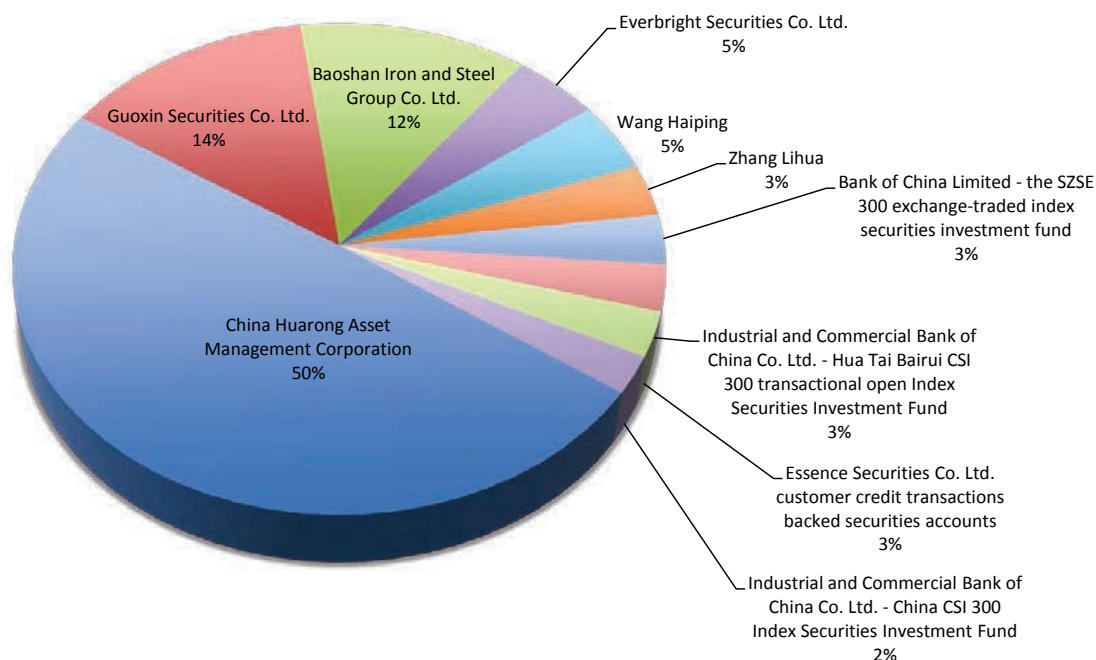
## **CFHI initial public offering**

CFHI needed 8.39 billion CNY to expand production capacity. The group issued 2 billion A-shares and intended to raise about 11.4 billion CNY with the offering. In February 2010, it opened at 5.48 CNY (0.8 U.S. dollar) per share for its debut on the Shanghai Stock Exchange, while originally it had set its IPO price at 5.7 CNY per share.

In 2013, the group has 240,857 shareholders.

The top ten shareholders have 385.6 millions shares, around 20% of the company.

One of the Shareholders, China Huarong Asset Management (CHAMC), owns almost 10% of the total number of shares. CHAMC is one of China's four asset management companies set up to deal with toxic assets of state-owned banks, it belongs to the Ministry of Finance with a minor investment from China Life Insurance Group and remains under the supervision of the State Council.



## CFHI's major projects in the nuclear power market

CFHI must become a leader in the forging industry. In that regard, almost every project in China that requires heavy forgings is allocated to the group.

In the beginning, two important projects were signed in 2005: In August for the China Experimental Fast Reactor (CEFR), and in September for the extension of Qinshan Phase II.

### The CEFR

Monitored by the Ministry of Science and Technology, CFHI was appointed to produce the bottom of the reactor vessel, the core radial shield support frame and reactor components. This project belongs to the "863" program.

China Institute of Atomic Energy was in charge of the design of the nuclear island and run the project for six years. CFHI carried out more than 200 experimental studies and scientific research.

The on-site installation and leak test passed two years later.

