Xinxing Ductile Iron Pipes Co. Ltd., China

Country : China
ISO member body : Standardization Administration of the People's Republic of China (SAC)
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Duration of the study : July 2011 – February 2012

8.1 Organization of the pilot project

Xinxing Ductile Iron Pipes Co., Ltd (hereafter Xinxing) was selected as the company for the SAC/ISO project to assess the economic benefits of standards. The objective of the project was to determine in a quantitative manner the benefits that a company can obtain from the use of consensus-based standards developed by standards organizations (irrespective of whether these standards are international, national or other types of standards). Such standards are also referred to as "external" standards to distinguish them from "internal" standards developed by companies themselves.

This pilot project began in July 2011, and was completed in February 2012. The parties involved were the Standardization Administration of China (SAC), the China National Institute of Standardization (CNIS), the China Metallurgical Information and Standardization Institute, Xinxing Ductile Iron Pipes Co., and the ISO Central Secretariat.

8.2 Introduction to the company

Xinxing is located in the North of Shangluoyang Village, Wuan City, Hebei Province, China. Since 1997 the company has been listed on the Shenzhen Stock Exchange and is exclusively sponsored by Xinxing Ductile Iron Pipes Group Co., Ltd (now renamed as Xinxing Cathay International Group, under the state-owned Assets Supervision and Administration Commission of China). It owns multiple production bases in the cities of Handan (Hebei Province), Wuhu (Anhui Province), Bayingol (Mongol Autonomous Prefecture, Xinjiang Province), Huangshi (Hubei Province), Taojiang (Hunan Province), and Chongzhou (Sichuan Province).

Xinxing is a large enterprise with 17 sales branches across China and 13 overseas sales agencies. It operates in several industries and integrates scientific developments, industrial manufacturing and trade.

8.2.1 Main Products

Xinxing's main products include centrifugal ductile iron pipes, hot-rolled ribbed bars, hot-rolled plain round bars, steel grading plates, bimetal (multi-metal) seamless steel pipes and steel-plastic composite pipes.

Cast pipe products are mainly used for water supply and drainage in urban and town infrastructural construction and in gas transmission.

These products are divided into composite pipes for hot and cold water and drinking water, for heating, fuels, and for special fluids (including industrial waste water, corrosive fluid, coal mine water supply, water drainage, and compressed air), water drainage and protection casing, They are extensively used in construction water supply projects, and in the communication, electric power, petroleum, chemical, pharmaceutical, food, mining and fuel gas sectors.

8.2.2 Market share of Xinxing's main products

The market share of Xinxing's main products in China is given in **Table 1.**

Product Name	Market Share (%)
Centrifugal Ductile Iron Pipe	42.5
Steel Grating Plate	40
Hot-Rolled Ribbed Bar and Hot-Rolled Plain Round Bar	3

Table 1 – Market share of Xinxing's main products

8.2.3 Income and Profit

Revenues and profits of Xinxing Ductile Iron Pipes are given in **Table 2.**

Year	Business Income (in CNY)	Business Profit (in CNY)	Total Profit Amount, incl. from other sources (in CNY)
2006	10 801 232 300	768 702 000	803 898 200
2007	14 258 104 000	920 652 300	969 427 500
2008	20 550 796 800	677 383 200	811 489 800
2009	25 188 193 400	1 294 268 900	1 350 308 500
2010	37 620 744 900	1 605 198 100	1 763 037 100

Table 2 – Income and profits – Total company (2006 – 2010)

The scope of the assessment covers two Xingxing factories in the Wuan Industrial Zone, which produce cast pipes and steel products. Income and profit for these two factories is given in **Table 3.**

Year	Business Income (in CNY)	Business Profit (in CNY)	Total Profit Amount, incl. from other sources (in CNY)
2006	6 473 633 100	541 885 800	793 054 100
2007	7 943 209 200	548 666 100	521 484 100
2008	9 771 289 000	107 030 500	359 194 800
2009	8 543 640 600	898 754 700	1 386 475 100
2010	10 063 438 000	488 292 200	569 239 000

Table 3 – Income and profits for the operations within the scope of the assessment (2006 – 2010)

8.2.4 Employees

The company currently employees 17 499 people, with 5 276 involved in the business functions falling within the scope of the assessment. The number of employees per function is given in **Table 4.**

Functions	Xinxing (total)	Xinxing (business functions in scope of assessment)
Production staff	15 361	4 378
Sales	432	234
Engineers	531	285
Finance and accounting staff	141	
Management	1 034	379
Total	**17 499**	**5 276**

Table 4 – Functions of employees

8.2.5 Organization of the company and its branches

Xinxing's organizational structure is composed of three main levels – general managers and deputy general managers constitute the management level, the management departments and subsidiaries represent the second level, while the production units such as the coking, pelletizing, power control, steel rolling, pipe casting, and other departments are at the third level.

Xinxing has a number of subsidiaries and branch companies in different parts of China including ten companies located in North- and Southwest China as well as in China's Special Administrative Region, Hong Kong, as shown in **Table 5.**

No.	Name of branch company	Location
1	Wuhu Xinxing Ductile Iron Pipes Co. Ltd	Wuhu City, Anhui Province
2	Hebei Xinxing Ductile Iron Pipes Co. Ltd	Wuan City, Hebei Province

No.	Name of branch company	Location
3	Xinxing Ductile Iron Pipes International Development Co., Ltd (a joint-venture company between Xinxing Ductile Iron Pipes Enterprise and China Hong Kong East China Stock Investment Co. Ltd, in conjunction with Huangshi Xinxing Pipe Industry Co. Ltd)	Huangshi City, Hubei Province
4	Taojiang Xinxing Pipe Fittings Co. Ltd	Yiyang City, Hunan Province
5	Sichuan Chuanjian Pipeline Co. Ltd	Chengdu City, Sichuan Province
6	Handan Xinxing Power Generation Co. Ltd	Wuan City, Hebei Province
7	Xinjiang Jinte Iron and Steel Co. Ltd	Bayingol Mongol Autonomous Prefecture, Xinjiang
8	Xinxing Ductile Iron Pipes (Xinjiang) Resources Development Co. Ltd	Urumchi Prefecture, Xinjiang
9	Xinxing Ductile Iron Pipes Xinjiang Co. Ltd	Bayingol Mongol Autonomous Prefecture, Xinjiang
10	Xinxing Huaxin (Hong Kong) Co. Ltd	Hong Kong

Table 5 – Xinxing's regional branch companies

8.2.6 Main raw material inputs

There are 85 different types of raw material used in the company's production processes, the most important of which are silicon iron, incubator, moulding powder, silicon aluminium barium, passivated magnesium powder, silico-manganese, steelmaking iron, zinc ingot, electrolytic manganese, ferrovanadium, ferromolybdenum, zinc wire, industrial pure iron, chromium metal, molybdenum bar, vanadium-nitrogen alloy, ferro-aluminum-manganese, ferromanganese, electrolytic nickel, ferrochromium, plain silicate cement, high sulfate resistant cement, and core making sand.

