

The Current Situation and Development Countermeasure for China Special Equipment Safety Supervision

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In China, special equipment is classified into eight categories; they are boilers, pressure vessels (including gas cylinders), pressure pipelines, elevators, lifting appliances, passenger ropeways, large amusement devices, and non-road vehicles. After 60 years of development and changes, China's special equipment safety supervision work has made great achievements. From the perspective of special equipment, supervision bodies, inspection agencies, and regulation and standard system, the paper outlines the development course and the current situation of China's special equipment safety supervision. The paper collects and analyses data of the last 10 years, China's special equipment annual increase rate is over 10%, but the accident rate and mortality of every ten thousand units of equipment are equal to or better than that of developed countries. It summarizes China's basic experience and shortages in special equipment safety supervision, and proposes three development countermeasures, namely simplify administrative procedures, delegate powers to lower levels, and strengthen regulating and improve service.

Keywords: special equipment, safety supervision, inspection, regulation, standard

Special equipment, which is widely used in industrial production and people's life, poses potential danger. Some special equipment work under high temperature and high pressure, some contain flammable, explosive, toxic, or harmful medium, and some run at high altitude or high speed. In the event of accident, it is prone to cause fire or explosion, casualty, environmental pollution, economic loss and has very bad social influence. Considering this, countries around the world all attach great importance to its safety and gradually establish a scientific and standardized system to supervise special equipment. As countries around the world differ in development history, cultural background, political system, economic level, and so on, the supervision bodies and supervision measures are different from each other. Some countries put the abovementioned equipment under the responsibility of one department for unified supervision and administration, in some countries, the

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special equipment are scattered and administrated in several departments of the government (Sun, 2013). In China, special equipment is under unified supervision and administration by specialized government bodies.

Development History and Current Situation

Basic Information of Special Equipment

Definition of special equipment. Special equipment has not yet formed a unified concept or reached broad consensus internationally. In China, it is a term referring to boilers, pressure vessels (including gas cylinders), pressure pipelines, elevators, lifting appliances, passenger ropeways, large amusement devices, non-road vehicles, and other equipment which is stipulated by laws or administrative regulations to be subject to the “Special Equipment Safety Law of P.R. China”. Special equipment has potential danger to safety of human lives and properties. Among special equipment, boilers, pressure vessels (including gas cylinders), and pressure pipelines are collectively referred to as pressure equipment; elevators, lifting appliances, passenger ropeways, large amusement devices, and non-road vehicles are classified as electromechanical special equipment. Special equipment usually has the following characteristics: They are sealed, pressure-bearing, composed of mechanical components, and usually they are key components of a continuously operating system (Zhong, Zhang, Luo, & You, 2009). China compiles special equipment directory for its supervision (AQSIQ [General Administration of Quality Supervision, Inspection and Quarantine] Notice on the Revision of the Special Equipment Directory [2014] No. 114).

Data and safety situation of special equipment. With the fast growth of economy and the development of technology, China has become the country with the biggest growth of in-service special equipment in the world. Over the past decade, its annual increase rate is over 10%, as shown in Table 1¹.

Table 1

2005-2015 Quantity of Special Equipment

	Boiler (10k)	Pressure vessel (10k)	Elevator (10k)	Lifting appliance (10k)	Passenger ropeway	Large amusement device (10k)	Non-road vehicles (10k)	Gas cylinder (10k)	Total (10k)
2005	55.38	152.30	65.18	71.03	821	1.59	28.73	12,981	376.30
2006	54.30	158.80	77.14	82.36	836	1.40	27.21	13,086	403.73
2007	53.41	169.71	91.73	95.79	814	1.44	28.58	13,210	443.32
2008	57.82	192.72	115.31	118.28	793	1.47	32.56	13,244	521.11
2009	59.52	214.32	136.99	135.27	850	1.56	34.81	13,239	582.56
2010	60.74	233.60	162.86	150.00	860	1.58	38.79	14,073	647.65
2011	62.03	251.54	201.06	171.74	863	1.64	41.03	13,564	729.15
2012	63.53	271.82	245.33	190.94	845	1.67	48.29	13,881	821.67
2013	64.13	301.12	300.93	213.50	873	1.79	55.36	14,387	936.91
2014	63.89	322.79	359.85	226.26	925	1.92	61.66	14,250	1,036.46
2015	57.92	340.66	425.96	210.44	985	2.04	63.02	13,698	1,100.13

By the end of 2015, the total number of special equipment production units (including design, manufacture, installation, alteration, repair, and gas filling) is 62,706 nationwide, a complete industrial chain has been formed from design, manufacture, inspection, installation, modification to repair, and the annual output is over

¹ The data come from the AQSIQ' official website. Pressure pipeline's data are not included in the statistics. Gas cylinder's data are not included in the total quantity of special equipment.