## CFHI projects in Qinshan, M310 and CPR1000

### Qinshan Phase II (CNNC)

In September 2005 CFHI signed the agreement for manufacturing the reactor pressure vessel and forgings for the primary pump and other critical forgings for Qinsnan II.

The hydrostatic test for the RPV was successful in December 2009.

### Hongyanhe (CGNPC)

In December 2007 Liaoning Hongyanhe Nuclear Power Co., Ltd., CFHI and CGNPC signed the supply of the RPV and other forgings. Harbin Electric Corporation, Shenyang Blower Works Group Co., Ltd., and others signed the cooperation agreement and supply contract with CFHI, and the RCC standard was mandatory. The acceptance from LHNP was successful in December 2010.

### **Fuqing (CNNC) Yangjiang (CGNPC)**

Before the Fukushima accident, Fuqing nuclear power plant was expected to become the showcase of Chinese management for Generation 2+ nuclear power plant - that would have included project management, and the construction of an assimilated foreign technology. With this project and three others to come, CFHI grew extensively in the domestic forging market (90%) and pressure vessel market (80%). The pressure vessels passed the hydrostatic tests for unit 1 (June 2011) and unit 2 (December 2011).

In 2011, CFHI supplied for 5 units: The pressure vessels hydrostatic tests were also successful in December for Yangjiang units 1 and 2, and Fangjiashan unit 1.

### **Fangjiashan (CNNC)**

In August 2008, CFHI signed a contract of supply for the two units in Fuqing and also two in Fangjiashan. The project faced several hurdles: after several changes in the organizational structure, turnover of its personnel, and manufacturing difficulties in Dalian in particular for procurement of welding consumables and nickel-based material. The group readjusted its organization, followed the RCC standard and was able to deliver the RPV in September 2011, which passed the hydrostatic tests.

### **Ningde (CGNPC)**

This project was strongly supported by China Guangdong Nuclear Power Group and Dongfang Electric. The localization rate for Ningde was targeted at 80%.

CFHI produced the entire forging for the low-pressure rotor.

CFHI benefited from the experience of CGNPC in technology research and development, quality control, nuclear safety culture construction, and developed a strong relationship with the group's supply chain.

### **CFHI projects in AP1000**

On December 24, 2009, the State Nuclear Power Technology Corporation (SNPTC) qualified CFHI in the first batch of suppliers for the AP1000.

A few months later, in May 2010, CFHI signed a contract of 565 million CNY with

Shandong Nuclear Power Company and Jiangxi Nuclear Power Company, both controlled by China Power Investment Corporation.

CFHI was to supply two reactor pressure vessels for the future Haiyang units 3 and 4, and Pengze 1 and 2. The first reactor vessel head was shipped in March 2011. In April 2011, SNPTC and CFHI signed a contract for the supply of the reactor vessel of future AP1000s.

CFHI is also the main supplier of forgings for the primary pump. In June 2010, the first contract of supply was signed with State Nuclear Power Engineering Company, Shenyang Blower Group and Harbin Electric Power Equipment.

### **Future opportunities and hurdles for CFHI**

CFHI benefits from the strong support of the State Council. Therefore it can dig into knowledge from the major EPCs, equipment manufacturers and research centers. Considered as the national champion for forgings, CFHI must upgrade its equipment, respect more stringent environment regulations, hire and retain expensive human resources and reorganize its management structure to become a global actor.

### **Enhance research and technology in third generation NPPs with engineering entities**

As indicated above, the cooperation between CFHI and CGNPC has been strengthened since the Hongyanhe project.

In 2011, China Nuclear Power Technology Research Institute and CFHI signed a research and testing agreement for the reactor, reactor components and the steam generator simulation platform. CFHI would run environmental impact evaluation, severe accidents, nuclear fuel cycle study, and severe accident emergency management. This agreement was followed in August 2012, with



a new project related to the large forgings for the ACPR1000 with China Guangdong Nuclear Power Engineering Co., Ltd.