8.2.7 Main customers

Xinxing's key products are divided into three main types – cast pipes, steel and steel grating plate products. Its sales network covers all of China. The domestic market share of cast pipe products is currently 42.5 %, and these products are sold in more than 90 countries and regions around the world.

8.2.7.1 Main customers for ductile iron pipe products

Customers are segmented into the following five types:

1. Customers characterized by high consumption and strong loyalty to the enterprise. These are the core customers and consist mainly of major municipal water supply and construction engineering companies operating directly for central government, provincial capitals and developed prefectural level cities in China and also overseas agencies with a relatively long history of cooperation.
2. Customers loyal to the enterprise characterized by low consumption. These are mainly dealers and re-sellers in various regions in China.
3. Customers characterized by high consumption but relatively low loyalty to the enterprise. This type of customer often switches between suppliers and tends to use competitive products.
4. Customers characterized by low consumption and a relatively low degree of loyalty to the enterprise, such as electric power, petrochemical, iron and steel, railway, and other industrial and mining enterprises.
5. Finally, there are potential customers, users of pipelines for transmitting solid or slurry in sewage treatment, and for dust removal from power plants and coal mines.

International sales are undertaken by Xinxing's international trade department, which maintains offices overseas and a sales network

to support core, priority, routine and new markets, and operate on a near-middle-far three-level market basis.

8.2.7.2 Main customers for steel products

The customer groups for steel products are major companies engaged in real estate and infrastructural construction projects. Sales are channeled through Xinxing Trade Company's steel products department that directly interacts with dealers and re-sellers.

8.2.7.3 Main customers for steel grating plate products

Steel grating plate products are used mainly for municipal engineering, industrial platforms, factory and mining enterprises. Customer groups are centralized in the petroleum, chemical, port and highway construction, railway, municipal engineering, pharmaceutical, iron and steel, real estate, and mining sectors.

8.2.8 Main competitors

At present, Xinxing's main competitors are leading ductile iron pipe companies including Saint-Gobain PAM (France), Kubota Corporation (Japan), the United States Pipe and Foundry Company, the Griffin Pipe Products Company and McWane, Electro-steel Steels Limited (ESL) USA, and Jindal SAW Ltd., India. Each company has its own strengths in specialized equipment and manufacturing technology. Xinxing's core technology is at an advanced international level comparable with these competitors.

8.3 Company attitude towards standardization

All departmental levels at Xinxing attach great importance to standardization work.

8.3.1 Company standards at Xinxing

In addition to using external standards widely, Xinxing has formulated many internal operating rules and standards, including internal management and work procedures. These have been developed by managers according to their own responsibilities to guarantee continuity of the work. Internal working procedures are typically developed by the production departments, including applicable scopes, responsibilities, safety and assessment. To date, some 19 subordinate departments of the company have developed a total of 1630 internal working procedures, and there is no job position without its own operating rules.

8.3.2 Training in standards and standards-related matters

Training is given before implementation of all standards and internal operating rules, to ensure that personnel fully understand and master the requirements, and apply them correctly in their work. Training is self-organized by the respective production departments, or arranged in a unified manner by the training department. Trainees undergo exams after training is completed and further study is arranged for those who have not passed the test.

Apart from internal training, key staff members with different specializations are frequently selected and sent to attend external study and training courses, which has brought new vitality to the company. Every year, the training department holds technical competitions to assess skills in different work situations, and awards certificates and prizes to the winners. These measures encourage employees to learn about, and use standards, and to make big efforts to improve their technical skills.

Implementation of standards is closely monitored by quality administrators and process supervisors in each production department, and employees are expected to self-examine their performance. Management personnel is required to not only ensure that these routine examinations take place, but also to take part in joint audits co-organized by respective departments. The objective is to raise employee awareness of standards, and encourage initiatives in using them. This has accelerated the healthy development of the company's business operations. It should be noted that, in addition to standards, Xinxing has to meet a significant number of regulations issued by different governmental agencies in China.

In the present era of market globalization, enterprise standardization has proven to be of particular importance for the following reasons. Firstly, trade takes place with different countries and customers, and the standards required in many cases differ from customer to customer and country to country. Secondly, since the requirements of different standards are not identical, company managers must design systems to accommodate new and different requirements. Thirdly, in order for an enterprise to maintain its competitiveness, it must continually innovate and upgrade its products, which requires the support of technical standards. As a consequence, the extension and improvement of standardization systems have become important and long-term activities in Xinxing.

8.3.3 Participation in national and international standardization committees

In addition to using standards, Xinxing also participates in the development of ISO International Standards as well as those of Chinese National and Industry Standards.

8.3.4 Use of standards at Xinxing

Xinxing uses many internal and external standards. The most important external standards can be classified as shown in **Table 6**:

Type of standard	Status	Number of standards used
Product standards	compulsory	38
	voluntary	345
Process standards	compulsory	36
	voluntary	298
Health, safety and environmental (HSE) standards	compulsory	50
	voluntary	48
Total :	Compulsory standards : 124 Voluntary standards : 691	815

Table 6 – Types of external standards used by Xinxing

As a consequence of new technologies and other factors, Xinxing products are subject to regular upgrades and shorter and shorter life cycles. In response to shifts in market demands, technical developments in China and abroad, and competitive pressures, Xinxing always uses the latest editions of standards. New standards or new editions of existing standards are implemented as soon as they have been published to ensure they are up-to-date, meet customer demands and are mutually consistent. Consequently, products with specific advantages that satisfy customers and boost Xinxing's competitiveness can be delivered to the market.

In addition to standards there are also 22 technical regulations that are important to Xinxing's activities (a detailed list is given in the **Annex**).