1.3 trillion yuan. Statistics show that China's special equipment import goes down each passing year, on the other hand, the export increases year by year. China has become the largest producer of heavy pressure vessels such as supercritical power plant boilers and hydrogenation reactors. Its maximum hoisting capacity of bridge crane has reached 22,000 tons, ranking the first in the world. China is the world's largest producer and exporter of non-refillable steel welded cylinders. China also ranks the first in the world for elevator in the aspects of registered installations, annual output, and annual growth rate. Of the annual newly built elevators, the elevator of China made accounted for 70%, in 2014, the registered elevator installations of China accounted for 27% of global share (Song, 2013; Zhang & Zhao, 2015).

By the joint effort of end users, supervision bodies, inspection agencies, research institutions, and the public, the special equipment safety accident rate of China decreases year by year. Special equipment safety situation continues to improve, especially in recent years, it maintains a steady decline trend as shown in Figures 1 and 2². On the global scale, there is still a large gap on the overall special equipment safety condition between China and industrialized countries, but in regards to some special equipment, the accident rate and mortality of every ten thousand units of equipment are equal to or better than that of developed countries.

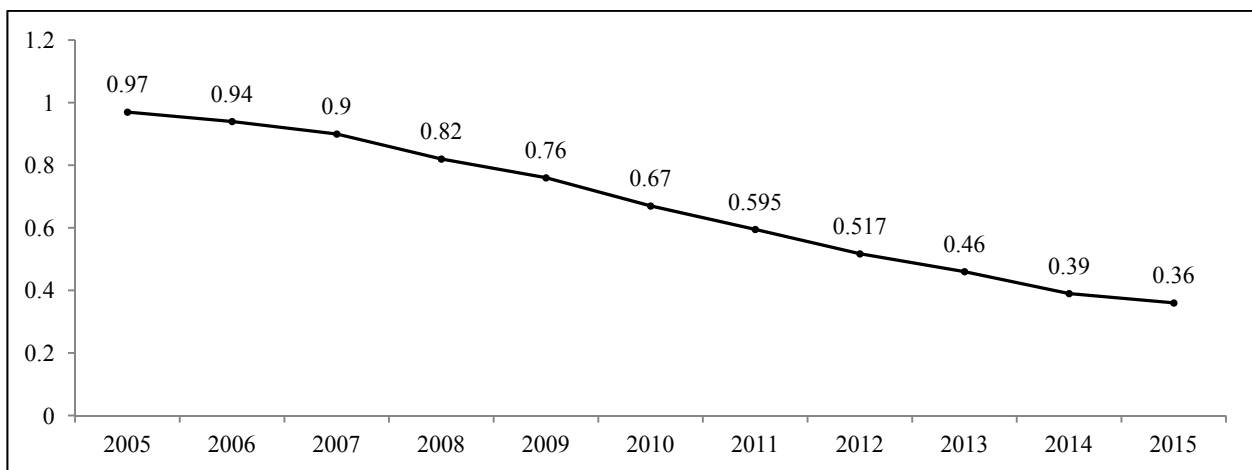


Figure 1. 2005-2015 China special equipment mortality rate (people/10k).

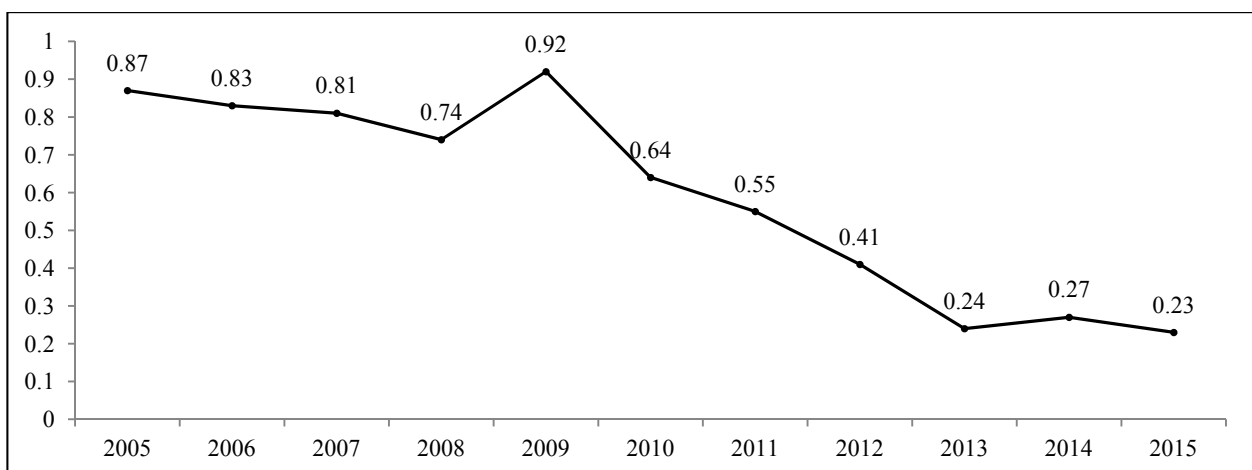


Figure 2. 2005-2015 China special equipment accident rate (case/10k).

