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Work safety in China's Thirteenth Five-Year Plan period (2016-2020): Current status, new challenges and future tasks

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ABSTRACT

The problem of work safety greatly affects many parts of the world, especially developing countries such as China. The release of the Thirteenth Five-Year Guideline for National Economic and Social Development in March 2016 marked the beginning of China's Thirteenth Five-Year Plan (13th FYP) period (2016–2020). Work safety continues to be a national priority. Since the release, a newly important work safety policy, namely the 13th FYP for Work Safety has been announced on February 3, 2017 in accordance with the Thirteenth Five-Year Guideline for National Economic and Social Development. What is the current status, what are new challenges and future tasks of work safety during China's 13th FYP period? The two key objectives of this paper are: (1) to analyze the current status of work safety in China, and (2) to introduce the new challenges and future tasks during China's 13th FYP period briefly. Firstly, a statistical analysis of accidents and occupational diseases in recent years in China was carried out, and a brief introduction to safety management on the national level in China has been given to analyze the work safety status in the whole of China. Secondly, combining with the demand for economic and social development in China, and according to the suggestions in the 13th FYP for Work Safety and the current status of work safety in China, the new challenges and future tasks of work safety during China's 13th FYP period are also introduced. This study can promote the cooperation and exchange of knowledge on work safety between China and other countries to provide evidence-based services for work safety.

Keywords: work safety; current status; new challenges; future tasks; Thirteenth Five-Year Plan (13th FYP); China

1. Introduction

Accidents not only cause serious human and financial losses, but also result in an extremely bad influence on society. Hence, the sustainable, rapid and healthy development of the national economy and of social stability is facing, as one of its critical problems, safety (Zhong et al., 2004; Liu et al., 2005). Safety is also an important symbol of social civilization and progress (Liu et al., 2005). Moreover, it is one of the basic policies in China. Considering that safety problems are complicated and the people's need for safety is continuously increasing, locating an effective safety solution is essential and urgent. At present, many countries around the world are taking various strategies and measures (e.g. scientific research, technology, legislation, administration, education and economy) to gradually reduce their nation's accidents and fatalities.

Although China is a developing country, it has already become one of the largest global producers and the world's most populous country (Rowley, 2012). However, it is also one of the most accident-influenced countries in the world because of the frequency of the occurrence of accidents. Several policies have been implemented to address issues related to safety, including mine safety, construction safety, chemical safety, traffic safety, etc. (SAWS, 2016a). Unfortunately, accidents are still very much present in China threatening people's lives, economic development and social stability (SAWS, 2016a; General Office of the State Council of PRC, 2017). Even with steady safety improvements in recent years, tens of thousands of people are still killed in accidents each year in China (SAWS, 2016b), many times the corresponding fatalities in developed countries, such as the United States and the European countries. China thus has an urgent need to strengthen the capacity to guarantee work safety.

On March 16, 2016, the Thirteenth Five-Year Guideline for National Economic and Social Development was approved at the annual meeting of the National People's Congress of PRC, marking the beginning of the Thirteenth Five-Year Plan (13th FYP) period (2016–2020). Work safety continues to be a national priority. On February 3, 2017, an important government document detailing new work safety targets and programs, namely the 13th FYP for Work Safety was drafted by the General Office of the State Council of PRC in accordance with the Thirteenth Five-Year Guideline for National Economic and Social Development. Moreover, the document 'Several Opinions of the Central Committee of the Communist Party of China and the State Council of PRC on Accelerating the Reform and Development of Work Safety' (State Council of PRC, 2016) was issued in December 2016, which is a milestone in China's work safety history because it is the first programmatic document for work safety issued directly by the Central Committee of the Communist Party of China and the State Council of PRC since the establishment of PRC in 1949. What are the new challenges and future tasks of work safety in China's 13th FYP period? To answer this question, we

conducted a systematic review of the new safety targets and programs. However, it is necessary first to analyze the current work safety situation in China. We limited our search to the national level, where the majority of work safety policies, laws and regulations are formulated. However, we acknowledge that provincial and municipal programs also play a role in work safety. Obviously, this study can promote the cooperation and exchange of knowledge on work safety between China and other countries to provide evidence-based services for work safety (Wang et al., 2017).

2. Analysis of the current work safety status in China

2.1 Statistical analysis of accidents

This section provides an overview of the accident situation in the whole of China. The statistical data for this section comes from a number of sources. Data about China's accidents originates from the SAWS, the [China Work Safety Yearbooks \(2004–2014\)](#) and the State Statistics Bureau of China; and data about the total gross domestic product (GDP) comes from the [China Statistical Yearbooks \(1990–2015\)](#). In this sort of research work, researchers (Liu et al., 2005; Wu et al., 2009) almost always choose the above-mentioned organizations or publications as their data sources.

According to Article 14 of 'Work-related Injury Insurance Regulations' (State Council of PRC, 2010), work-related or, in other words, occupational injury of workers is recognized in the following cases:

- Injured in an accident at work during working hours in the workplace.
- Injured in an accident while engaging in preparatory or finishing-up work related to work before or after working hours in the workplace.
- Injured by violence or in other accidents in one's performance of job duties during working hours in the workplace.
- Suffering from an occupational disease.
- Injured at work in an accident during work-related travel where one's whereabouts are unknown.
- Injured by automobile on the way to and from work.
- Other cases justified by laws and regulations.

Article 15 of the insurance regulations has provided additional items:

- Dead immediately or within 48 hours after emergency treatment for a disease suddenly arising during working hours in the workplace.
- Injured in an act to protect national interests or public interests such as emergency rescue and disaster relief.
- Injured and disabled in war or on duty while in military service and has obtained a revolutionary injured and disabled soldier certificate, but suffers from a relapse of the old injury while being employed by the employer.

In China, an accident is defined as an unexpected and untoward event that causes casualties or economic losses in production and business operation activities (State Council of PRC, 2007; SCNPC, 2014). According to Article 3 of the 'Byelaw Governing Reporting, Investigation and Handling of Accidents' (State Council of PRC, 2007), accidents shall in general be divided into the following levels in terms of bodily injuries and deaths or direct economic losses resulting from the accident: all categories include acute industrial poisoning resulting in serious injury.

- Particularly serious accident: refers to an accident that has resulted in over 30 cases of death or over 100 cases of serious injury or over 100 million RMB (Renminbi) direct economic losses.
- Major accident: refers to an accident that has caused over 10 but below 30 cases of death, or over 50 but below 100 cases of serious injury, or direct economic losses amounting to over 50 million but below 100 million RMB.
- Serious accident: refers to an accident that has resulted in over 3 but below 10 cases of death, or over 10 but below 50 cases of serious injury, or direct economic losses over 10 million but below 50 million RMB
- Ordinary accident: refers to an accident that has resulted in below 3 cases of death, or below 10 cases of serious injury, or direct economic losses of below 10 million RMB.

"Over" as used in this article describes a category that includes the cited number and "below" does not include the cited number. We realized that these definitions do not correspond at all to the Western notion of incident/accident. However, these are the official definitions used in China. This may reflect the very large number of fatalities occurring each year in China and perhaps the desire on the part of the authorities to lower the figures in the serious accident category by using this high definition. Obviously, the grading standard for an accident in China is faced with a problem of being in conformity with the international standard.

In China, serious injury can be identified by the 'Standard for the Identification of Human Body Injury Degree' (Ministry of Public Security of PRC et al., 2013). According to its Article 2, serious injury refers to any of the following:

1. injuries resulting in a person's disability or disfigurement;
2. injuries resulting in a person's loss of his hearing, sight or the function of any organ; or
3. other injuries that cause grave harm to a person's physical health.

According to the 'Statistical Reporting System of Accidents' (SAWS, 2014a), an accident has to be reported if it has resulted in one case of death or more, or one case of serious injury or more, or direct economic losses of one million RMB or more. Fatalities are counted if they occur within 30 days after the accident, except for fatalities in road accidents and fire accidents which are counted if they occur within 7 days after occurrence. The statistical analysis of

accidents in this study is based on reportable accidents. Although the ‘Production Safety Law of PRC’ (SCNPC, 2002; SCNPC, 2014) and the ‘Statistical Reporting System of Accidents’ (SAWS, 2014a) make strict requirements for accident-reporting and prescribe legal penalties for under-reporting, there are still accidents that have not been reported for various reasons, such as the lack of safety supervision, avoiding the severe punishment for accidents, reducing the impact of accidents on the local governments’ and personal achievements, as well as the enterprise reputation (Yuan et al., 2014). To reduce and avoid the under-reporting, China should adopt a series of practical measures, thereby improving the safety punishment mechanism and the safety regulatory environment (Yuan et al., 2014). Obviously, this under-reporting has a negative influence on the accuracy of the statistical analysis of accidents.