8.3.5 System and product certification

Xinxing has eight certifications issued by international agencies as listed below:

8.3.5.1 Certification of management systems

- In October 1995, Xinxing obtained quality management system (QMS) certification from the China Quality Mark Certification Group (CQM). In July 2003, the company changed its certification service provider to Lloyd's Registered Quality Assurance Ltd, UK, and was awarded ISO 9001 QMS certification in August 2009
- In November 2000, the company first received ISO 14001 environmental management system (EMS) certification from the Huaxia Environmental Audit Center under the State Environmental Protection Administration, and was awarded Royal UKAS QMS certification. In June 2010, it obtained ISO 14001 EMS certification from Beijing Grand Honour Management System Certification Co. Ltd
- In August 2004, Xinxing gained occupational health and safety management (OHSAS) system certification from the Safety Scientific Research Certification Center, State Administration of Work Safety for the first time. In June 2010, it attained GB/T 28000 OHSAS certification from Beijing Grand Honour Management System Certification Co., Ltd
- In December 1998, its metrological management was audited by the State Bureau of Quality and Technical Supervision, and was awarded the Certificate of Competency for the Gauging and Inspection Improvement System. In May 2009, Xinxing gained the GB/T 19022 Measurement Management System Certification by the Zhongqi Measuring System Certification Center

8.3.5.2 Certification of products

- ISO 2531, ISO 7186, ISO 4179, ISO 8179-1, ISO 8179-2, EN 545, EN 598, EN 15189, EN 15655, ABNT NBR 7675 ductile iron pipe and pipe fitting product standard certifications were awarded for the first time by Bureau Veritas (Italy) and Bureau Veritas (China) in November 1999, and renewed in July 2009
- Korean KS Product Certification for ductile iron pipe and pipe fitting products was awarded for the first time in July 2003, and again in October 2009
- Australian AS/NZS 2280 product certification for ductile iron pipe and pipe fittings was awarded In March 2009
- Flat steel S 235JR and S 275JR, and round steel S 235JRUK products were accredited in May 2007 and May 2010 by Lloyd's CE Certification, UK

8.4 Value Chain Analysis

8.4.1 Industry value chain

The iron and steel sector, one of the most important raw material industries in China, is engaged in the mining, smelting, refining and processing of ferrous metals. Other production activities include mining and smelting of iron, chrome, and manganese, iron and steel making, steel processing, ferroalloy refining, and steel wire manufacture.

Iron and steel production also involves non-metal minerals mining, smelting of coking and refractory materials, and carbon products. These industrial sectors are generally classified within the scope of the iron and steel industry. The value chain is typical of a manufacturing industry, from smelting of iron ore to sales of iron and steel products as shown in **Figure 1.**

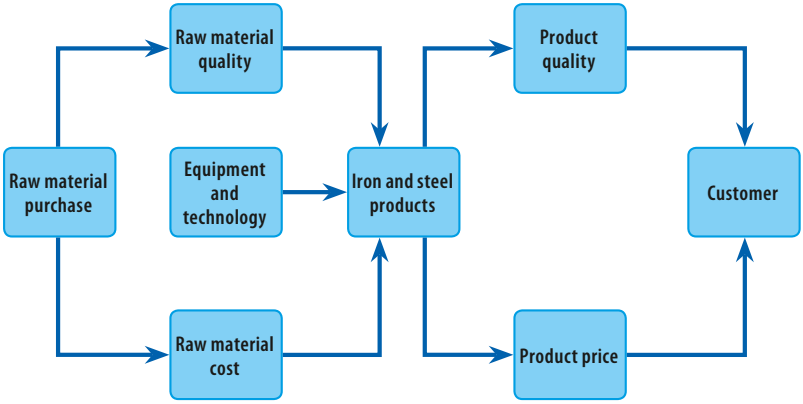

Figure 1 – Value chain of the iron and steel industry

Quality and price are the two key criteria that influence the selection of iron and steel products by customers. The first is mainly determined by the refining equipment, the applied technologies and the quality of iron ore as the chief raw material. The price of iron and steel products depends mainly on the cost of iron ore and other raw materials.

In order to maintain its competitiveness in the market for iron and steel products, to retain existing customers and win new ones, an enterprise must be able to offer products at an advantageous price and of high quality.

8.4.1.1 Iron ore

The most important element in the iron and steel industry value chain is iron ore. The price of iron ore determines to a large extent the price of the final iron and steel products, while its quality directly affects finished product quality.

The quality of iron ore itself depends on the following three factors:

1. The total iron content
2. The content of contaminants in iron ore
3. The content of harmful elements in iron ore

1. Total iron content

The total iron content for high quality iron ore must be at least 60 %. Iron ore can be divided into lump ore and ore fines. According to the future Chinese National Standard *Classification of Iron Ore Grades*, which is currently in draft stage, the total iron content can be divided into five grades, as shown in **Table 7.**

Brand	Grade	Chemical composition (in %)						
		TFe	SiO2	Al2O3	P	S	Moisture content	Particle size
KKI	1	≥64.0	≤4.0	≤1.5	≤0.06	≤0.03	≤4.0	–6.3 mm : ≤5.0, +31.5 mm : ≤10.0
KKII	2	62.0 ~ < 64.0	≤5.0	≤2.0	≤0.07	≤0.05		
KKIII	3	60.0 ~ < 62.0	≤7.0	≤2.5	≤0.08	≤0.07		
KKIV	4	58.0 ~ < 60.0	≤7.5	≤3.5	≤0.10	≤0.09		
KKV	5	48.0 ~ < 58.0	≤150	≤4.0	≤0.13	≤0.11		
Note : Moisture indicator is for reference								

Table 7 – Classification of lump ore grades

Chinese National Standards for testing total iron content include :

- GB/T 6730.5 – 2007, *Iron Ores – Determination of Total Iron Content – Titanium (III) Chloride Reduction Methods*
- GB/T 6730.65 – 2009, *Iron ores – Determination of Total Iron Content – Titanium (III) Chloride Reduction Potassium Dichromate Titration Methods (Routine Methods)*
- GB/T 6730.66 – 2009, *Iron Ores – Determination of Total Iron Content – Automatic Potentiometric Titration Methods*

2. Content of contaminants in iron ore

The more contaminants the iron ore contains, the more additives will be required to treat these contaminants, resulting in higher costs. The main contaminants in iron ore are silicon (SiO_2) and aluminium (AL_2O_3). There are various Chinese standards used to test the content of silicon and aluminium.

3. Content of harmful elements in iron ore

Harmful elements in iron ore will affect the quality of iron and steel products, such as an increase in brittleness of steel, reducing its weld-ability, flexibility and corrosion resistance, and can also increase environmental pollution. The main harmful elements are phosphorus, sulphur, and arsenic.

There are various Chinese standards for testing phosphorous, sulphur and arsenic content as well as for testing moisture and particle size of iron ore.

8.4.1.2 Equipment and core technologies

At the end of the 20th century, significant funds were granted by the Chinese government, to help iron and steel enterprises undertake large-scale retrofits and upgrades of old equipment that typically consumed high levels of energy and emitted serious pollution. Such equipment was basically replaced with modern equipment of an advanced international level.