The AP1000 reactor pressure vessel manufacturing technology is treated as an important issue in major national science and technology projects. In 2008, CFHI with the Shanghai Nuclear Engineering Research and Design Institute, and Dongfang Electric established an innovative team to absorb the AP1000 drawings and supply for the AP1000. The latest project in June 2012, reviewed by the National Energy Administration, is the involvement of CFHI in the CAP1400. Technical challenges are machining, nondestructive testing, heat treatment, anti-distortion technology, nickel-based defect analysis, welding deformation analysis and structural stress analysis. CFHI signed for the pressure vessel of Rongcheng project Units 1 and 2 by the end of 2011.

In order to overcome these challenges, several institutes and universities were involved in the research and CFHI had to upgrade its equipment to produce a 715 ton steel ingot - the largest in the world.

## Major Challenges: profitability and human resources

As already stated, CFHI is a tool dedicated to the "863" program. Its main goals are to occupy the domestic market, gradually stop the import of foreign forgings, raise its standard to the quality of Japan Steel Works, and export to foreign markets.

Until now, the company has competed on price, and has invested 4~5% of its revenue in research of development - indeed, the foreign pressure vessel sold to China was 300,000 CNY per ton, but CFHI reduced the price to 100,000 CNY per ton.

However the company still has heavy debts (around 8 billion CNY), the support from Huarong is still limited to 10% of shares in the company, the cash dividend per share in June 2012 dropped to 0.00567 CNY and the company needs to hire more diversified specialists and its operation cost will increase.

## Large diversification in recruitment

We will not provide a full study in this article of the human resources in CFHI, but a description of the skills needed. During the last six years, CFHI has extensively opened its recruitment to several universities and technical schools from the northeast and east of China.

The main target of CFHI is to split its manufacturing resources between senior technicians (1%), technicians (5%), senior workers (35-40%) and mid-level workers (40-50%).

The jobs are better paid than the national average, the simple apprentice without any experience would earn 2000-3000 CNY per month and most of the recruits at execution level would start at 4000-6000 CNY.

We reviewed all the recruitments since 2007 and split the organization into four major fields.

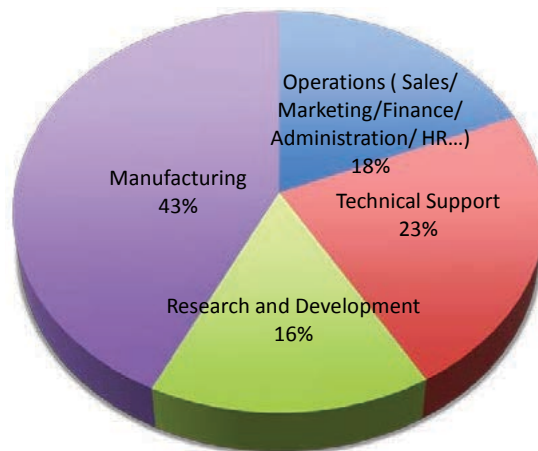
**Note:** This distribution of skills in these four fields was executed by Dynatom and does not reflect the exact structure of the human resources in CFHI. Our intent is to show which skills are researched the most and we decided to categorize the recruitment in four major fields:

The full list of other National and International certifications and quality systems are available on the website:

<http://www.cfhi.com/en/contents/1054/3598.aspx>

<http://www.cfhi.com/yzjt/contents/617/5190.aspx>

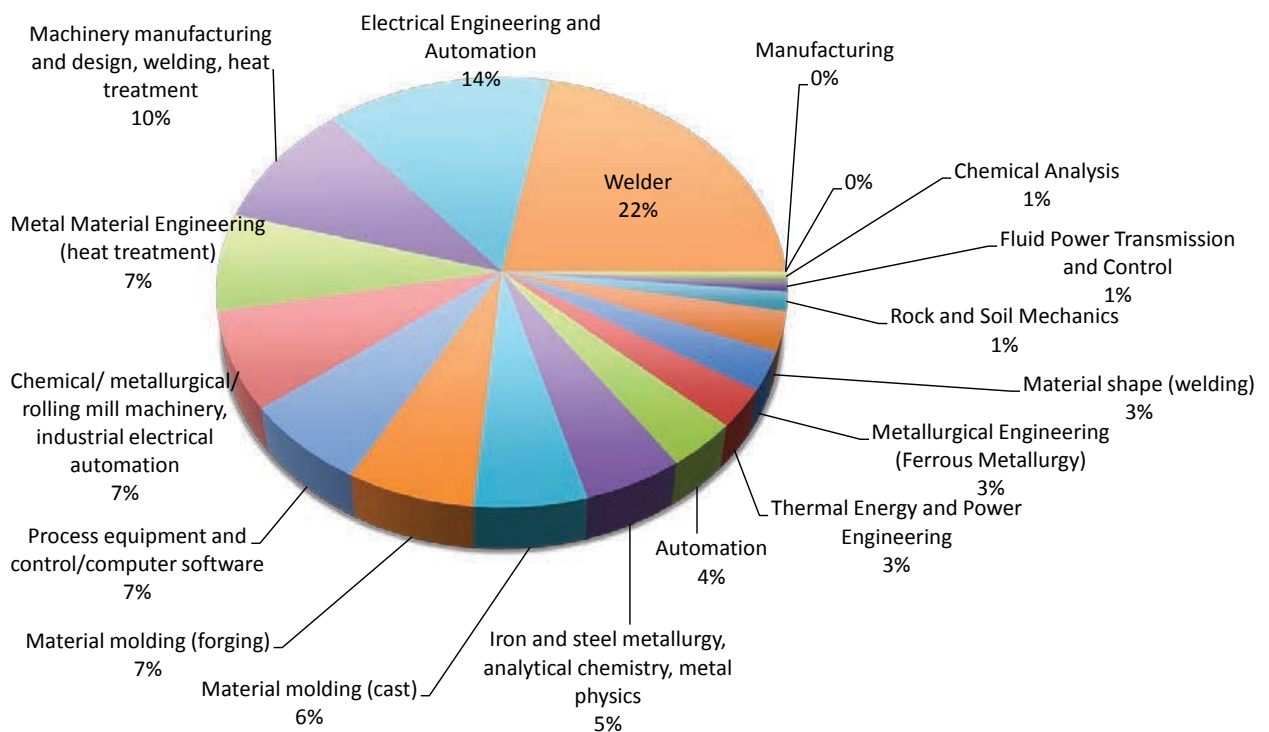
The AP1000 is the key technology retained by the government for the development of third generation nuclear power plants. All the major groups, including China First Heavy Industries, China Erzhong, Dongfang Electric Group, HEC Group, Shanghai Electric, Shenyang Blower Group and another ten equipment manufacturing groups signed the AP1000 third generation nuclear power technology transfer sub-license agreement with SNPTC in 2011.



**Manufacturing:** which relates to engineering and fabrication mostly, and includes the following skills:

chemical analysis, fluid power transmission and control, rock and soil Mechanics, material shape (welding), metallurgical engineering (ferrous metallurgy), thermal energy and power engineering, iron and steel metallurgy, analytical chemistry, metal physics, material molding (cast and forging), process equipment and control/computer software, chemical/metallurgical/rolling mill machinery, industrial electrical automation, metal material Engineering (heat treatment), machinery manufacturing and design, welding, heat treatment, electrical engineering and automation welder.

The best-paid jobs are for electrical and mechanical graduates from technical colleges who can expect a first salary of 6000-8000 CNY per month. This skill is the most researched at CFHI.