Obviously, the number of fatalities and the number of accidents are two important dimensions of the safety record of a country. Fig. 1 shows the evolution of the number of accidents and fatalities in China in each year between 2001 and 2015. During this period, a temporary increase in the number of accidents and fatalities emerged in 2001–2002 and peaked in 2002, and then the curves display a substantial concavity. In 2015, the number of fatalities in accidents was 66,182, and the number of accidents was 274,911, a drop of 72.57% and 49.28% respectively compared to 2001. Meanwhile, in 2001–2003 and 2011–2015, the figures indicate that there are more accidents than fatalities, which means that most accidents involve multiple serious injuries and no fatalities during these two periods. Although this is still a very high figure, the figure shows a steadily decreasing trend, but a slight tendency to flatten out in the last 10 years. Fig. 2 shows the evolution of the death rates in China between 2005 and 2015 per 10^5 workers (a common index for industrial accidents in China), death rate per 10^6 tons of coal produced (an index for coal mine accidents in China) and death rate per 10^4 vehicles in road traffic (an index for road traffic accidents in China). According to Fig. 2, these three indexes were declining year after year from 2005 to 2015. Fig. 1 and Fig. 2 show that the situation of work safety in China has become relatively more stable in recent years.

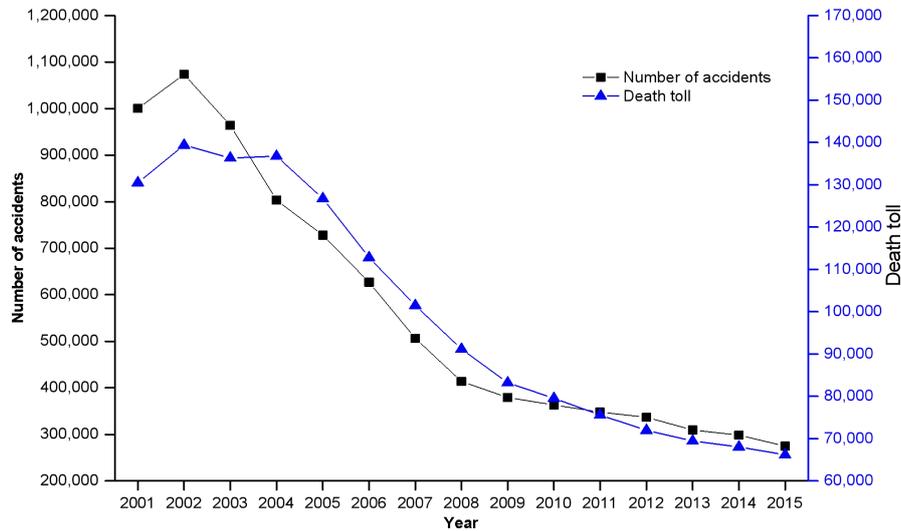


Fig. 1. Annual number of various accidents and death toll in China.

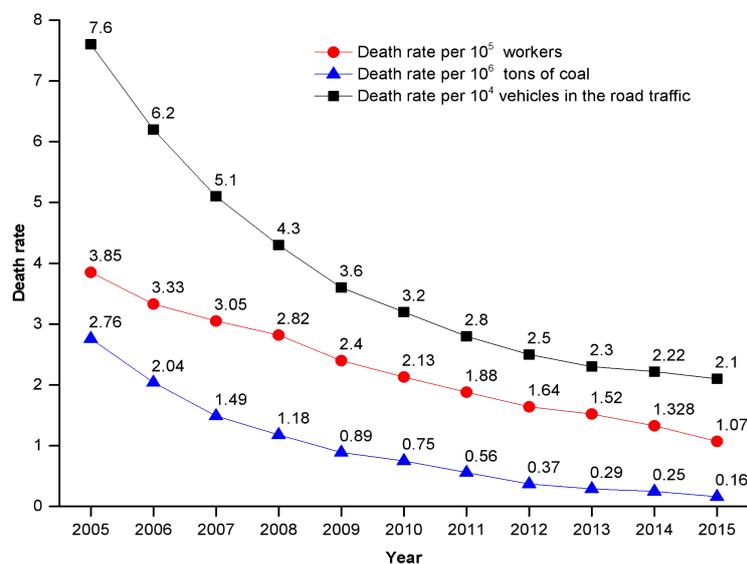


Fig. 2. China annual death rate per 10^5 workers, death rate per 10^6 tons of coal and death rate per 10^4 vehicles in the road traffic. Source: State Administration of Work Safety (SAWS).

Notes: In the calculation of China's death rate per 10^5 workers, the data of deaths is confined to the industrial, mining and commercial enterprises, excluding the primary and tertiary industries, but the data of workers employed includes all industries. It is released by the SAWS.

Since both GDP and fatality data exist in China, the Chinese government often uses a computed index, death rate per 10^9 RMB of GDP. The evolution of that index between 1990 and 2015 is displayed in Fig. 3. Alongside the increase of the GDP, a decreasing trend of death rate per 10^9 RMB of GDP is clear in Fig. 3, from 3.93 in 1990 to 0.10 in 2015. There is a plateau in 1997-2002 because the GDP and fatalities were basically unchanged, which is determined by the relatively stable economic structure in this period (Wu et al., 2009). A dramatical decrease emerged in 2002–2003 since the ‘Production Safety Law of PRC’ (SCNPC, 2002) was promulgated and implemented in 2002. The tremendous safety success in that level could be reflecting the effect of safety initiatives and better safety supervision by the Chinese government to reduce the likelihood of accidents. These include laws, such as the before-mentioned ‘Production Safety Law of PRC’ (SCNPC, 2002; SCNPC, 2014), the ‘Law of PRC on Prevention and Control of Occupational Diseases’ (SCNPC, 2001; SCNPC, 2016), the ‘Road Traffic Safety Law of PRC’ (SCNPC, 2003; SCNPC, 2011) and the ‘Emergency Response Law of PRC’ (SCNPC, 2007). They include explicit policies, such as “implementing the system of affixing responsibilities to accidents”, “establishing and perfecting the system of responsibility related to work safety”, “improving the high-risk industry admittance standard”, “implementing work safety standardization”, “punishing or closing enterprises violating the safety laws”, “promoting technology development”, “guiding and promoting the development of safety culture”, “closing small-scale mines” and “consolidate unqualified safety condition mines” (SAWS, 2010a; SAWS, 2011a; SAWS, 2013a; SAWS, 2015a; SAWS, 2016a; Yin et al, 2017) and regulations (Table 1 shows some representative work safety regulations of China since 2010.). Unfortunately, both the death rate per 10^6 tons and the death rate per 10^9 RMB of GDP are not necessarily evidence of improved safety. Specifically, the death rate of miners per 10^6 tons of coal has dropped. At the same time the mechanization of Chinese coal mines has increased so that productivity of miners has increased. If safety remained unchanged but production increased, this would result in the observed drop in fatalities per 10^6 tons. There is a similar problem with the fatality rate per 10^9 RMB of GDP. Fig. 3 shows that GDP has increased dramatically in China in recent years so of course fatality rate per 10^9 RMB of GDP will drop even though there may be no change in underlying safety. The problem is that China is using an indicator that is unable to timely reflect safety performance. We therefore suggest that the Chinese government should use a more reliable indicator. For example, the indicator that would be preferred in the West would be fatalities per million man-hours worked.

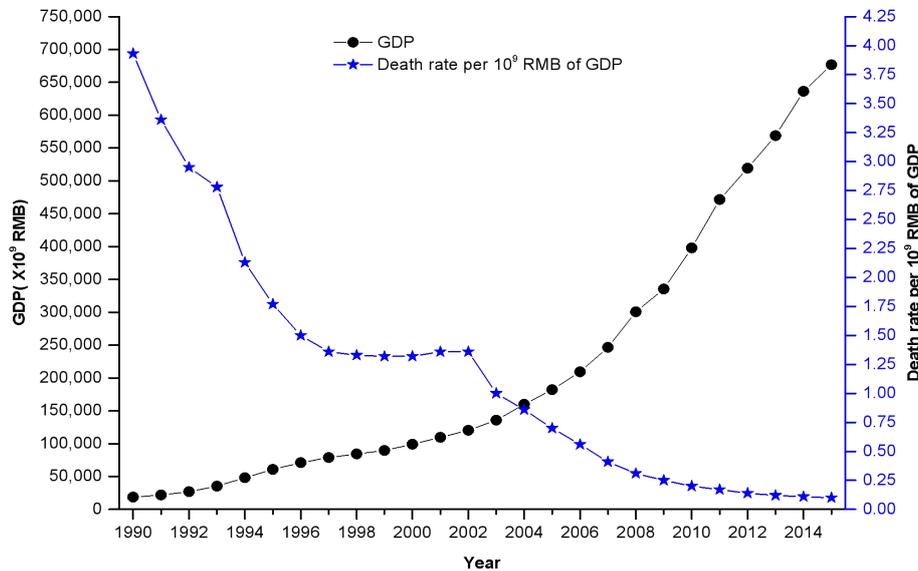


Fig. 3. China annual GDP and death rate per 10^9 RMB of GDP in latest 25 years.

Table 1.

Some representative work safety regulations of China since 2010. Source: State Administration of Work Safety (SAWS) and State Administration of Coal Mine Safety (SACMS).