² The data come from the AQSIQ' official website.

Development History of Special Equipment Safety Supervision

China's special equipment safety supervision was gradually developed along with major and extraordinarily serious accidents. On April 25, 1955, the state-run Tianjin First Cotton Mill's boiler exploded, eight people were killed and 69 were wounded. In July 1955, referencing the safety supervision pattern of the former Soviet Union, the State Council approved to set up the Boiler Safety Inspection Bureau under the Ministry of Labor to supervise boiler, pressure vessel, hoisting machinery, and other special equipment. Over 60 years of development, China's special equipment safety supervision continues to improve, and according to studies of government bodies, experts, and scholars (Pen, 2009; Nie, 2010; Shi, 2009), it can be summarized into four stages.

The first stage (1955-1982), the exploration period. Influenced by historical conditions, it had not formed a coherent, systematic safety supervision system. During this period, the safety supervision body experienced twice removal and merger, which severely affected the safety supervision work. After 10 years of "cultural revolution", safety accident was frequent. In 1979, every ten thousand units of boiler and pressure vessel accident rate was 7.9, and the safety situation was severe.

The second stage (1982-2003), perfection period. In 1982, the State Council promulgated the "Provisional Regulations on Boiler and Pressure Vessel Safety Supervision", providing regulating basis for the building of China's boiler and pressure vessel safety supervision system. Since reform and opening-up, market economy has been preliminarily established, and the administrative reform unveiled. For special equipment safety, the "double track" system of supervision and inspection was gradually established and perfected. Governmental safety supervision bodies and inspection agencies at different levels across the country were established, and as a result, all kinds of safety accidents saw sharp drop, and special equipment safety supervision work had made substantial progress.

The third stage (2003-2013), development period. In March 2003, the State Council announced the No. 373 Decree "Regulations on Safety Supervision of Special Equipment", laying a solid legal foundation to guarantee the safe operation of special equipment. Special equipment safety supervision formed the working pattern under unified leadership, government bodies supervise in accordance with law and regulations, inspection agencies provide technical checks, enterprises bear overall responsibility, and the public take part in supervision.

The fourth stage (2013-present), reform period. In June 2013, the Standing Committee of the National People's Congress reviewed and approved the "Special Equipment Safety Law", completing the five-level legal structure for special equipment safety supervision, namely, law, regulations, rules, technical codes, and standards. The new supervision mechanism was finally established, which was constituted by government supervision bodies, inspection agencies, and social organizations. Special equipment safety supervision function reform, administrative license reform, and inspection reform continue to make progress, and special equipment inspection agencies integration begin to take shape.

The Current Status of Special Equipment Safety Supervision Work

Special equipment safety supervision mechanism. AQSIQ is the competent government body responsible for special equipment safety supervision. AQSIQ is a ministry directly under the State Council in charge of national quality, metrology, special equipment safety, entry-exit commodity inspection, entry-exit health quarantine, entry-exit animal and plant quarantine, import and export food safety, certification,

accreditation, and standardization. It also has administrative law enforcement duty. AQSIQ sets up 17 internal departments (bureaus) including Special Equipment Safety Supervision Administration Bureau (SESA). In addition, AQSIQ manages two committees, 17 affiliated entities, and 14 industrial associations. It vertically manages 35 entry-exit inspection and quarantine bureaus throughout the country, and leads the provincial Quality and Technical Supervision Bureaus of the whole country as shown in Figure 3.