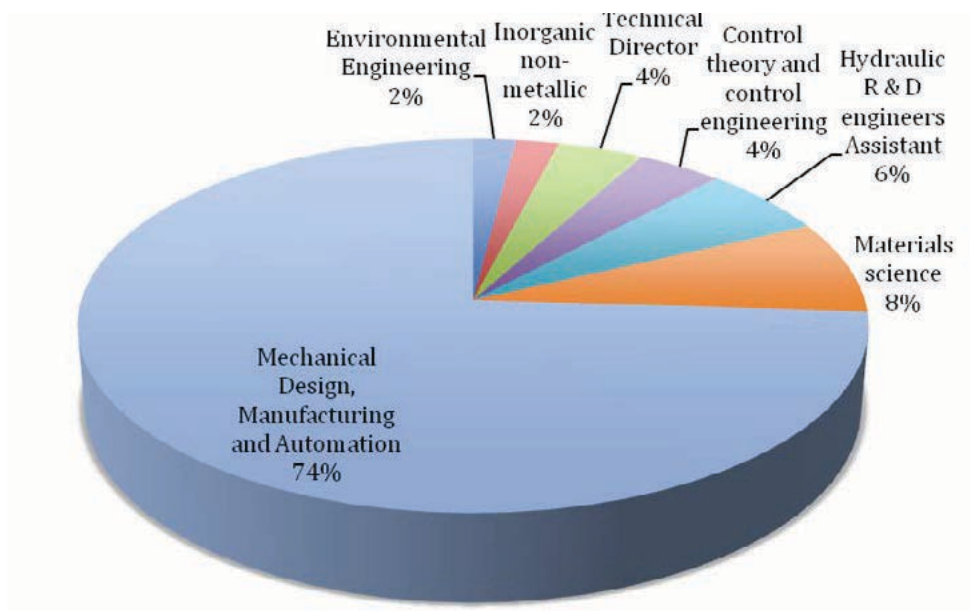


**Research and Development** is related to design capabilities, science and environmental engineering. The skills researched as are as follows:

environmental engineering, inorganic non-metallic, technical director, control theory and control engineering, hydraulic r & d engineers assistant, materials science, mechanical Design, manufacturing and automation.

The manufacturing and automation expertise is the core of the recruitment with salaries of 6000-8000 CNY per month for the first year.

In 2013, CFHI was looking for two major skills: technical director and researchers in Hydraulics.



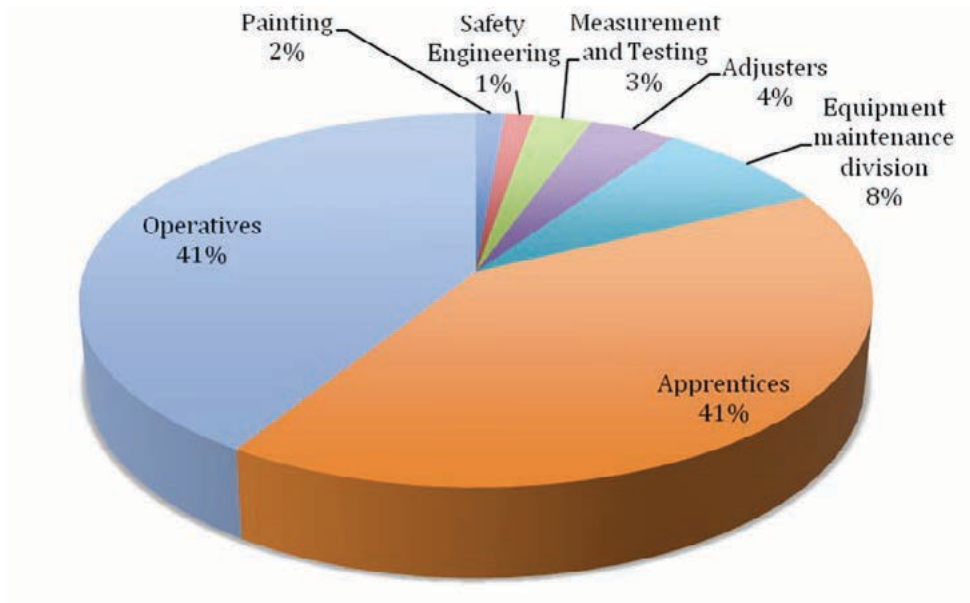
### Technical Support

This is the “poor” side of the group with operatives, merchandisers and other support that can expect a monthly salary of 2,000-3000 CNY. Since last year, CFHI has been recruiting more apprentices that will be trained internally.