Regulation	Description
Basic Norms for Work Safety Standardization of Enterprises	To make the safety conditions of enterprises meet the requirements of safety laws, regulations, standards and rules by establishing safety management systems and rules for enterprises, and carrying out the investigation and control of potential dangers of enterprises etc..
Six Risk-informed Regulations for Enterprise	To strengthen the enterprise's risk information by making six risk-informed regulations for enterprises, such as setting up risk-informed boards at the conspicuous places of enterprises and marking operation hints and safety requirements on the operation

	position.
Regulations for the Implementation of Enterprise's Responsibility for Safety	To strengthen and perfect the enterprise's responsibility for safety by six regulations, such as implementing reporting system for work safety and ensuring an adequate safety investment by the enterprises.
Guidelines for Enterprises to Develop Emergency Response plan for Work Accidents	To provide guidelines for enterprises to develop emergency response plan for work accidents.
Eight Work Safety Regulations for Labor-intensive Enterprise	To put forward eight work safety regulations relating to the key safety problems in labor-intensive enterprises, such as ensuring industrial workshops are in accord with the safety standards and design codes, and providing the necessary emergency and rescue facilities.
Ten Work Safety Regulations for Non-coal mine	To propose specific work safety requirements for metal and non-metal mines, tailings dams, as well as oil and gas exploitation enterprises.
Ten Work Safety Regulations for Chemical Enterprise	To propose ten work safety regulations relating to the main safety issues in chemical enterprises for the prevention and control of chemical accidents.
Ten Work Safety Regulations for Firework and Firecracker Enterprise	To establish ten work safety regulations for firework and firecracker enterprises, such as forbidding the use of chlorate and prohibiting unrelated persons from entering into the factory premises.
Coal Mine Safety Regulations	To provide the overall requirements for coal mine safety.

Although the total fatality for accidents in China has significantly decreased in recent years, if we calculate an index of death rate per accident (the death toll/the number of accidents) for the years 2001 to 2015 (see Fig. 4), we can show that there has been an ongoing increase in the death rate per accident between 2001–2015 apart from a temporary and slow decrease in 2008–2012. This trend shows that currently fatal and serious accidents resulting in huge economic losses and fatalities are still frequent in China and perhaps that the current safety policies are having more success in preventing less serious accidents than multiple fatalities. Table 2 lists some of the representative industrial accidents each causing more than 60 deaths in China from 2005 to 2016. This shows that there is still much room for improvement in the current safety situation in China. The high death rate per accident is becoming more and more unacceptable for the country and shows that the Chinese government must adopt reasonable and effective measures and technologies to prevent and control major accidents. The main characteristics of major accidents in China in the past decade are as follows (SAWS, 2016c):

- The major accidents cover seven main locations: mine accidents, road traffic accidents, construction accidents, hazardous chemical accidents, fire accidents and water traffic accidents. Of these, road traffic accidents and coal mine accidents make up the largest percentage (over 60%) in the major accidents each year.
- Gas explosion and water inrush account for more than 80% of the total major coal mine accidents. Major road traffic accidents involving sightseeing buses and other buses account for over 76% of the total major road traffic accidents. Major accidents happen frequently in the process of transportation and storage of hazardous chemicals, in mines, in the process of lifting operations on construction sites, in labor-intensive enterprises and in densely populated areas. Extreme weather events were also important reasons for major accidents.
- In recent years, the accident risks have grown gradually with the rapid expansion of the scale of cities and the excessive concentration of their populations. Also, less predictably some major accidents have occurred in organizations such as meat-processing enterprises and the nursing homes with a low accident risk previously.
- Currently, there are 2,390 coal mines with high gas, or coal and gas outburst hazards; 9,799 major hazards (such as large oil and gas tanks) in the chemical industry, and 939 large tailing dams in China. Obviously, the above-mentioned major accident hazards, particularly those in densely populated areas could cause major accidents.

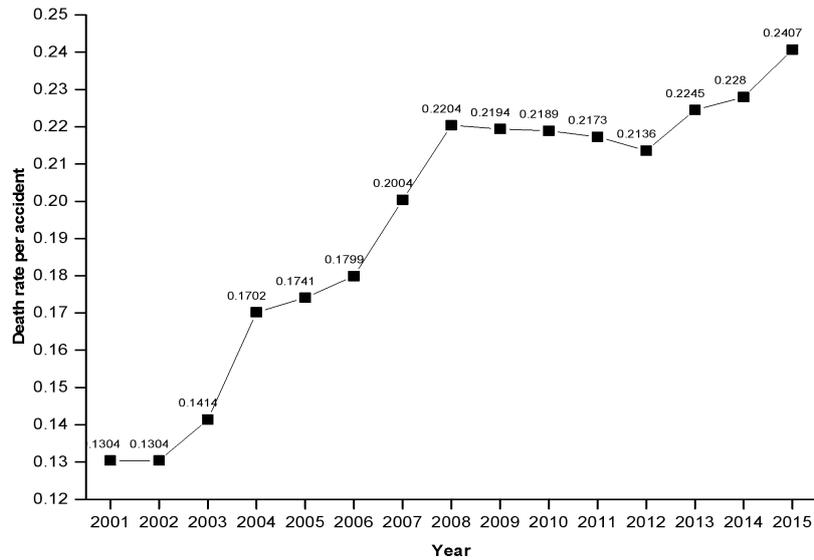


Fig. 4. China annual death rate per accident 2001–2015.

Table 2.

Industrial accidents each resulting in more than 60 deaths in China after 2005. Source: State Administration of Work Safety (SAWS).

Date	Province/municipality	Location/ enterprise	Accident types	Deaths	Direct property losses ($\times 10^4$ RMB)
14/2/2005	Liaoning	Sunjiawan mine	Gas explosion	214	4,968.90
19/3/2005	Shanxi	Xishui mine	Gas explosion	72	2012.50
11/7/2005	Xinjiang	Shenlong mine	Gas explosion	83	3,517.00
7/8/2005	Guangdong	Daxing mine	Water inrush	121	4,725.00
7/12/2005	Hebei	Hengyuan mine	Gas explosion	108	4,870.67
27/11/2005	Heilongjiang	Dongfeng mine	Gas explosion	169	4,293.00
17/8/2007	Shandong	Huayuan mine	Water inrush	172	—
5/12/2007	Shanxi	Ruizhiyuan mine	Gas explosion	105	4,275.08
8/9/2008	Shanxi	Xinta mine	Tailings dam failure	277	9,619.20
8/9/2009	Henan	Xinhua No.4 mine	Gas explosion	76	3,986.40
22/2/2009	Shanxi	Dunlan mine	Gas explosion	78	2,386.94
21/11/2009	Heilongjiang	Xingxing mine	Gas explosion	108	5,614.65
3/6/2013	Jilin	Baoyuanfeng poultry	Fire	121	18,200.00
22/11/2013	Shandong	Pipeline Transportation and Storage Company, SINOPEC	Oil pipeline explosion	62	750,000.00
2/8/2014	Jiangsu	Zhongrong metal products	Dust explosion	97	35,100.00
12/8/2015	Tianjin	Tianjin port	Fire and explosion	165	686,600.00
24/11/2016	Jiangxi	Fengcheng power plant	Building collapse	74	—

In recent years, road traffic accidents are among the leading causes of deaths and injuries of various levels, followed by industrial accidents in China. For example, among the accidents occurring in 2014, road traffic ones take up 85.98% of the total deaths as shown in Fig. 5. All others together total 14.02%.

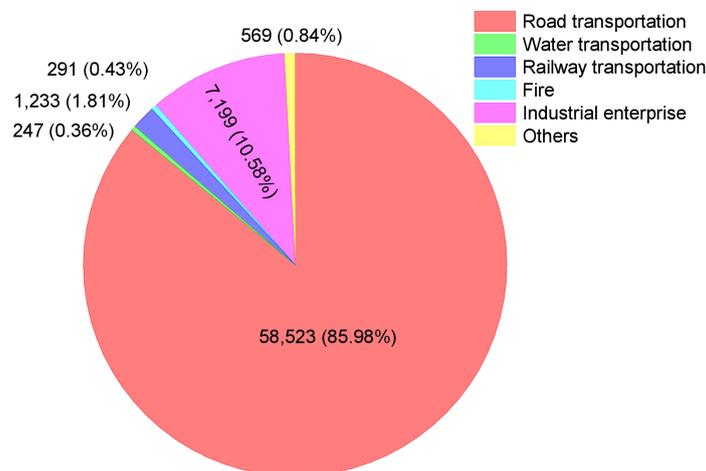


Fig. 5. Distribution of fatalities of China's various accidents in 2014.

As shown in Fig. 5, 10.58% of China's various accidents in 2014 are industrial accidents. In China, the frequent occurrence of industrial accidents has affected the normal production of enterprises, and threatened the safety of workers, as shown in Fig. 6, which compares accident rates in a range of countries. China's death toll of industrial accidents ranks the first in the world. This comparison shows that the casualties from industrial accidents in China are heavier, and thus societally more uncomfortable, and hence China must adopt all kinds of reasonable measures and technologies to prevent and control industrial accidents. This should not, however, conceal the fact that there is a great difference between China's data and those of other countries. For example, in the calculation of China's death rate per 10^5 workers, the data of deaths is restricted to industrial, mining and commercial enterprises, excluding the primary and tertiary industries, whilst the data of workers employed include all industries. Therefore, great care must be exercised in using the data for comparisons. Hence these are not pursued further in this paper.