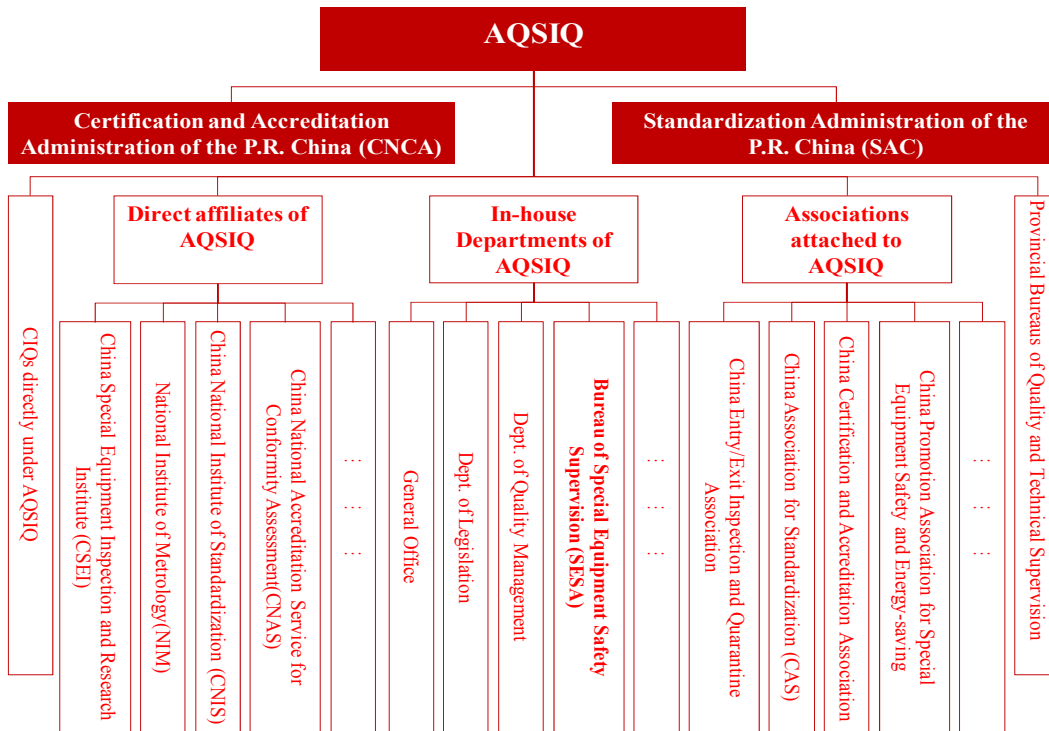


Figure 3. Organizational structure of the AQSIQ.

SESA carries out special equipment safety supervision and administration, and oversees special equipment design, manufacture, installation, alteration, maintenance, use, testing, inspection, import, and export. Within its scope of authority, SESA organizes investigation of special equipment accident and handles statistical analysis. It supervises and manages qualifications of special equipment inspection agencies, inspectors, and operators and monitors the energy saving performance of high energy-consumption special equipment. SESA has seven internal divisions. They are comprehensive division, inspection and information management division, boiler and pressure vessel safety supervision division, pressure pipeline and gas cylinder safety supervision division, elevator and hoisting machinery safety supervision division, special equipment energy saving supervision division, and accident investigation division.

Before the beginning of the reform and opening-up, special equipment safety supervision relied on administrative supervision only. After the reform and opening-up, by referencing the experience of developed countries and based on China’s basic national conditions, the “double track” system of special equipment safety supervision gradually comes into being, safety supervision bodies work side by side with technical inspection agencies and pay equal attention to afterwards treatment and beforehand prevention. With the establishment and perfecting of the market economic system and the deepening of the reform and opening up, special equipment safety supervision changed to “troika” mode, in which supervision bodies, inspection agencies, and

social organizations all play a part as shown in Figure 4. Today, it has formed an overall process safety supervision mechanism which covers eight categories of special equipment and eight phases of the equipment’s life including design, manufacture, installation, alteration, repair, sale, use, and inspection, and the basic tools are the administrative licensing and supervisory inspection as shown in Figure 5.

The Third Plenary Session of the 18th Central Committee of the CPC (Communist Party of China) proposed to comprehensively deepen reform, build a new pattern for special equipment safety supervision that bears Chinese characteristics, and advance the modernization of governance.

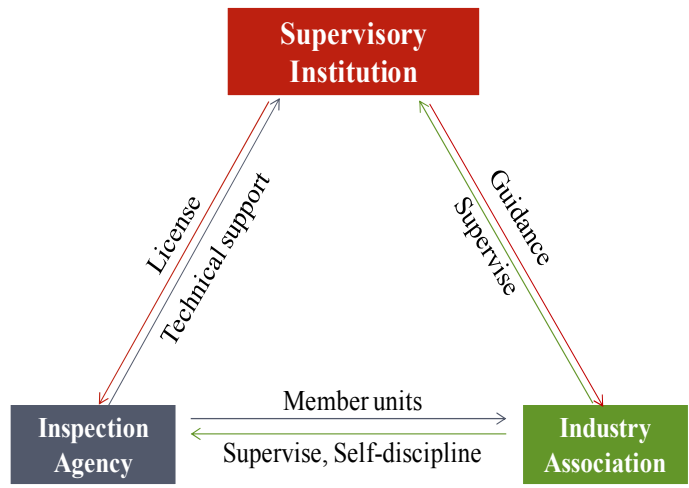


Figure 4. China special equipment safety supervision system.