However, an important task in the early stage in the refining process was to control energy consumption to reduce cost, and increase the economic performance of the enterprise. The standards for this purpose include *Limitation for Electricity Consumption for Steel Refining of Electric Furnaces* (Draft for Approval), YB/T 4209 – 2010, Regenerative Combustion Technical Specification of the Iron and Steel Industry, Sintering and Cooling System Waste Heat Recycling Technical Specifica-

tion (Draft for Approval), and *Coke Dry Quenching Energy Conservation Technical Specification* (Draft for Approval). Another important task in the refining process was environmental protection.

In recent years, enterprises have improved their environmental performance. New standards that correspond to current requirements for environmental protection are being published, as well as standards such as *Assessment of Clean Product Levels of Coking Enterprises* (exists currently as a draft), and *Assessment of Clean Production Levels of Iron and Steel Enterprises* (also in draft stage).

China is a big iron and steel-producing country with an annual output exceeding 600 million tons. At present, demand for low-end iron and steel products has fallen and supply exceeds demand, resulting in a serious overstock situation in some companies. At the same time there is an undersupply of high-end iron and steel products. It has been estimated that the yield for high-end products is three times that of low-end products, with each 1 % increase in market share of high-end iron and steel products resulting in an increase in a company's profit margin of CNY 1.5 billion. The key to the production of high-end iron and steel is access to core technologies and availability of quality iron ores.

In the structural economic adjustment currently taking place in China, industries with high energy consumption like iron and steel do not receive special support from the government, and, as a consequence, its future perspectives are not very promising. The challenge faced by Chinese iron and steel enterprises is how to increase the variety of their products and the market share of high-end products, so that they can tap into a beneficial cycle of demand-driven development.

8.4.1.3 Iron and steel products

In the iron and steel industry, high-end products manufactured by Chinese companies with independent core technologies include steel plates for the nuclear power industry, high-speed railways, urban mass transit, and high-end cars, and steel pipes for boilers, the aerospace industry and the military.

Some recently developed national standards have played a leading role in creating such a market. These standards, some of which exist currently only as draft standards, are: *Seamless Steel Pipe for High-Pressure Boilers, Seamless Steel Pipe for Low-and-Medium-Pressure Boilers, Seamless Steel Pipe for Nuclear Power Stations*; GB 3531 – 2008, *Low Alloy Steel Plate for Low Temperature Pressure Vessels*; GB 24511 – 2009, *Stainless Steel Plate, Sheet, and Strip for Pressure Equipment, Steel Plate and Strip for Welding Gas Cylinders, Seamless Steel Pipe for Gas Cylinders*; GB 19189 – 2011, *Quenched and Tempered High Strength Steel Plate for Pressure Vessels, Composite Seamless Steel Pipe for Gas Cylinders*; GB 2585 – 2007, *Hot-Rolled Steel Rails for Railways, and Hot-Rolled H-Shaped Steel for Overhead Contact Line Poles for Electrified Railways*.

Several high-priority standards for high-strength sheet steel for cars have been developed to promote innovation and extend advanced production capabilities, to guide and standardize the application of Chinese high-strength sheet steel, and to achieve domestically produced top-class automotive steel sheet. These include standards for component testing methods for *High-Strength Cold Continuous Rolling Steel Plates and Strips for Automobiles* – Part 1: *Bake-Hardening Steel, etc., and Steel – Method for Determination of Bake-Hardening Value (BH2), Welding Steel Pipe for Automobile Transmission Axles* (Draft for Approval), *High-Performance Shaped Seamless Steel Pipe for Automobile Axles*. Additionally, the publication of national standards for steel

pipes in nuclear power applications has also brought new economic growth to iron and steel enterprises.

8.4.2 Enterprise value chain

Xinxing is a large enterprise positioned in the downstream segment of the iron and steel industry value chain. The company's value chain, based on the model originally developed by Michael Porter of Harvard Business School, is shown in **Table 8.**

Management & administration				
Research & development				
Engineering				
Procurement : including procurement of raw materials, fuels, and charges				
Inbound logistics	**Production/ operation : iron making, steel**	**Outbound logistics**	**Marketing & sales**	**After-sales service**
train and truck transport	making, steel rolling, and pipe casting	train and automobile transport	Sales of cast and steel pipe and steel grating plate products	

Table 8 – Enterprise value chain of Xinxing

Xinxing uses 85 different types of raw material and fuel. According to the different transport methods, in- and outbound logistics are divided into two categories – train transportation and truck transportation. The transport department takes charge of train transport. Suppliers are generally responsible for delivering supplies if transported by trucks.

Outbound logistics using trucks is generally outsourced to transport service providers. Xinxing's production business function involves iron and steel making, steel rolling, and pipe casting. Its main products include three types of cast pipes, steel products, and steel grating plates.

Xinxing's profits in recent years have grown steadily, making it one of the more profitable enterprises in the industry. In the company

value chain, the production business function is central to generating good economic results. While some Xinxing products are high-end and have therefore shown rapid development in recent years, its main products are facing fierce competition in the market.

8.4.3 Key value drivers

Since the second half of 2008, the company began to reform its internal management by establishing different departments as autonomous cost centres and legal entities, and by implementing close and efficient linkages between production, supply, marketing, transportation, and application. All of Xinxing's activities are focused on optimizing profits, and all processes have been improved in terms of cost control, working procedures and efficiency.

Xinxing has explored profit growth opportunities in procurement and production operations, as well as marketing and sales. Competiveness in these functions has increased through innovation and changes in management approaches, and on the basis of accurate judgments and predictions of market trends. The result has been higher responsiveness to market demands, and improvements in internal management.

8.4.3.1 Procurement

In March 2009, Xinxing decided to flatten the organizational structure of the procurement department in order to adapt to market changes and requirements, and improve its responsiveness.

Based on implementation of the system of " authorized tendering and parity-rate purchasing ", Xinxing made the procurement department the centre for all procurement activities by establishing four departments and one office, and by further clarifying the scope of responsibility of the purchasing manager under the leadership of

the department director. A group for purchasing raw materials and another for purchasing fuels was established. They meet almost every day to study market trends and adjust the structure of crude fuels and charges for the respective production departments. In the new structure, the production departments are responsible for implementing production processes, while groups in the procurement centre are responsible for the purchase of crude fuels.

8.4.3.2 Production/operation

In recent years, the focus of the production departments has shifted from meeting certain predefined economic indicators, to pursuing maximum profit. Market demand became the key driver, profit improvement the main objective, and attention to cost reduction – on the basis of autonomous cost centres – the main approach in the organization.