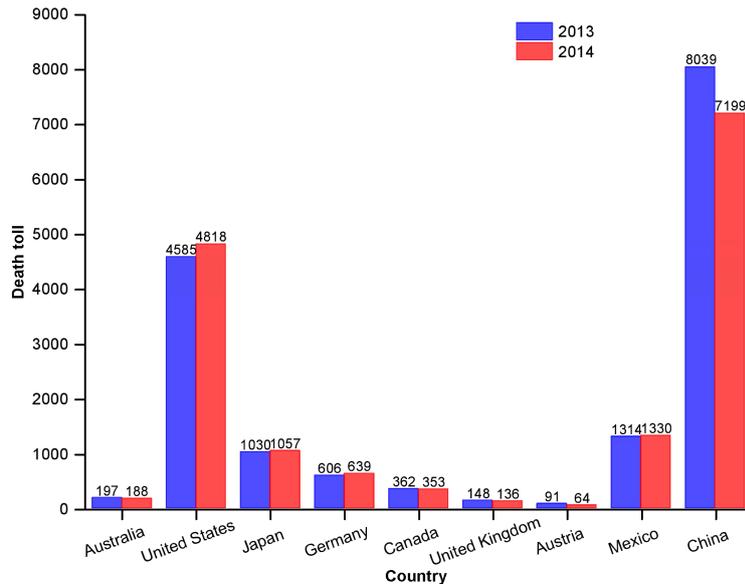


Fig. 6. Comparison of death tolls of industrial accidents between China and some other countries in 2013 and 2014. Source: [International Labour Organization \(ILO\)](#) and [State Administration of Work Safety \(SAWS\)](#).

Notes: In the calculation of China's death rate per 10^5 workers, the data of deaths is restricted to industrial, mining and commercial enterprises, excluding the primary and tertiary industries, whilst the data of workers employed includes all industries. It is released by the SAWS.

The SAWS (2014a) classifies industrial accidents into six categories, namely:

1. coal mine accidents,
2. other metal and non-metal mine accidents,
3. construction accidents,
4. chemical accidents (in enterprises producing, storing, marketing and/or using chemicals),
5. firework and firecracker accidents (in enterprises producing, storing or marketing them) and
6. other accidents in industrial and commercial enterprises (the rest of the production-related accidents).

In China, industrial accidents mainly occur in such high-risk industries as construction, coal mining and metal and non-metal mining. Taking the year 2014 as example, the total number of industrial accidents was 5,774, and the number of fatalities was 7,199, the highest percentage of both accidents and fatalities are found in construction (30.93% and 30.52% respectively). This is followed by metal and non-metal mining and coal mining (see Fig. 7 and Fig. 8). However, about a decade ago, coal mine accidents took up the largest percentage in industrial accidents, followed by construction (Liu et al., 2005).

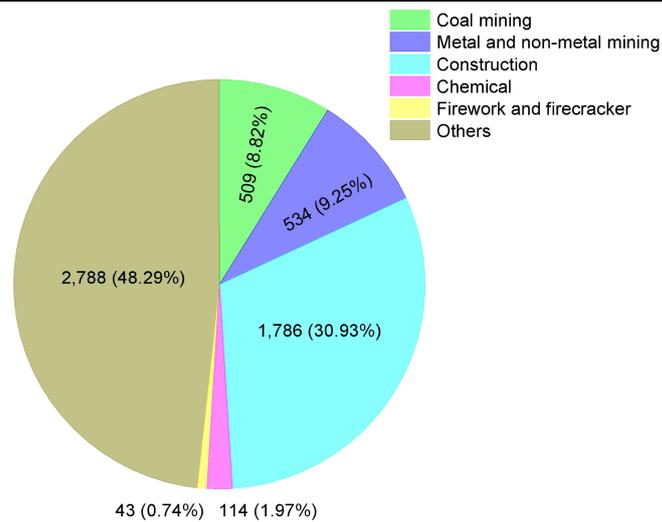


Fig. 7. Distribution of China's industrial accidents in 2014.

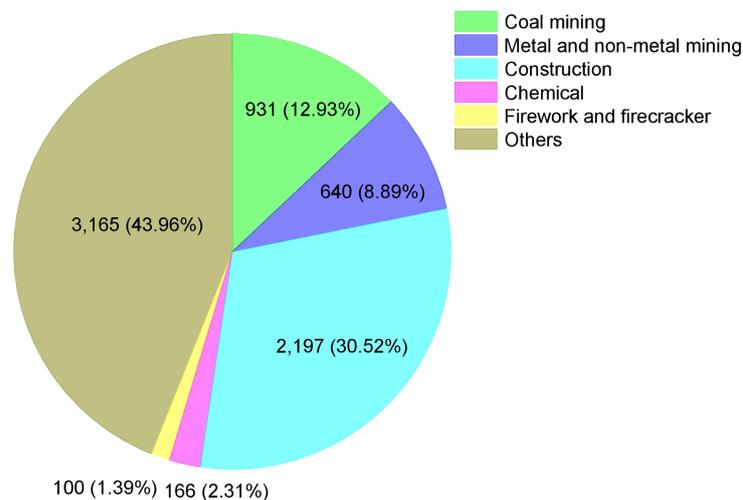


Fig. 8. Distribution of fatalities of China's industrial accidents in 2014.

2.2 Statistical analysis of occupational diseases

Alongside accidents, occupational health is also one of the major concerns in work safety in China. This section provides a statistical analysis of occupational diseases in China. The statistical data for this section comes from [National Health and Family Planning Commission of China](#) (named the Ministry of Health of PRC before 2013). According to Article 2 of the 'Law of PRC on Prevention and Control of Occupational Diseases' ([SCNPC, 2001](#); [SCNPC, 2016](#)), occupational disease refers to a disease caused by exposure to dust or radioactive substances, or by other poisonous and harmful factors that are present in the occupational activities. According to the 'Occupational Disease Classification and Catalogue' ([NHFPC of PRC, 2013a](#)), occupational diseases shall be classified into 10 types:

1. occupational pneumoconiosis and other occupational respiratory diseases,
2. occupational dermatoses,
3. occupational eye diseases,
4. occupational ear, nose and throat diseases,
5. occupational poisonings,
6. occupational diseases caused by physical factors,
7. occupational radiation-induced diseases,
8. occupational infectious diseases,
9. occupational tumors and
10. others.

There are 132 subtypes. Occupational diseases are diagnosed and identified by the 'Regulation of the Occupational Disease Diagnosis and Identification' ([NHFPC of PRC, 2013b](#)).

On Apr. 29, 2015, the Innovation Center for Social Risk Governance in Health (ICSRGH), a research group consisting, among others, of Fudan University, Tsinghua University, Harbin Medical University, Xinjiang Medical University, and the NHFPC of PRC, published a Research Report on the 'Warning and Control of Occupational Health

Hazards in China' ([Social Science in China, 2015](#)). There were four important conclusions in this study:

(1) at present China has the highest incidence of occupational diseases in the world (cases of occupational disease, the cumulative number of deaths and the new cases of occupational disease)

(2) Fig. 9 shows the distribution of occupational diseases of China in 2014, showing that there is one pervasive and dominant reportable occupational disease in China, namely pneumoconiosis. As shown in Fig. 10, pneumoconiosis cases in China come mainly from coal mining and dressing (38.02% of the total cases in 2014), and non-ferrous metals mining and dressing (37.48%).

(3) peasant-workers are the primary group exposed to occupational hazards and

(4) occupational health hazards have begun to spread to the new types of industry, such as computer and information technology, biology and medicine.

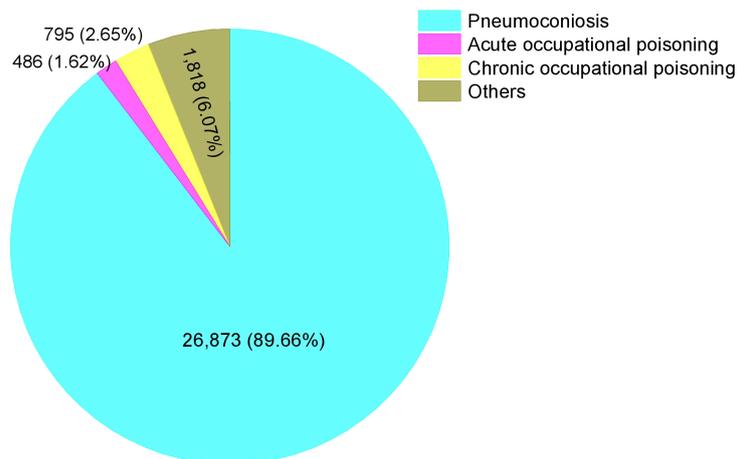


Fig. 9. Distribution of occupational diseases of China in 2014.