The skills expected are as follow:

painting, measurement and testing, adjusters equipment, maintenance, apprentices, operatives and safety engineering.

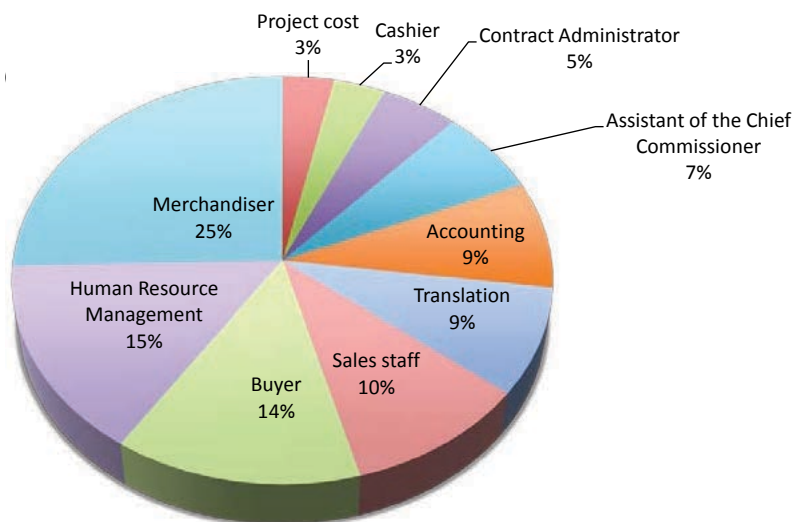
During the last two years, CFHI has been recruiting tens of apprentices with no experience and low academic knowledge.



**The Operation** includes project management, finance, procurement and contract. The recruitment has been extensive during the last three years in the field of project cost, cashier, contract administrator, assistant of the chief commissioner, accounting, translation, sales staff, buyer, human resource management, merchandiser.

This field is positioned at the management level. It deals with the buyers and suppliers. The monthly salary starts at 6,000-8,000 CNY for the first year and requires three to five years of academic study.

The most recent skills required are for accounting, procurement, English translation and human resources management.



## CFHI in the global market

In the nuclear field, only one project has been signed for the Chasma II project, in August 2008. CFHI provided the RPV.

However despite this unique reference, we can assume CFHI will become the leading forging company in the world:

Between 1995 and 2012, the company upgraded its know-how in the manufacturing of steel ingots, from 280 to 780 tons, and dealt with all types of reactors, such as CEFR, second generation and now third generation nuclear power plants.

The strong purchase orders from the government and heavy subsidies lowered the cost of the RPV from 300,000 CNY to 100,000 CNY per ton making CFHI the cheapest manufacturer of large forgings.

The company will benefit from the largest nuclear market in the world for the next 30 years and is raising its standards: its main target is to match the standards of Mitsubishi Heavy Industry and Japan Steel Works, and to provide parts that follow either ASME or RCC-M standards.

Finally, in March 2012 CFHI was designated as one of the first global suppliers for AP and CAP projects by SNPTC and Westinghouse.

## CFHI HAF 601 Certifications

Corporation	Equipment	Safety Level	Range	Registration Date	ASME
CFHI( China First Heavy Industries)	Pressure vessel	Class 1 & 3	Manufacture	2006/3/17	Yes
	Reactor internals				No
	Brace				
	Casting and Forging	2010/8/4		yes	
	Pipes and pipe fittings	2011/8/1			

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