Procurement is not the only department responsive to changes in the raw materials market, the production departments also closely monitor the market and adjust their stocks and optimize raw materials on the basis of changes in prices. By broadening the types of raw materials and thereby reducing dependence on any single material, Xinxing was able to reduce its exposure to some market risks.

On the other hand, the production departments have paid special attention to increasing the proportion of high value-added products in Xinxing's product portfolio, thus ensuring stable manufacturing of the required quantity and quality of products.

Processes have been continuously improved and innovated, thus reducing overall manufacturing costs and iron and steel consumption per ton of output.

8.4.3.3 Marketing and sales

The sales departments in Xinxing have applied the vision of "Sales Volume, Price, Market Share and Capital Recovery as an organic whole". This approach has contributed to a good balance between sales volume and profits. Through vigorous measures aimed at consolidating capital recovery and changes in its trading models, the quality of Xinxing's operations has improved. These departments continue to attach high importance to reinforcing Xinxing's position in conventional markets by stabilizing prices under normal sales conditions and volume, and by consolidating the company's leading status in the conventional domestic water supply and drainage market.

However, Xinxing has also taken an active part in opening up new markets, developing sales channels for special steel pipes, and successfully implementing preparatory measures to secure market access. As an example of its presence in new markets, X52/952 bimetal nickel-based alloy composite pipes and 2205 dual phase stainless steel tube have been successfully used in oil and gas fields.

8.5 Scope of the pilot project assessment

The scope of this project covers Xinxing operations in the Wuan Industrial Zone, and involves the production of case pipes and steel products. The impact of standards assessed cover the whole company value chain and comprise the seven business functions of management and administration, research and development, engineering, procurement, production/operation, marketing and sales, and after-sales service, represented by 16 organizational departments and groups in the company. The relationship between the business functions and the relevant organizational entities in Xinxing are shown in **Table 9.**

Business functions	Organizational entity in Xinxing
Management & administration	Quality supervision department
	Safety and environmental protection department
Research & development	Xinxing Hebei Engineering Technology Co., Ltd
	Research institute
Engineering	Engineering management department
Procurement (incl. inbound logistics)	Procurement department
Production/operations	Hebei Xinxing Ductile Iron Pipes Co., Ltd
	Second pipe casting department
	Third pipe casting department
	Steel making department
	Steel rolling department
	Pelletizing department
	First iron making department
	Second iron making department
Marketing & sales (incl. outbound logistics)	Trading company
After-sales service	Quality supervision department

Table 9 – Organizational entities assessed

8.6 Implementation of standards in the company

The standards with the most impact on the seven business functions under assessment are listed in **Table 10** below.

Business functions	Key standards used in the business functions
Management and administration	ISO 9001:2008, *Quality management systems – Requirements*
	ISO 14001:2004, *Environmental management systems – Requirements with guidance for use*
	GB/T 28001 – 2001, *Occupational Health and Safety Management Systems – Specification*
	GB/T 13234 – 2009, *Calculating Methods of Energy Saved for Enterprise*
	GB/T 15316 – 2009, *General Principles for Monitoring and Testing of Energy Saving*
	GB/T 2589 – 2008, *General Principles for Calculation of the Comprehensive Energy Consumption*
	GB/T 8222 – 2008, *The Principles for Electricity Balance of Equipment*
	GB 1499.1 – 2008, *Steel for the Reinforcement of Concrete – Part 1 : Hot-rolled Plain Bars*
	GB 1499.2 – 2007/XG1 – 2009, *Steel for the Reinforcement of Concrete – Part 2 : Hot-rolled Ribbed Bars No. 1 Amendment*
Research and development	API Specification 5LD Third edition, March 2009, *Specification for CRA Clad or Lined Steel Pipe*
	BS EN 545:2010, *Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods*
	GB 50011 – 2010, *Code for Seismic Design of Buildings*
	GB 50013 – 2006, *Code for Design of Outdoor Water Supply Engineering*
	GB 50014 – 2006, *Code for Design of Outdoor Waste water Engineering*
	GB 50016 – 2006, *Code of Design on Building Fire Protection and Prevention*
	GB 50019 – 2003, *Code for Design of Heating Ventilation and Air Conditioning*
	GB 50427 – 2008, *Code for Design of Blast Furnace Iron-making Technology*
	GB 50491 – 2009, *Code for Design of Iron Pellet Engineering*
	GB 6222 – 2005, *Safety Code for Gas of Industrial Enterprises*
	GB/T 13295 – 2008, *Ductile Iron pipes, Fittings and Accessories for Water or Gas applications*

Business functions	Key standards used in the business functions
Research and development	GB/T 50103 – 2010, *Standard for General Layout Drawings* ISO 2531:2009, *Ductile iron pipes, fittings, accessories and their joints for water applications* All design standards and specifications (techniques, civil work, electric automation, instruments, water supply and drainage, heat ventilation, environmental protection and hydraulic pressure, etc.)
Engineering	GB 50496 – 2009, *Code for Construction of Mass Concrete* GB 50231 – 2009, *General Code for Construction and Acceptance of Mechanical Equipment Installation Engineering* GB 50303 – 2002, *Code for Acceptance of Construction Quality of Electrical Installation in Building* GB 50235 – 2010, *Code for Construction of Industrial Metallic Piping Engineering* GB 50300 – 2001, *Unified Standard for Constructional Quality Acceptance of Building Engineering*
Procurement	GB 12706.3 – 2008, *Power Cables with Extruded Insulation and their Accessories for Rated Voltages from 1kV(Um=1.2kV) up to 35kV (Um=40.5kV)* – Part 3 : *Cables for Rated Voltage of 35kV(Um=40.5kV)* GB 17930 – 2011, *Gasoline for motor vehicles* GB 252 – 2011, *Common Diesel Oil* GB/T 1996 – 2003, *Coke for Metallurgy* GB/T 2272 – 2009, *Ferrosilicon* GB/T 272 – 1993, *Rolling Bearing – Identification Code* GB/T 3649 – 2008, *Ferromolybdenum* GB/T 6516 – 2010, *Electrolytic Nickel* GB/T 7737 – 2007, *Ferroniobium* JB/T 3715 – 2006, *Bonded Abrasive Products – Depressed Centre Grinding Wheel* YB/T 5296 – 2006, *Pig Iron for Steelmaking*