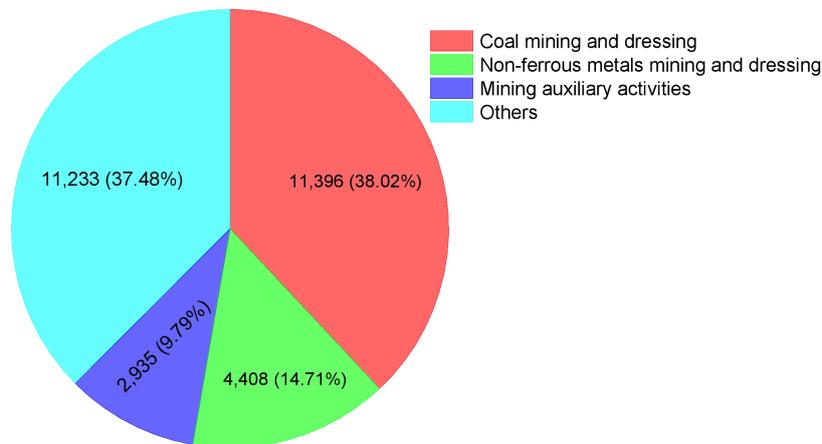


Fig. 10. Distribution of pneumoconiosis cases of China in 2014.

Fig. 11 shows the evolution of the cases of occupational disease and pneumoconiosis in China between 2005 and 2014. During this period, they show a general rising tendency with a temporary and relatively smaller decrease in 2011–2013, after which the numbers rose again. Why did a sudden increase in the cases of occupational disease and pneumoconiosis emerge in 2013–2014 and peak in 2014? A primary reason is that China expanded the scope of occupational disease in 2013. Specifically, 18 new subtypes of occupational disease were listed into the ‘Occupational Disease Classification and Catalogue’ ([NHFPC of PRC, 2013a](#)) revised on December 23, 2013. Data from the [NHFPC of PRC](#) show that, since China’s reform and opening up in 1978, more than 830,000 cases of occupational disease have accumulated in China. Currently, pneumoconiosis is still a horrible disease accounting for about 80% of the total cases of occupational disease, which is approximately equal to the total sum of cases of pneumoconiosis in all the other countries of the world combined. There are more than 10,000 new cases each year, and the new cases are still increasing ([Social Science in China, 2015](#)).

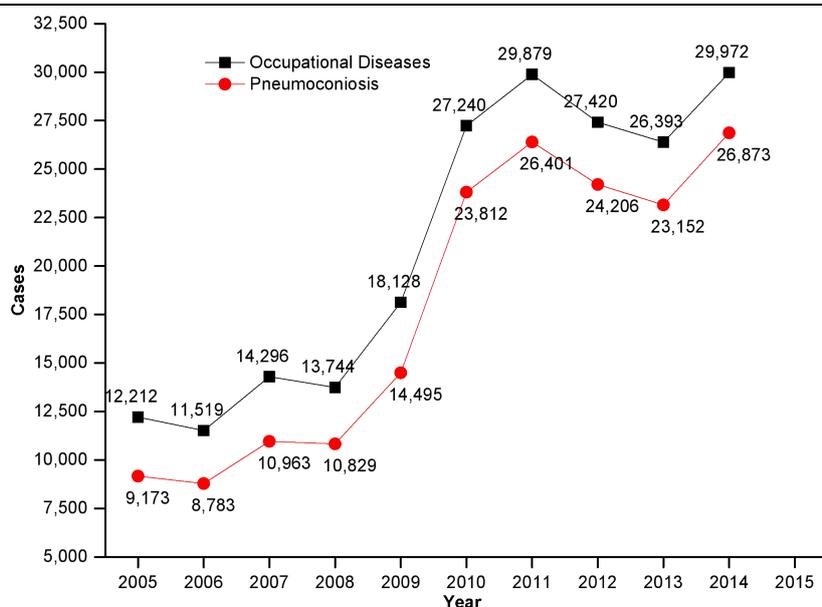


Fig. 11. Cases of occupational disease and pneumoconiosis in China 2005–2014.

2.3 Brief introduction to the work safety management on a national level

In recent years, the Chinese government adheres to the construction of safe society and the people-oriented concept. In addition, the government attaches great importance to work safety to take a series of effective measures for supporting work safety management. Work safety management has actually obtained an apparent progress. This section only briefly introduces the legal frameworks of work safety and the regulatory organization of work safety in China to show the current situation of work safety management on a national level.

2.3.1 Legal frameworks of work safety

Laws, regulations, and standards related to work safety were the basis of all work safety actions. In 2002, the ‘Law on Safety in Production of PRC’ was published and enforced (SCNPC, 2002). In 2014, this law was revised (SCNPC, 2014). It was a great and powerful law for work safety, and consisted of the following parts: General Provisions; Guarantee of Safety by Production and Business Operation Entities; Rights and Obligations of Employees; Supervision and Administration of Work Safety; Emergency Rescue, Investigation and Handling of Work Safety Accidents; Legal Responsibility; and Supplementary Provisions (SCNPC, 2014). At present, the supported work safety laws, regulations, rules and standards and technical specification system of the ‘Production Safety Law of PRC’ has been established in China. The legal system of work safety in China is divided into four levels. Table 3 shows the legal frameworks of work safety in China at present. Although China has primarily established a relatively adequate legal system for work safety, there are still many problems. According to the ‘Several Opinions of the Central Committee of the Communist Party of China and the State Council of PRC on Accelerating the Reform and Development of Work Safety’ (State Council of PRC, 2016), these problems mainly include: (1) some work safety laws and regulations are devoid of clarity and maneuverability, (2) there are many inconsistencies among laws and regulations related to work safety; (3) the legal system for safety supervision, chemical safety, etc. is insufficient, (4) some illegal activities (e.g. refusing to remove major hidden dangers, ordering any worker to work at risk against laws and regulations) easily leading to major accidents are not listed in the ‘Criminal Law of PRC’, (5) complementary laws and regulations for work safety are imperfect or are not revised timely, and (6) the laws, regulations, rules and standards related to work safety and health are not integrated well.

Table 3.

Legal frameworks of Work Safety in China at present. Source: Information Database of China’s Laws and Regulations (<http://law.npc.gov.cn/FLFG/>) and Standardization Administration of PRC (<http://www.sac.gov.cn/>).

Notes: Table 3 only lists some main China’s work safety laws, regulations, rules and standards on the national level; in China, the national work safety standards are divided into compulsory standards (GB) and recommendatory standards (GBZ); and industry standards (AQ) related to work safety are not included in Table 3.

No.	Main law, regulation, rule and standard related to work safety
1	Constitution of PRC
2	1. Labor Law of PRC 2. Production Safety Law of PRC 3. Law of Prevention and Control of Occupational Disease of PRC 4. Road Traffic Safety Law of PRC 5. Emergency Response Law of PRC 6. Fire Control Law of PRC 7. Law on Safety in Mines of PRC

8.	...	
3	1.	Regulations on the Implementation of the Production Safety Law of PRC
	2.	Regulations on the Implementation of the Law of Prevention and Control of Occupational Disease of PRC
	3.	Regulations on the Implementation of the Law on Safety in Mines of PRC
	4.	Regulations on Work Safety license
	5.	Regulations on Insurance for Work-Related Injuries
	6.	Regulations on Special Equipment Safety Supervision
	7.	Byelaw Governing Reporting, Investigation and Handling of Accidents
	8.	Administrative Regulations on Safety in Construction Projects
	9.	...
4	Rules on Work Safety	1. Coal Mine Safety Rules
		2. Management Measures of Dangerous Chemicals Registration
		3. Management Measures of Emergency Plan for Work-Related Accident
		4. Catalogue of Safety Facilities for Construction Projects of Metal and Non-metal Mine
		5. Eight provisions on Work Safety in Labor-Intensive Manufacturing Enterprise
		6. Provisions on Safety Supervision and Administration of Tailings Dam
		7. Occupation Disease Classification and Catalogue
		8. Management Measures of Occupational Health Service Institutions
		9. Regulations on Enterprise' Safety Training
		10. ...
	National Work Safety Standards	1. Classification for Casualty Accidents of Enterprise Staff and Workers (GB 6441)
		2. Safety Colours (GB 2893)
		3. Safety Signs and Guideline for the Use (GB 2894)
		4. Classification and Code of the Hazardous and Harmful Factors in Process (GB/13861)
		5. Identification of Major Hazard Installations for Dangerous Chemicals (GB18218)
		6. General principles for the requirements of safety and health in production process (GB 12801)
		7. Safety Code of Electric Power Industry (GB 26860)
		8. Safety Regulation for Working under Hazardous Condition (GB8958)
		9. Hygienic Standard for the Design of Industrial Enterprises (GBZ 1)
		10. ...

2.3.2 Regulatory organizations of work safety

In order to ensure the implementation of work safety laws, regulations, and standards, some work safety supervision organizations should be established. After years of exploration and development, China has primarily established a relatively good regulatory organization system for work safety at present. Table 4 lists the main regulatory organizations related to work safety in China at present. However, the capability of safety supervision is still unable to meet the demands of the development of the economy and society at present, there is no clear provision about the responsibilities of some regulatory organizations of work safety, and the work safety supervision and administration system, and the local work safety supervision and law-enforcement system are neither sound nor standardized (State Council of PRC, 2016).