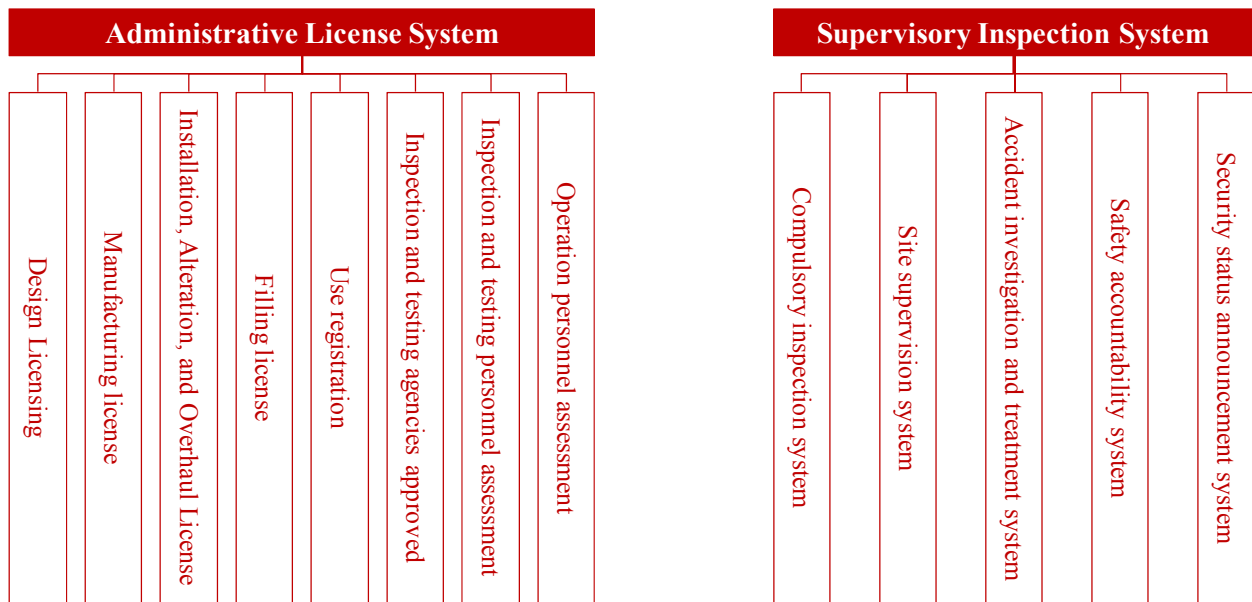


Figure 5. Fundamental system of safety supervision of special equipment in China.

Special equipment supervision bodies and inspection agencies. China has established special equipment safety supervision bodies at country level, province level, city level, and county level. By the end of 2015, there are 2,550 special equipment safety supervision bodies, including one national body, 32 provincial bodies, 469 municipal bodies, and 2,048 prefectural bodies; the total number of special equipment safety

supervisors throughout the country is 23,648. The relationship between supervision bodies and inspection agencies is shown in Figure 6.

Inspection belongs to the high technology service industry, and it provides technical support for special equipment safety supervision. Special equipment inspection bodies are mainly composed of two groups: One is the government affiliated inspection agencies; the other includes enterprise owner-user inspection organizations, industry inspection organizations, and other social forces. By the end of 2015, there are a total of 485 comprehensive special equipment inspection bodies, of which 295 are government affiliated inspection agencies, 190 are industry inspection organizations and owner-user inspection organizations.

Regulation and standard system. In China, special equipment legislation and standard system includes five levels: law, regulations, rules, safety technical codes, and standards (Song, Shi, & Xie, 2005). The special equipment legislation system includes one law, one administrative regulation, 10 rules, 121 safety technical codes, and over 2,000 standards (Qi, 2014; Qi, Qian, Shi, & Zhang, 2014). The “Special Equipment Safety Law” is the fundamental law, regulations and rules are refinement of the law, and safety technical codes are mandatory technical regulations. Standards are classified as national standards and local standards, industry standards and enterprise standards. National standards and industry standards are further divided as mandatory or voluntary standards. The legal status of mandatory national and industry standards is almost equivalent to that of safety technical codes, all being issued by competent government departments in the form of notice. Mandatory national and industry standards focus on the technical specification and its implementation method, and safety technical codes focus on the basic safety requirements and management measures. At present, China is promoting the integration of safety technical codes and the development of standardization. Hundreds of safety technical codes are planned to be integrated into dozens of comprehensive safety technical codes, mandatory standards of special equipment will be phased out. To be in line with international practice, China encourages the development of social organization standards.