Business functions	Key standards used in the business functions
Production/operations	BS EN 545:2010, *Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods*
	BS EN 598:2007+A1:2009, *Ductile iron pipes, fittings, accessories and their joints for sewerage applications – Requirements and test methods*
	GB 12706.3 – 2008, *Power Cables with Extruded Insulation and their Accessories for Rated Voltages from 1kV (Um=1.2kV) up to 35kV (Um=40.5kV)* – Part 3 : *Cables for Rated Voltage of 35kV (Um=40.5kV)*
	GB 1499.1 – 2008, *Steel for the Reinforcement of Concrete* – Part 1 : *Hot-rolled Plain Bars*
	GB 1499.2 – 2007/XG1 – 2009, *Steel for the Reinforcement of Concrete* – Part 2 : *Hot-rolled Ribbed Bars No. 1 Amendment*
	GB 16917.1 – 2003/XG1 – 2010, *Residual current operated circuit-breakers with integral over current protection for household and similar uses (RCBO)* – Part 1 : *General rules No. 1 Amendment*
	GB/T 10044 – 2006, *Welding Electrodes and Rods for Cast Iron*
	GB/T 13295 – 2008, *Ductile Iron pipes, Fittings and Accessories for Water or Gas Applications*
	GB/T 13927 – 2008, *Industrial Valves – Pressure Testing*
	GB/T 14048.12 – 2006, *Low-voltage Switchgear and Controlgear* – Part 4-3 : *Contactors and Motor Starters – AC Semiconductor Controllers and Contactors for Non-motor Loads*
	GB/T 1412 – 2005, *Pig Iron Used for Spheroidal Graphite Cast Iron*
	GB/T 14405 – 2011, *General Bridge Crane*
	GB/T 1504 – 2008, *Cast Iron Rolls*
	GB/T 1996 – 2003, *Coke for Metallurgy*
	GB/T 2101 – 2008, *General requirement of Acceptance, Packaging, Marking and Certification for Section Steel*
	GB/T 222 – 2006, *Permissible Tolerances for Chemical Composition of Steel Products*
	GB/T 2272 – 2009, *Ferrosilicon*
	GB/T 25715 – 2010, *Sphere Nodular Cast Pipe Mould*

Business functions	Key standards used in the business functions
Production/operations	GB/T 271 – 2008, *Rolling Bearings – Classification*
	GB/T 272 – 1993, *Rolling Bearing – Identification Code*
	GB/T 4008 – 2008, *Ferromanganese-Silicon*
	GB/T 5751 – 2009, *Chinese Classification of Coals*
	GB/T 70.1 – 2008, *Hexagon Socket Head Cap Screws*
	GB/T 700 – 2006, *Carbon Structural Steels*
	GB/T 7737 – 2007, *Ferroniobium*
	GB/T 984 – 2001, *Hardfacing Electrodes for Shielded Metal Arc Welding*
	ISO 2531:2009, *Ductile iron pipes, fittings, accessories and their joints for water applications*
	ISO 262:1998, *ISO general purpose metric screw threads – Selected sizes for screws, bolts and nuts*
	JB/T 10105 – 1999, *YZR Range of Three-phase Slip-ring Rotor Induction Motors for Crane and Metallurgical Applications – Technical Specifications*
	JB/T 10391 – 2008, *Specification for Y series (IP44) Three-phase Asynchronous Motor (Frame Size 80 to 355)*
	JB/T 10563 – 2006, *Technical Specification for General-purpose Centrifugal Fans*
	JB/T 1700 – 2008, *Components of Valves – Nuts, Bolts and Plugs*
	JB/T 8853 – 2001, *Reduction Cylindrical Gear Units*
	YB/T 2011 – 2004, *Continuous Casting Square and Rectangular Blank*
	YB/T 319 – 2005, *Metallurgical Manganese Ore*
	YB/T 421 – 2005, *Iron and Sintering Ore*
	YB/T 5268 – 2007, *Silica*
	YB/T 5296 – 2006, *Pig Iron for Steelmaking*
	YB/T 2011 – 2004, *Continuous Casting Square and Rectangular Blank*

Business functions	Key standards used in the business functions
Marketing and sales	AS/NZS 2280:2004, *Ductile iron pipes and fittings* KSD 4311:2004, *Ductile iron pipes* BS EN 545:2010, *Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods* BS EN 598:2007+A1:2009, *Ductile iron pipes, fittings, accessories and their joints for sewerage applications – Requirements and test methods* ISO 2531:2009, *Ductile iron pipes, fittings, accessories and their joints for water applications* GB/T 13295 – 2008, *Ductile Iron pipes, Fittings and Accessories for Water or Gas Applications* ISO 9001:2008, *Quality management systems – Requirements* ISO 14001:2004, *Environmental management systems – Requirements with guidance for use* GB/T 28001 – 2001, *Occupational Health and Safety Management Systems – Specification*
After-sales service	ISO 9001:2008, *Quality management systems – Requirements*

Table 10 – Key standards used in the different business functions

8.7 Selection of operational indicators to measure the impact of standards

The key operational indicators to measure the impact of standards used in each business function are given in **Table 11** below:

Business function	No.	Operational indicators
Management & administration	1.	Possibility of obtaining production permission certificates for the production and sales of reinforcing steel bars. Without production permission certificates, production and sales are not permitted.
	2.	Reduction in energy consumption and costs, energy savings, avoidance of administrative fines imposed by government agencies.
	3.	Through the environmental protection management system, the company can ensure that smoke and dust emissions, noise, and wastewater discharge do not exceed the maximum limits, and thus avoid administrative fines from local governments for illegal transfer of hazardous wastes in accordance with relevant laws and regulations.
	4.	1. Through the OHSAS system, hazard control accounts are systemically prepared and hazards are prevented more scientifically ; emergency plans are formulated to limit personal injury and equipment loss from accidents wherever possible ; the death rate from occupational diseases and accidents can be reduced, and administrative fines due to nonconformity with state policy can be avoided. 2. Establishing files to record the occupational health of workers, organizing regular physical examinations, and application of relevant labour protection regulations can lead to fewer occupational hazards.
Research & development	5.	Improvement of design efficiency, and reduction of design faults and costs.
	6.	Greater efficiency of product research and reduction in research projects. The objective is that, through the implementation of standards, it should be possible to choose a typical specification from the group of same types and conduct fewer research programmes.
	7.	Reduction of risk in material selection for bi-metal composite pipes. Standardized material selection processes can enhance efficiency and shorten research and development time.
Engineering	8.	Reduction in construction costs and investment, simplified organization of procurement and public tenders for equipment and spare parts, and more efficient organization of construction and acceptance checks resulting from the use of relevant standards.