Table 4.

Key regulatory organizations related to work safety at central government level of China at present. Source: [Work Safety Commission of the State Council of PRC \(WSCSC\)](#), [State Administration of Work Safety \(SAWS\)](#), [State Administration of Coal Mine Safety \(SACMS\)](#) and [National Health and Family Planning Commission \(NHFPC\)](#) of PRC.

Organization	Key responsibilities (all organizations have other more minor responsibilities not listed here)
Work Safety Commission of the State Council (WSCSC) of PRC	<ol style="list-style-type: none"> 1. Discussing, disposing, directing and coordinating the national work safety under the leadership of the State Council of PRC; 2. Studying and putting forward the major principles and policies for national work safety; 3. Providing countermeasures for solving the major matters in national work safety.
State Administration of Work Safety (SAWS)	<ol style="list-style-type: none"> 1. Establishing the drafts of general work safety laws and regulations, drawing up policies and programs for work safety; analyzing and forecasting the work safety situation in the whole of China, and publishing the national work safety information; 2. Bearing the responsibility for comprehensive supervision and management of work safety; exercising its functions and powers for comprehensive supervision and management of work safety in accordance with the laws; coordinating, supervising and inspecting national work safety, and supervising accident investigation; 3. Bearing the responsibility for supervision and management of industrial and commercial safety; 4. Bearing the responsibility for occupational health supervision and inspection in industrial and commercial workplaces except coal mine workplaces; 5. Making, publishing and implementing regulations, standards and rules for industrial and commercial safety, and investigating and punishing the enterprises failing to satisfy work safety conditions in accordance with the laws; 6. Directing and coordinating emergency rescue in accidents.
State Administration of Coal Mine Safety (SACMS)	<ol style="list-style-type: none"> 1. Participating in drafting the laws and regulations of coal mine safety, and drawing up policies, programs, regulations, standards and rules for coal mine safety; 2. Bearing the responsibility for the supervision and management of safety and health in coal mines; 3. Directing and coordinating emergency rescue in coal mine accidents.

National Health and Family Planning Commission of PRC	1. Making, publishing and implementing some regulations, standards and rules of occupational health; 2. Managing and publishing the national occupational disease report, and organizing to carry out scientific research on occupational diseases prevention and control; 3. Supervising and managing the occupational disease diagnosis and identification.
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3. New challenges and future tasks of work safety in China

Section 2 forms the backdrop to the rest of this paper, showing what a challenge China faces to tackle this still huge number of accidents and occupational disease cases. In recent years, the work safety situation in China, in terms of accidents, has become relatively stable. However due to the frequent occurrence of fatal and serious accidents resulting in huge economic losses and fatalities, the high incidence of occupational diseases, and the restrictions from social and economic development, there exist many problems that still need to be resolved. The 13th FYP period as a critical stage of building a moderately prosperous society in all respects and safe China, so the promotion of work safety in the 13th FYP period is particularly important. Alongside the demand for economic and social development, and the current work safety situation in China, the [13th FYP for Work Safety](#) formulated by the [General Office of the State Council of PRC](#) on February 3, 2017 provides guidance for work safety in China in the next five years (2016—2020), and lists the performance targets to be reached by the end of 2020 (see Table 5), where the column ‘drop’ refers to the targeted fall in the indices by the end of 2020 in comparison to 2015. This section gives a brief introduction to the new challenges and future tasks of work safety in China according to 13th FYP for Work Safety and the current work safety status in China.

Table 5.

13th FYP national targets for work safety. Source: [13th FYP for Work Safety](#).

No.	Index	Drop
1	Number of work-related accidents	10%
2	Number of deaths for work-related accidents	10%
3	Number of particularly serious accidents and major accidents	20%
4	Number of deaths for particularly serious accidents and major accidents	22%
5	Death rate per 10 ⁹ RMB of GDP	30%
6	Death rate per 10 ⁵ workers	19%
7	Death rate per 10 ⁶ tons of coal	15%
8	Death rate per 10 ⁴ vehicles	6%
9	Death rate per 10 ⁴ special equipments	20%

3.1. New challenges

Currently, China is still in the process of new-style industrialization and urbanization, which is the key stage of transition from a low-income country to a middle-income country and requires a safe and healthy environment for this development. At present, China’s work safety is facing a series of challenges. According to the analysis of the current status of China’s work safety in Section 2 and the [13th FYP for Work Safety](#) ([General Office of the State Council of PRC, 2017](#)), the problems and challenges in work safety are the following:

- (1) A range of deep-rooted safety-related problems have not been solved completely, such as the non-perfection of mechanisms and institutions for safety supervision, and the lack of safety awareness and legal consciousness in the whole society.
- (2) Different hazards have been interwoven because of the constantly enlarging production-scale, and a large number of high-risk industries such as mining and chemicals.
- (3) With the changes in urban structure and size, risks in areas such as urban construction, rail transportation, oil and gas pipelines, dilapidated housing, glass curtain walls, elevator equipment all in densely populated areas, have been gradually highlighted.
- (4) Because of the emergence of a mixture of traditional and new production technologies, materials and equipment and marketing patterns, the problem of accidents and particularly of complex accidents has dramatically increased.
- (5) The capabilities of safety supervision and inspection have been unable to meet the demands of the development of the economy and society at present, because of the failure to meet the enterprise’s responsibility for safety, the lack of safety supervision and the imperfect safety laws and regulations. There is an urgent need to enhance the standardization, legalization and authority of safety supervision.
- (6) The people’s need for safety is increasing and work safety has engaged the concern of the whole society, which provides a huge boost to work safety.

3.2 Future tasks

Future tasks according to the [13th FYP for Work Safety](#) ([General Office of the State Council of PRC, 2017](#)) will cover the following topics, which include plans to add the enterprise and regulatory levels of safety management to the current technology-dominated approaches, and to strengthen the work safety capabilities.

3.2.1 Build a more strict safety responsibility system

According to Article 4 of the ‘[Production Safety Law of PRC](#)’ (SCNPC, 2014), the enterprises need to fully consider the ‘[Production Safety Law of PRC](#)’ and other relevant laws, regulations concerning the work safety, strengthen the administration of work safety, establish and perfect the system of responsibility for work safety, promote work safety standardization, and ensure the safety in work. Since 1970, many Western countries have paid more attention to ‘self-regulation’ (e.g. Löfstedt, 2011) in which every individual director, manager and employee is expected to take responsibly with respect to safety risks. To actively learn and adopt this good safety policy, China started to continually strengthen the enterprise’s responsibility for safety in recent years. Article 5 of the ‘[Production Safety Law of PRC](#)’ (SCNPC, 2014) shows that the person-in-charge of enterprises shall take charge of the overall work of work safety of the entity concerned. The person-in-charge of enterprises shall have the following duties and responsibilities regarding the work safety of their own entity (SCNPC, 2014; [General Office of the State Council of PRC, 2017](#)):

- (1) establishing and perfecting the system of responsibility relating to work safety;
- (2) organizing the formulation of rules of safe production and operational rules of the entity;
- (3) ensuring the effective execution of input in work safety;
- (4) overseeing and inspecting the work of work safety of the entity and eliminating in good time the potential work-related accidents;
- (5) organizing the formulation and execution of plans for emergency rescue and relief of work-related accidents of the entity, and
- (6) reporting work-related accidents truthfully and in good time.

The countermeasures to strengthen the enterprise’s responsibility for safety need to be agreed and implemented, are as follows:

- (1) implementing the fully responsibility of the directors of enterprises for occupational safety and health in their units;
- (2) carrying out strictly the safety responsibility system of the entire personnel in enterprises;
- (3) perfecting the safety education and training system of enterprises;
- (4) ensuring an adequate safety investment by the enterprises;
- (5) promoting work safety standardization of enterprises to realize the standardization of safety management, operational behaviors, equipment and working environment;
- (6) implementing the “three simultaneous” system of safety and health strictly. The safety and health facilities of the newly built or rebuilt or expanded engineering projects of the production and business operation entities shall be designed, built and put into production and use at the same time of the principal part of the projects (SCNPC, 2014);
- (7) perfecting the standard for classification and gradation of hidden hazard, establishing the third-party assessment system for the check and control of hidden hazards and the self-check, self-control and self-report system of hidden hazard.
- (8) developing the guideline to hazard identification and management, and the registration, filing, identification, assessment and monitoring system of major hazard, and
- (9) encouraging enterprise to establish the safety management system which coincides with the international safety management practice.

3.2.2 Strengthen work safety supervision and administration in accordance with the safety law

According to Article 8 of the ‘[Production Safety Law of PRC](#)’ (SCNPC, 2014), the State Council of PRC and the people’s governments at all levels shall strengthen the leadership with respect to work safety, and support and urge the relevant departments to perform their respective duties of supervision and administration regarding work safety. The people’s governments on the county level and higher shall coordinate and handle the serious problems that exist in the supervision and administration of work safety in good time. And according to Article 9 of the ‘[Production Safety Law of PRC](#)’ (SCNPC, 2014), the work safety supervision and administration of supervision departments shall be in accordance with the safety law. Therefore, strengthening work safety supervision and administration in accordance with the safety law should be an increasing focus on work safety supervision and administration in the future.