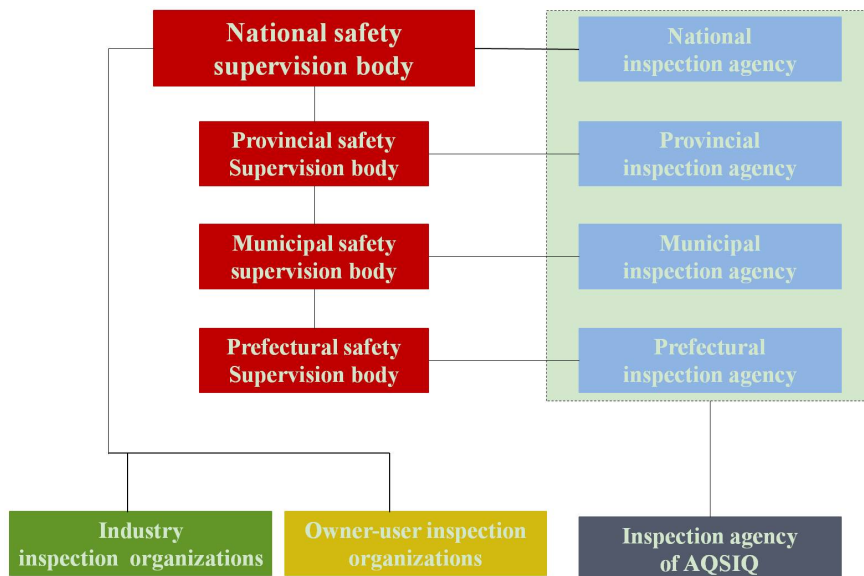


Figure 6. China special equipment safety supervision bodies and inspection agency relationship³.

³ National special equipment safety supervision body qualifies and approves inspection agencies at various levels; local safety supervision body supervises inspection agencies within its jurisdiction.

Experience Summary and Problem Analysis

Basic Experience

China has applied safety supervision to special equipment for over 60 years, referencing the mature experience of developed countries, and by using the accident causation theory and the system safety theory, China established the basic supervision mechanism which includes administrative licensing and supervisory inspection and perfected the whole process safety supervision system. The following five basic experiences can be summarized after reviewing the development course of special equipment safety supervision.

The unified leadership of the government provides guarantee. Every year, the State Council issues special equipment accident control targets to provincial governments. Governments at all levels supervise and notify major potential safety hazard. In-service industrial boiler energy efficiency testing, as one of the energy-saving responsibility evaluation element, has been incorporated into the performance assessment system of the government. Special equipment safety supervision bodies' functions have been unified; the procedures, time limit, and requirements of special equipment administrative licensing and supervisory inspection have been clearly defined (Tao, Shen, Yu, & Li, 2015). The unified leadership of the government has laid a solid foundation for the development of special equipment safety supervision and energy saving.

The overall process supervision and classified supervision continue to improve and play fundamental function. Whole process safety supervision to special equipment is an effective measure to control accidents and reduce safety risk. This measure conforms to China's national conditions and the basic law of safety. On the basis of risk analysis, China applies classified supervision to equipment, entities, and areas. Critical equipment field is the focal point for supervision. Supervision differentiations are applied to different entities according to actual local conditions. Different supervision measures have been deployed for different areas. Thus the allocation of resources is optimized and has received good results.

Supervision and inspection work together to improve effectiveness. Setting up special equipment safety supervision bodies parallel with inspection agencies at the same jurisdictional level improves the organizational construction. Inspection agencies are technical supporting organizations, and they shall perform inspections in accordance with law. Supervision bodies and inspection agencies work independently while closely with each other, bringing respective advantages into full play to produce synergy effect.

Science and technology research provide support for safety supervision. Special equipment science and technology development is mainly led by government affiliated special equipment inspection agencies, and jointly undertaken by end users, research institutions, institutions of higher learning, and social inspection and testing institutions. During China's 12th Five-Year-Plan period, led by China Special Equipment Inspection and Research Institute, the special equipment inspection industry undertook altogether 245 scientific research projects of various kinds with total investment of 301 million yuan, tackled nearly 300 key technologies, and won the national science and technology progress prize twice. Special equipment safety inspection and evaluation innovation team has been awarded as one of the national key innovative teams. China special equipment safety and energy saving technology demand framework for the 12th Five-Year-Plan is as shown in Figure 7.