Business function	No.	Operational indicators
Procurement	9.	With standardized documents and specifications procurement personnel can share information more efficiently and reach agreements more quickly.
	10.	Reduction in procurement costs of raw materials including common diesel oil, automotive gasoline and metallurgical coke.
	11.	Reduced cost of procuring furnace materials.
	12.	Reduced cost of procuring equipment .
Production/ operations	13.	Reduction in mould repair costs : Standardized production may reduce the number of mould cycles required for non-standardized products, thus further reducing mould maintenance costs.
	14.	Reduce investment in, and cost of, moulds (including repair and maintenance) : Standardized production reduces the manufacture of non-standardized products and inputs in moulds, and also shortens process downtime and enhances effective operating uptime : Fewer production specifications also shorten downtime caused by modifying specifications, thus enhancing effective uptime, creating economic benefit and reducing loss caused by waste products. Fewer product specifications and modifications reduces the quantity of product rejects, thus creating economic benefit.
	15.	Reduce investment in moulds and costs : Standardized production can reduce the number of non-standardized products and inputs in moulds and can also shorten remodeling time : pipe off-specification variations are likely to increase without relevant standards ; reduction in loss caused by waste products, reduction in product specifications can reduce the quantity of technical waste products.
	16.	Implementing standards broadens the versatility of equipment parts, increases replaceability, and also establishes requirements for checking the acceptance of related parts, thus greatly reducing part costs.
	17.	Standardization of steel varieties and the external quality of casting blanks enables continuous casting production to be standardized. The entire converter steelmaking process is programmed via software, including lance position, charging time and quantity, etc., to further standardize process handling. The level of quality conformity achieved for steel water and blank has increased in recent years while waste products have decreased as a result of more efficient quality management.
	18.	The steel rolling department prefers to purchase top-quality standardized equipment and spare parts, thus strengthening interchangeability and compatibility, and greatly reducing equipment failure rate and maintenance costs.

Business function	No.	Operational indicators
Production/ operations	19.	Standardization of steel types and the quality of continuous casting blanks also enables standardization in steel production processes, including material procurement, batch numbering, heating, charging, tapping, roller wiring, on-site roller guide installation, pre-installation of standby roller guides, roll collar acceptance checks, steel shearing, selection, packaging, weighing, binding and storage (in accordance with GB/T 19001:2008). The rate of quality conformity achieved for steel water and blank in recent years has increased while waste products have decreased due to more efficient quality management.
	20.	1. Lower equipment failure rate : Before the production process was standardized, product quality was often deficient and differed from the design and assembly specifications of other manufacturers. However, the failure rate has been dramatically reduced as a consequence of the standardization of the whole process of equipment from design, to procurement to installation. 2. Shorter maintenance time : In addition to the maintenance advantages of standardized tool components, standardized processes can help maintenance engineers replace parts more easily. In comparison, non-standard pieces usually require extra handling. 3. Reduce inventory of spare parts and capital needs : Standardization has greatly reduced the number of spare parts. Economic benefits have been achieved as a result of standardized components such as blowers, speed reducers, electric fans, carrier rollers and pressure gauges.
	21.	Simpler, more efficient and economic operation and maintenance of equipment : The first iron-making department prefers to choose standardized equipment, spare parts and key materials, resulting in greater interchangeability and compatibility ; the introduction of competitive and goods-comparable systems can greatly reduce the inventory of spare parts and materials, and enhance their quality ; the lower costs of spare parts and materials, fewer failures and shorter maintenance time has resulted in reduced equipment operating costs.
	22.	Adoption of standards for products, raw fuels and quality control has simplified the production and quality control process, making it more orderly, economical and efficient. The economic benefits of steelmaking have been increased by optimizing the structure of sintered material charging and blast furnace materials, and by using relevant adjustments and controls.
	23.	The preference of the second iron-making department in choosing standardized equipment has enhanced interchangeability and compatibility, and greatly reduced equipment failure rates and maintenance costs.

Business function	No.	Operational indicators
Production/ operations	24.	Standardization has simplified production and quality management, reduced the number of quality and operational incidents and disputes, and lowered production costs. Simplified management has also reduced management costs
Marketing & sales	25.	By implementing in parallel standards of different regions, it is possible to open up the markets in which these standards are used and increase thereby sales volumes and achieve higher profits.
	26.	By implementing standards, it is possible to reduce negotiating time and thereby achieve greater efficiency in business negotiations.
	27.	Overseas pipeline product customers require conformity to certain standards. Special client groups and key project customers in China, accounting for 10 % of domestic sales volume, only accept products after the relevant quality and environmental protection certificates have been obtained.
After-sales service	28.	1. QMS implementation helps improve production, distribution and service quality and reduce external quality losses. 2. QMS implementation can improve the effectiveness of supervision and control in checking and accepting materials, and reduces internal losses by 10 %.

Table 11 – Operational indicators selected to quantify the impact of standards

8.8 Calculating the economic benefits of standards

Following are the aggregated impacts as shown in **Table 12** resulting from the use of the standards applied to the seven business functions in the value chain on the basis of the operational indicators defined in section 7. The principle followed in the calculation is that the impacts of the standards on each indicator are estimated as a percentage reduction in the costs of the respective activity or an increase in revenues resulting from the use of standards. Finally all of these financial impacts are summed up to arrive at the aggregated impact for the selected business functions and the whole company in the scope of the assessment.

As one example for the calculation, the standards used in procurement resulted in a general increase in the efficiency of procurement, less personnel and shorter procurement times in purchasing crude fuels, equipment and charging materials for the furnace which at an annual level contributed to savings of over 9 million CNY.

Business functions (in the value chain)	Impacts (in CNY)	% contribution
Management & administration	3 260 000	4.8 %
Research & development	5 850 000	8.61 %
Engineering	6 798 400	10 %
Procurement (incl. inbound logistics)	9 110 900	13.4 %
Production/operation	21 859 300	32.16 %
Marketing & sales (incl. outbound logistics)	19 103 100	28.10 %
After-sales service	1 991 500	2.93 %
Total	**67 973 200**	**100 %**

Table 12 – Contribution of standards to selected business functions

As shown in **Table 12**, the total impact of standards in the scope of the assessment is nearly **CNY 68 million**, (approximately USD 10 772 700 based on May 2012 exchange rates). The contribution of standards as a percentage of the annual sales revenue of Xinxing in 2010 is 6797.32 / 10 06343.8 = **0.67 %**, while the **percentage of the EBIT is close to 14 %** (6797.32 / 48829.22 = **13.92 %**).