Firstly, China will need to perfect some aspects of the Chinese legal system and the standard system for work safety. To achieve this goal, some valid strategies can be proposed, which are:

- (1) strengthening the top level of design of work safety legislation;
- (2) making mid to long term plans for work safety legislation;
- (3) implementing the evaluation system for the effectiveness of safety laws and regulations;
- (4) enhancing the connection between work safety and occupational health legislation;
- (5) speeding up the formulation and revision of work safety laws and regulations that have received great attention from the public or are urgently needed to be solved in practice, and
- (6) building a work safety standard system by taking the mandatory standards as primary sources and the recommended standards as their supplement.

Secondly, China will need to implement the responsibility of safety supervision and administration. The Chinese government at all levels will need to strengthen their leadership in work safety actions. For example, in order to

promote the harmonious development between work safety and the economy or society, work safety will need to be put on the agenda, and brought into the overall plan of the region's economic and social development. In order to further implement the responsibility of safety supervision, the responsibility for administrative law enforcement and the regulatory field of the departments responsible for the safety supervision and administration will need to be clarified. Moreover, the safety supervision system of major industries or areas will have to be improved, including mining, hazardous chemicals, road traffic, offshore petroleum, and so on.

Thirdly, China will need to increase the intensity of regulatory supervision, administration and law enforcement related to work safety. The system to achieve this will need to be improved, the subjects, ways, procedure, frequency and coverage of law enforcement will need to be confirmed more clearly, and the labels and uniforms of law enforcement will need to be unified for further standardizing law enforcement activities and setting a clear distinction and good image of law enforcement. Meanwhile, the integration of supervision, administration and law enforcement of work safety and occupational hygiene will need to be implemented. Moreover, the investigation and learning from accidents will need to be continually improved, such as by perfecting the rules of investigation of accidents and strengthening causal analysis.

Finally, China will need to perfect the administrative approval system related to work safety, including further reforming of the administrative approval and safety access mechanism such as simplifying procedures, developing a guide on work safety administrative approval, establishing detailed regulations for reviewing works, and standardizing the procedures, standards and contents of work safety administrative approval.

3.2.3 Effectively prevent and resolutely curb major accidents

Currently, major accidents mainly including mine accidents, road traffic accidents, construction accidents, chemical accidents, fire accidents and water traffic accidents still occur too often in China (SAWS, 2016a). In order to effectively prevent and resolutely curb major accidents, some strategies are proposed, which are:

- (1) strengthening risk management and hidden-hazard investigation and control;
- (2) taking effective technology, engineering and management measures to prevent major accidents and
- (3) establishing and perfecting the forewarning system and emergency mechanism to reduce the frequency and loss associated with major incidents as far as possible.

3.2.4 Strengthen occupational health hazards control

To prevent occupational health hazards effectively, China will need to take some measures for occupational health hazards control, which include:

- (1) carrying out better surveys of occupational health hazards;
- (2) establishing an effective information network for occupational health hazards reporting, a dynamic updating mechanism of that information, and an effective monitoring and statistical system relating to the occupational health information;
- (3) extending the application of advanced and new technologies, approaches, equipment and materials for occupational disease prevention;
- (4) preventing and controlling the health hazards of poisonous dust and highly toxic substances in the workplaces for preventing pneumoconiosis and occupational poisoning effectively;
- (5) doing the basic research on occupational health hazards such as the identification and control of new occupational hazards;
- (6) developing and promoting the key technologies and equipment for preventing and controlling the typical occupational health hazards and
- (7) building a national big data platform for occupational health.

3.2.5 Attach importance to the research and application of safety science and technology

Firstly, there will need to be a commitment to provide strong support for the research and development of safety science and technology. For this, some strategies need to be implemented in China:

- (1) making an innovation plan for safety science and technology;
- (2) establishing a system participated in by the significant and relevant parties (such as governments, enterprises and institutions of higher education) to promote research and development in safety science and technology;
- (3) building the Innovation Group of the Basic Theoretical Research of Safety Science (IGBTRSS), a research group consisting of institutions of higher education, enterprises, government departments and other social organizations, to promote research on the theories of major accidents prevention and control, the basic theories of safety science and the common and key safety technologies and so on;
- (4) supporting the research and development of safety science and technology through a series of national science & technology programs, such as the Project of National Natural Science Foundation of China and the National Key Research and Development Program;
- (5) enhancing the independent innovation capacity of the key laboratories and innovation centers of safety science and technology;

- (6) creating a strong think tank for work safety;
- (7) perfecting the sharing mechanism of the key resources of safety science and technology, and
- (8) strengthening the cooperation between enterprises and research institutions or universities.

Secondly, China will need to make full use of a series of advanced safety technologies, which may include among of others:

- (1) automatic mining in large-scale mines,
- (2) mechanized mining in small and medium-sized mines,
- (3) unmanned mine facilities;
- (4) monitoring and management of mine's ground pressure disasters;
- (5) mining equipment used in small and medium-sized mines of metal and non-metal,
- (6) protection monitoring of hydrogen sulphide in oil and gas fields,
- (7) safety technologies used in high-sulphur oil processing processes,
- (8) lightning warning systems in the hazardous chemical areas,
- (9) monitoring and warning systems for dams with the high and steep slope;
- (10) on-line safety monitoring of hydropower dams,
- (11) dust-tracking and spraying dust suppression systems,
- (12) substitutes for highly toxic substances,
- (13) small mobile systems for emergency command,
- (14) rescue equipment used in high speed railways and long railway tunnels;
- (15) safety control technology for passenger vehicles and other vehicles carrying dangerous chemicals,
- (16) emergency command decision systems for major traffic accidents happening on highways.

Thirdly, China will need to promote work safety information systems. In order to achieve this goal, some important tasks will need to be completed, which are:

- (1) promoting the deep integration of information technology and work safety;
- (2) unifying the standards of work safety information systems;
- (3) improving the infrastructure and network systems for work safety information by relying on the national e-government network platform;
- (4) promoting the general application of information technologies such as big data to safety management;
- (5) achieving work safety data resource sharing;
- (6) making high-risk industries (such as mining and metal smelting) use the safety information management systems (such as intelligent safety equipments and on-line monitoring and control);
- (7) building whole-processed traceability systems in high-risk industries such as hazardous chemicals and fireworks and
- (8) improving the safety management of small and medium-sized enterprises through the procurement of information services.

3.2.6 Improve accident emergency rescue capabilities

Accident emergency rescue capability embodies the emergency capability of the government. To improve this, China will need to make efforts in these two aspects:

- (1) perfecting emergency response mechanisms, such as setting up a decision support system for emergency response to major accidents and developing a rapid response plan for accident emergency rescue;
- (2) improving the capacity to cope with accidents, such as the accountability and assessment of emergency drill performance and the improvement of the professional quality of emergency rescue workers.

3.2.7 Promote safety education and develop an effective safety culture

China will need to take a series of measures to promote safety education, such as addressing the popularization of safety knowledge into the national education system, developing safety education in middle and primary schools, improving work safety education systems, supporting the disciplines and majors of higher education related safety science and technology, perfecting safety training systems and setting up safety training systems for peasant-workers in high-risk industries. Moreover, to enhance safety culture, China will need to foster an effective safety culture in enterprises, schools, government departments, communities, families and the public areas, such as bus stations, railway stations, large-scale squares, large shopping malls and large tourist attractions, and organise the choice of "demonstration enterprises" to be used to foreground safety culture development and the choice of "demonstration cities" to fulfil the same role as safety development communities.

4. Conclusions

Our analysis shows that, in recent years, with the support and encouragement of the Chinese government at all levels, the work safety situation in China has become relatively stable. However, accidents with high numbers of fatalities and injuries still occur regularly, occupational diseases have not been prevented and controlled effectively, and there are

many limitations in work safety management. Obviously, due to the restrictions from social and economic development, there exist many work safety problems that still need to be resolved. Fortunately, China has clearly put forward some potentially effective suggestions in the 13th FYP for Work Safety to guide the work safety actions during the 13th FYP period.

The future development of work safety during the 13th FYP period in China will play a significant role in making China safer, but also in China's sustainable development, its well-off society, and the development of a harmonious society. It will deepen work safety study further, and help locate an effective safety solution to solve work safety problems. According to the requirements of economic development and work safety, during the 13th FYP period, China should extend the application of work safety achievements, and implement scientific demonstration projects related to work safety. Meanwhile, China should strengthen its capability for work safety. Moreover, there are no boundaries between countries on science and technology. China should actively advance the cooperation and exchange of knowledge on work safety between China and other countries to promote the development and advancement of work safety to get a safer and better environment in China and the rest of the world. For example, China should actively adopt many effective approaches (such as the self-regulatory approach and the 'safety case' justification system) that can be found in Western literature (e.g. Le Coze, 2013; Waring, 2015) to improve work safety.