Build the multi-party cooperation management mechanism to create a good working atmosphere. For special equipment safety supervision, the establishment of multi-party cooperation management mechanism of "unified leadership, enterprises undertake overall responsibility, joint supervision by different government

departments, inspections provide technical support, and extensive social participation” plays a positive role in encouraging the whole society to take part in safety supervision.

The Existing Main Problems

With the rapid development of economy, China’s special equipment safety work has achieved remarkable achievement, but compared with the developed industrial countries, accident rate is still high, major and extraordinary accidents still occur, and the safety situation is still grim. Under the economic development of the new normal, special equipment safety supervision work still has some deep-seated contradictions and obvious problems. Government supervision effectiveness needs to be improved, market mechanism does not play its role well, the social credit system is not sound, and the social safety awareness is not enough.

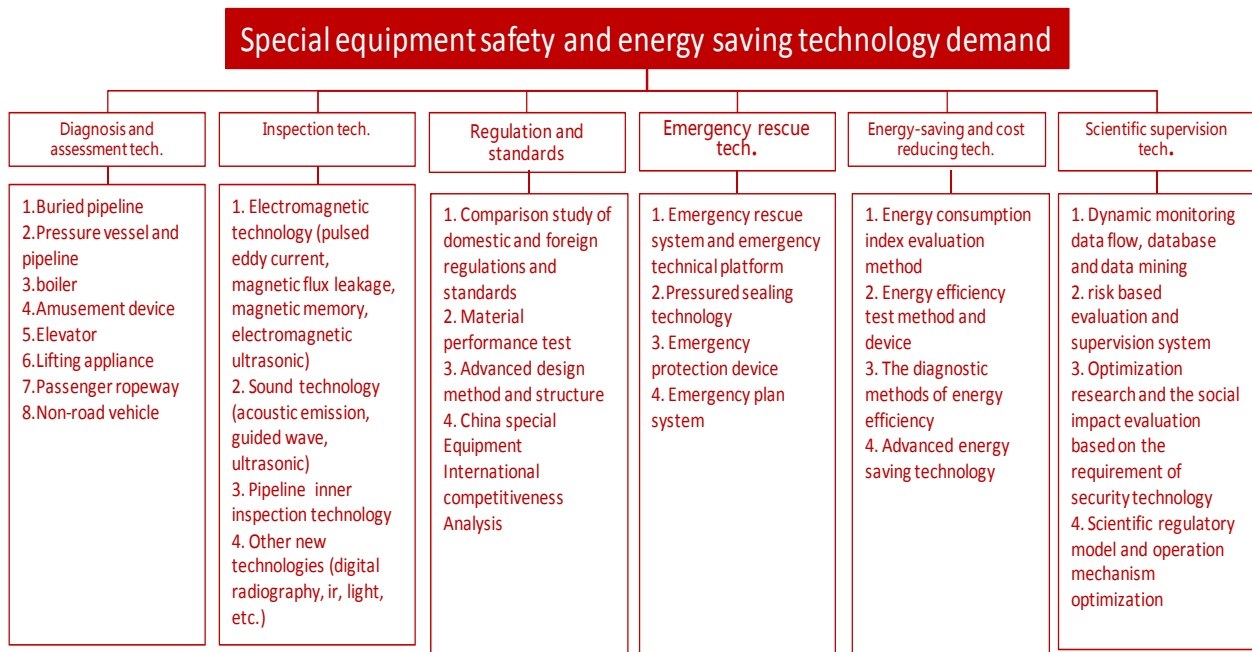


Figure 7. China special equipment safety and energy saving technology demand framework.

Conclusions and Recommendations

In May 2016, the State Council issued a notice of key work points for 2016 (State Council Notice [2016] No. 30), which clearly defines work plans to further streamline administration, strengthen regulating, and improve service. SESA formulated and published the “Top-level Design for Special Equipment Safety Supervision Reform”, which points out the direction for the present and the future work of special equipment safety supervision (Song, 2016). In the next period, special equipment safety supervision reform should pay special attention to the following three aspects:

Decentralization, Promote the Administrative Licensing Reform and Inspection Reform

According to the safety risk level and publicity degree of the equipment, considering its type and life stage to promote the administrative licensing reform, as shown in Figure 8. According to the inspection’s nature and type to promote inspection reform, reasonably adjust its content, interval, and charge. Towards the direction of public welfare, define the role and function of government affiliated special equipment inspection agencies, scientifically differentiate their existing business and optimize their responsibility allocation, structure, and

staffing to establish a new mechanism that separates the quasi-governmental institutions' function with that of enterprises', each with clearly defined functions, and each performs its function for the coordinated development. Promote the establishment and development of special equipment inspection groups; actively explore the new path of nonprofit organization for the healthy and sustainable development of special equipment inspection. Please refer to Figure 9 for the reform direction of government affiliated special equipment inspection agencies.