8.9 Evaluation of the results

8.9.1 Economic benefits of standards for Xinxing

From the seven business functions assessed, it was found that the greatest economic benefits of standards could be achieved in production. Xinxing applies the latest international, Chinese national and

Chinese industry standards in a very timely manner, with the result that production and quality control processes can be simplified and organized in an orderly, economical, and highly effective way. This has resulted in reduced moulding costs, increased machine operating uptime, less equipment downtime and fewer defective products.

Another business function that gains from standards is marketing and sales. Standards have assisted the company in opening up new markets, in reducing negotiation time and in increasing sales volumes and profits. Compared with the business functions of production/operation and marketing and sales, the contribution of external standards to other business functions, such as after-sales services, is much less. Therefore, Xinxing may consider increasing the use of standards in those other functions with the objective of further improving the quality and effectiveness of these services.

8.9.2 Principles observed in the assessment process

This project has received strong support from all levels of Xinxing management. The scope of the assessment was agreed following comprehensive and objective analysis, and frequent consultations at management and departmental level. Consequently, the impact of external standards on the company have been assessed in a comprehensive and balanced manner based on evidence. The results reflect the economic contributions of standards to the selected business functions in the value chain.

8.10 Conclusions

8.10.1 Standardization is a pillar in enhancing enterprise competitiveness

Any enterprise operating in today's globalized business environment should implement standards since they can have a positive impact on products and technologies. Following rapid economic development and scientific and technical progress, productivity in China's industries has increased significantly. Many enterprises have engaged in technical upgrades as well as mergers and reorganizations. Through participation in standardization they can engage in global competition, and upgrade the level of company standardization through technical innovation. Companies should extend standardization through system certification, and use it as the basis for developing new products related more closely to research, and also to tie the introduction of new technical equipment more closely to retrofitting existing equipment.

Chinese enterprises have many competitive advantages in manufacturing, in marketing, in research and development, in the availability of trained human resources and in some aspects of standardization. There are also significant opportunities for industrial upgrades and structural adjustments. As long as new ideas can be absorbed, guided and supported by the government, and stimulated by their own initiatives, there is no doubt that Chinese enterprises can advance their role as the key force contributing to the work of standardization in China.

8.10.2 The assessment of the economic benefits of standards can spur further company standardization

The ISO methodology for assessing the economic benefits of standards has been applied in case studies in China, and the results have been compared with those in other countries under different economic

and social environments. The objective is to study approaches and methods to further enhance the economic benefits of standards, and to provide recommendations for formulating relevant policies. The successful application of this assessment method has contributed to a better understanding of the benefits for various stakeholders, and has enhanced the awareness of the importance of standards for enterprise managers and technical staff. Objective and scientific data has been gathered, and conclusions reached, which have the potential to further stimulate the initiative of enterprise managers towards standardization work, and to leverage standardization as a means to increase company competitiveness.

8.10.3 Recommendations towards further improvement of the assessment method

By using the ISO methodology, Xinxing has been able to identify the economic contributions of standards for selected business functions in the company value chain through an evidence-based approach, which is also conducive to the effective allocation of resources inside the company. However, there are still aspects of the assessment method that can be improved.

The concept of the "value chain" constitutes the basic framework of the ISO methodology. However, the biggest challenge in using this method is to differentiate the influences resulting from the implementation of standards from the influence of other factors. Such a differentiation requires that one develops a certain familiarity with the operations of the chosen company, at least for those activities that are within the chosen scope of the assessment.

In order to obtain original data for the assessment that reflect multiple perspectives, it is also necessary to relate the data from interviews with individuals responsible for different operations in the company to

corresponding information representing the whole industry, or from studies about similar companies, in order to compare the findings.

Since the standards management system in China is based on a combination of compulsory and voluntary standards, it is necessary to consider the economic benefits of these standards to the enterprise, even though some of them are compulsory (which is not in line with some statements in the ISO methodology which suggest that mandatory standards should not be included in the assessment).

Although company-internal standards are not considered in the assessment methodology, those that contain technical indicators which are higher than external standards (international standards, Chinese national standards, industry-branch standards, and other standards) cannot be omitted from the assessment.

It is necessary to further refine the assessment indicators in the methodology applying to the specific characteristics of companies from different countries, to ensure that they are operable, and to reduce possible overlaps between or repetition of indicators.

8.10.4 Assessment of the economic and social benefits of standards

The impact of standards on socio-economic development is not only reflected in measurable economic indicators, but also in aspects such as environmental protection and human health that cannot be quantified easily. Therefore, a comprehensive study of the economic and social benefits of standards is required, in order to scientifically and objectively assess the functions of standards for national economic and social development, to provide a foundation for decision-making by government agencies at all levels, to guide the development of standardization strategies for industry sectors, and to further enhance initiatives that encourage enterprises to become involved in standardization.

Annex : Technical regulations relevant for Xinxing

No.	Title of regulations
1	Product Quality Law of the People's Republic of China
2	Standardization Law of the People's Republic of China
3	Metrology Law of the People's Republic of China
4	Criminal Law of the People's Republic of China
5	Law of the People's Republic of China for Countering Unfair Competition
6	Law of the PRC on the Protection of the Rights and Interests of Consumers
7	Administration Regulation for Production License for Industrial Products
8	Provisions on Labeling of Product Identification
9	Economic Contract Law
10	Provisions on Administrative Penalty for the Safety Supervision of Boilers, Pressure Vessels, Pressure Pipes and Special Equipment
11	Provisions on Administration and Safety Supervision of Pressure Pipelines
12	Provisions on Accident Management of Boilers, Pressure Vessels, Pressure Pipeline and Special Equipment
13	Qualification and Supervision Management Rules for the NDT Testing Personnel of the Special Equipment
14	Examination, Management Rules and Explanations for Welding Operators of Boilers, Pressure Vessels and Pressure Pipelines
15	Special Equipment Safety Surveillance Regulations
16	TSG Z0004 – 2007, *Basic Requirements for Special Equipment Quality Assurance System on Manufacture, Installation, Alteration and Repair*
17	TSG Z0005 – 2007, *Appraisal Guidelines for Manufacture, Installation, Alteration and Repair of Special Equipment Licensing*
18	TSG D6001 – 2006, *Examination Requirements for Safety Administrators and Operators of Pressure Pipe*
19	TSG D7002 – 2006, *Pressure Piping Components Type Test Regulations*
20	TSG D7001 – 2005, *Pressure Pipe Unit Manufacture Supervision Inspection Regulation*
21	TSG D2001 – 2006, *Pressure Piping Components Manufacture Appraisal Regulation*
22	TSG D2001 – 2006/XG1 – 2010, *Pressure Piping Components Manufacture Appraisal Regulation No. 1 Amendment*