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References

- General Office of the State Council of PRC, 2017. Circular of the General Office of the State Council of PRC on Printing and Issuing the 13th FYP for Work Safety. <http://www.gov.cn/zhengce/content/2017-02/03/content_5164865.htm> (in Chinese) (accessed 02.03.2017).
- Le Coze, J.-C., 2013. New models for new times— an anti-dualist move. *Saf. Sci.* 59 (11), 200-218.
- Liu, T., Zhong, M., Xing, J., 2005. Industrial accidents: Challenges for China's economic and social development. *Saf. Sci.* 43 (8), 503-522.
- Löfstedt, R.E., 2011. Reclaiming health and safety for all: An independent review of health and safety legislation. Report to the Secretary of State for Work and Pensions. Command 8219. London, HM Stationery Office.
- Ministry of Public Security of PRC, Ministry of State Security of PRC, Ministry of Justice of PRC, 2013. Standard for the Identification of Human Body Injury Degree. Law Press, Beijing, CHN.
- National Health and Family Planning Commission (NHFPC) of PRC, 2013a. Circular on Printing and Issuing the Occupational Disease Classification and Catalogue. <<http://www.nhfpc.gov.cn/jkj/s5898b/201312/3abbd667050849d19b3bf6439a48b775.shtml>> (in Chinese) (accessed 12.30.2013).
- National Health and Family Planning Commission (NHFPC) of PRC, 2013b. Regulation of the Occupational Disease Diagnosis and Identification. <<http://www.moh.gov.cn/mohzcfgs/s3576/201302/72c11ed245a14cfd8207ffeb3d7f1c8c.shtml>> (in Chinese) (accessed 03.18.2013).
- National People's Congress of PRC. Thirteenth Five-Year Guideline for National Economic and Social Development. <http://www.npc.gov.cn/wxzl/gongbao/2016-07/08/content_1993756.htm> (in Chinese) (accessed 03.16.2016).
- Rowley, C., 2012. Development in China: position and nationhood in Asia and the world. *Asia Pac. Bus. Rev.* 18(1), 87-92.
- Social Science in China, 2015. A Warning Sign of Occupational Health Hazards Spreading to the New Industries. <http://ex.cssn.cn/xk/xk_wtbt/201505/t20150504_1718277.shtml> (in Chinese) (accessed 05.04.16).
- State Administration of Work Safety (SAWS), 2005. The China's Work Safety Yearbook 2004. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2006. The China's Work Safety Yearbook 2005. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2007. The China's Work Safety Yearbook 2006. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2008. The China's Work Safety Yearbook 2007. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2009. The China's Work Safety Yearbook 2008. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2010a. Basic Norms for Work Safety Standardization of Enterprises (AQ/T 9006–2010). China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2010b. The China's Work Safety Yearbook 2009. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2011a. Main Points of National Work Safety Works in 2010. <http://www.chinasafety.gov.cn/newpage/Contents/Channel_20587/2011/0113/120731/content_120731.htm> (in Chinese) (accessed 01.13.2011).
- State Administration of Work Safety (SAWS), 2011b. The China's Work Safety Yearbook 2010. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2012. The China's Work Safety Yearbook 2011. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2013a. Main Points of National Work Safety Works in 2012. <http://www.chinasafety.gov.cn/newpage/Contents/Channel_5345/2013/0118/197981/content_197981.htm> (in Chinese) (accessed

- 01.18.2013).
- State Administration of Work Safety (SAWS), 2013b. The China's Work Safety Yearbook 2012. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2014a. Circular of the State Administration of Work Safety on Printing and Issuing the Statistical Reporting System of Accidents. <http://www.chinasafety.gov.cn/newpage/Contents/Channel_5330/2014/0926/241080/content_241080.htm> (in Chinese) (accessed 09.26.2014).
- State Administration of Work Safety (SAWS), 2014b. The China's Work Safety Yearbook 2013. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2015a. Main Points of National Work Safety Works in 2014. <http://www.chinasafety.gov.cn/newpage/Contents/Channel_21712/2015/0126/245715/content_245715.htm> (in Chinese) (accessed 01.26.2013).
- State Administration of Work Safety (SAWS), 2015b. The China's Work Safety Yearbook 2014. China Coal Industry Publishing House, Beijing, CHN.
- State Administration of Work Safety (SAWS), 2016a. A Review of National Work Safety in 2015. <http://www.chinasafety.gov.cn/newpage/Contents/Channel_4181/2016/0219/264936/content_264936.htm> (in Chinese) (accessed 02.19.2016).
- State Administration of Work Safety (SAWS), 2016b. Several Opinions of the CPC Central Committee and the State Council on Accelerating the Reform and Development of Work Safety. <http://www.gov.cn/zhengce/2016-12/18/content_5149663.htm> (in Chinese) (accessed 12.18.2016).
- State Administration of Work Safety (SAWS), 2016c. The Analysis of National Work Safety with Data in 2015. <http://www.chinasafety.gov.cn/newpage/Contents/Channel_21411/2016/0116/263744/content_263744.htm> (in Chinese) (accessed 01.16.2016).
- State Council of PRC, 2007. Byelaw Governing Reporting, Investigation and Handling of Accidents (March 28, 2007), The 172th Executive Meeting of the State Council of PRC.
- State Council of PRC, 2010. Work-related Injury Insurance Regulations (Revised edition, December 8, 2010), The 136th Executive Meeting of the State Council of PRC.
- State Council of PRC, 2016. Several Opinions of the Central Committee of the Communist Party of China and the State Council of PRC on Accelerating the Reform and Development of Work Safety. <http://www.gov.cn/zhengce/2016-12/18/content_5149663.htm> (in Chinese) (accessed 12.18.2016).
- State Statistic Bureau of China, 1991. China Statistical Yearbook 1990. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1992. China Statistical Yearbook 1991. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1993. China Statistical Yearbook 1992. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1994. China Statistical Yearbook 1993. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1995. China Statistical Yearbook 1994. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1996. China Statistical Yearbook 1995. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1997. China Statistical Yearbook 1996. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1998. China Statistical Yearbook 1997. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 1999. China Statistical Yearbook 1998. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2000. China Statistical Yearbook 1999. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2001. China Statistical Yearbook 2000. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2002. China Statistical Yearbook 2001. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2003. China Statistical Yearbook 2002. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2004. China Statistical Yearbook 2003. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2005. China Statistical Yearbook 2004. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2006. China Statistical Yearbook 2005. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2007. China Statistical Yearbook 2006. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2008. China Statistical Yearbook 2007. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2009. China Statistical Yearbook 2008. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2010. China Statistical Yearbook 2009. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2011. China Statistical Yearbook 2010. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2012. China Statistical Yearbook 2011. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2013. China Statistical Yearbook 2012. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2014. China Statistical Yearbook 2013. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2015. China Statistical Yearbook 2014. China Statistics Press, Beijing, CHN.
- State Statistic Bureau of China, 2016. China Statistical Yearbook 2015. China Statistics Press, Beijing, CHN.
- The Standing Committee of the National People's Congress (SCNPC), 2003. Road Traffic Safety Law of PRC (October 28, 2003), The 5th Session of the Standing Committee of the Tenth National People's Congress.
- The Standing Committee of the National People's Congress (SCNPC), 2002. Production Safety Law of PRC (June 29, 2002), The 28th Session of the Standing Committee of the Ninth National People's Congress.
- The Standing Committee of the National People's Congress (SCNPC), 2014. Production Safety Law of PRC (Revised edition, August 31, 2014), The 10th Session of the Standing Committee of the Twelfth National People's Congress.
- The Standing Committee of the National People's Congress (SCNPC), 2001. Law of PRC on Prevention and Control of Occupational Diseases (October 27, 2001), The 21th Session of the Standing Committee of the Twelfth National People's Congress.
- The Standing Committee of the National People's Congress (SCNPC), 2016. Law of PRC on Prevention and Control of Occupational Diseases (Revised edition, July 2, 2016), The 21th Session of the Standing Committee of the Twelfth National People's Congress.
- The Standing Committee of the National People's Congress (SCNPC), 2007. Emergency Response Law of PRC (October 27, 2001), The 21th Session of the Standing Committee of the Twelfth National People's Congress.
- Wang, B., Wu, C., Shi, B., et al., 2017. Evidence-based safety (EBS) management: A new approach to teaching the practice of safety management (SM). *J. Saf. Res.* 63 (12):21-28.

-
- Waring, A.E., 2015. Managerial and non-technical factors in the development of human-created disasters: a review and research agenda. *Saf. Sci.* 79 (11), 254-267.
- Wu, Q., Liu, Y., Yu, Z., Wang, L., 2009. Statistical prediction and analysis of work safety accidents based on BP Neural network. *China Saf. Sci. J.* 19 (9), 47-52.
- Yin, W., Fu, G., Yang, C., et al., 2017. Fatal gas explosion accidents on Chinese coal mines and the characteristics of unsafe behaviors: 2000–2014. *Saf. Sci.* 92 (2), 173-179.
- Yuan, X., Yan, Y., Zhang, J., 2014. Overview of researches on coal accident in China. *China Saf. Sci. J.* 24(8), 132-138.
- Zhong, M., Fan, W., Liu T., 2004. China: some key technologies and the future developments of fire safety science. *Saf. Sci.* 42 (7), 627-637.