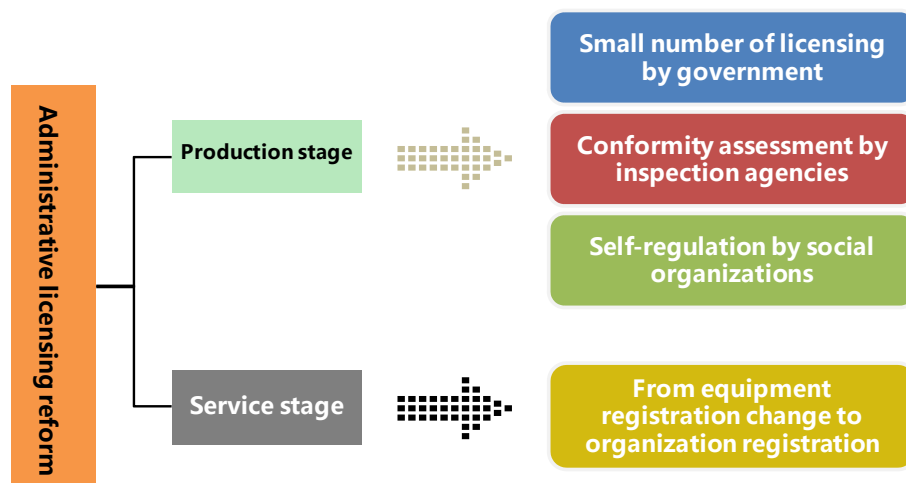


Figure 8. The reform direction for special equipment administrative licensing.

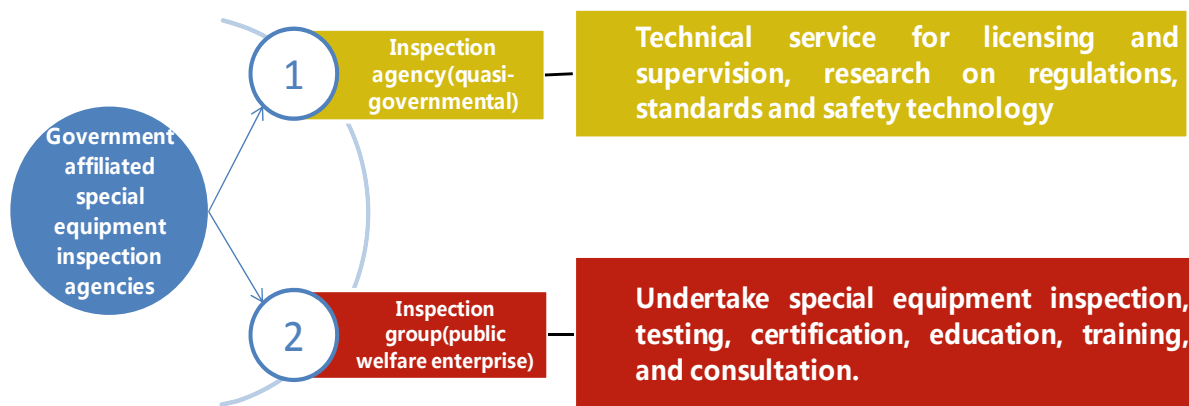


Figure 9. The reform direction of government affiliated special equipment inspection agencies.

Strengthen Regulating to Improve Safety Supervision Efficiency

Further consummate the legislation system: quickly develop and revise relevant regulations and safety technical codes, expedite the process of safety technical codes integration, solve the coordinating problem between the mandatory standards and safety technical codes, support and promote the construction of special equipment social organization standards, promote international exchanges and mutual recognition of standards. Further implement the policy that enterprise undertakes main responsibility, establish and perfect the enterprise credit incentive and disciplinary mechanism. Urge enterprises to establish and improve the practice of hazard self-inspection, self-rectification, and spontaneous reporting, concentrate on the management of hidden dangers in critical equipment fields, and promote safety liability insurance through pilot projects.

Improve Service, Build Public Service Platform

Establish special equipment data reporting system and construct unified national information service platform to realize the traceability of quality and safety information of special equipment during its whole life cycle, and to promote the opening of important public safety related information to the public. Vigorously support the development of social organizations, and recognize industry association's appraisal results. Increase the service purchasing intensity of government and promote industry associations' self-discipline, publicity, consultation, education, training, technical appraisal, and other services.

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