# INDUSTRIAL FIRE AND EXPLOSION HAZARD ASSESSMENT METHODS IN CHINA

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#### **ABSTRACT**

Fire is one of the serious disasters in China. In this paper the general situation of fires in recent years was introduced. Three kinds of fire and explosion hazard assessment methods: hazard severity classifications of propellant, explosive and ammunition factories, hazard severity classifications of chemical plants, and fire and explosion hazard assessment method were briefly presented.

Key words: industrial fire. risk assessment, accident prevention

#### INTRODUCTION

Protecting worker's safety and health is a policy consistantly pursued by the govenement of China. It is also one of the basic principles guiding the management in the state economic administration as well as in factories, mines and enterprises.

Fire is one of the most common hazard or accident vectors encountered in the workplace. It is offen accompanied by explosion. The Chinese government, since the founding of the People's Republic, has attached great importance to worker's safety, formulated a series of relevant polices, laws, regulations and standards. Full—time staffed organizations specially responsible for occupational safety have been established in the departments in charge of industries and enterprises, in the governments at both central and local levels. Ministry of labour is charged with ensuring the provision of a safety working environment and protecting the public and surroundings from the harmful effects of work activities.

As the rapid growth of economy in recent years, fires loss is getting seriously (see Table 1). Such figures do not, however, reveal the true impact of the large industrial fires or fires in public places, their consequences are social rather than individual. They often produce high casualties, environmental damage or economic con-

sequences. Incidents such as the tragic fire in Karamay City (killed 325 people), the fire and explosion accident of the hazardous chemicals warehouses in Shenzhen City (kill 15, injured 873 people) are examples.

Item	No. of Fire	Casualties		Property Loss Estimated	
		killed	Injured	(million. yuan)	
1992	39391	1937	3788	690	
1993	38094	2467	5971	1000	
1994	39120	2831	4236	1240	

Table 1 Fire Loss Figure in China, 1992-1994

### FIRE AND EXPLOSION HAZARD ASSESSMENT METHODS

Fire is a complex phenomenon involving many disciplines and a wide variety of tools and techniques must be brigaded to permit identification and quantification of the hazard.

The contents of the hazard assessments are comprised of an investigation of the extent of the disaster and the calculation of the areas likely to be affected by it. The assessment will also address problems regarding disaster prevention and the establishment of preventive countermeasures. The Chinese government and enterprises feel it neesary to use hazard assessment in accident prevention. Since the early 1980's, the Ministry of Labour and other organizations have sponsored a series of projects on fire, explosion hazard assessment and accident prevention, many local governments and enterprises have developed—their hazard assessment methods.

1. Hazard Severity Classifications of Propellant, Explosive and Ammunition Factories[1].

There exist immense fire and explosion risks in propellant, explosive and ammunition factories and enterprises. A model of hazard severity classifications of propellant, explosive and ammunitive factories are developed by China North Industries Group.

The hazard index of propellants and explosives for the unit evaluated is obtained in following equation:

$$H = W_B + W_B DP + \sum (1 - R_{Ii}/Roi)C_i$$

 $=W_B(1+KDP)+\sum_{i}(1-R_{ii}/Roi)C_i$ 

where H=hazard index of the unit,

W<sub>B</sub>=hazardous material index

D=population factor in the hypothetecal affected area

P=index of accident frequency rate

C<sub>i</sub>=severity of accident effect

Roi=safety distance required by the regulation

R<sub>1i</sub>=actual distance between the unit evaluated and the facility (i)

If  $R_{1i} > R_{oi}$ , then let  $R_{1i} = R_{oi}$ .

Table 2 Hazard Severity Classification of Factories

Hazard Index	Hazard Severity		
	Classification		
≥1500	I very high risk		
1200-1500	I high risk		
800 - 1200	moderate risk		
500 <del>- 8</del> 00	N risk		
≤ 500	V low risk		

# 2. Hazard Severity Classifications of Chemical Plants[2].

Because large amounts of flammable and exploive substances are daily handled and routinely stored in chemical industry, chemical plants are believed to be continuously exposed to the risk of fires and explosion accidents. A hazard assessment method based on the Dow Fire and Explosion Index and Mond Index has been developed by the Labour Protection Research Institute of Ministry of Chemical Industry and has been used in many chemical plants. The main procedures of the method are as follows:

- (1)Divided the plant to units. Here a unit is defined as a part of a plant which can be readily and logically characterised as a separate entity.
- (2) Determine the fire, explosion index F and toxicity index P and calculate the material index M:

$$M=F+P$$

(3) Calculate material weight index W.

$$W = (\sum_{i=1}^{n} M^{3}K_{i} W_{i})^{1/3}$$

where

M=material index,

K<sub>i</sub>=coefficient of material state,

Wi=weight of material.

(4) Calculate the process coefficient a<sub>1</sub>, equippent coefficient a<sub>2</sub>, building coefficients a<sub>3</sub>, safety device coefficient a<sub>4</sub>, environment coefficient a<sub>5</sub> and calculate the hazard index of the unit:

$$g = a_1 a_2 a_3 a_4 a_5 W$$

(5) Calculate the hazard index of the plant according to five of the extremely hazadous units:

$$G = (\sum_{i=1}^{5} g_i^2/5)^{1/2}$$

(6) Determine the hazard severity classification of the plant:

Table 3 Hazard Severity Classification of Chemical Plants

Hazard Index	hazard Severity		
	Classification		
>1500	1		
10001-1000	I		
501-1000	III		
201-500	N		
⟨200	V		

- (7) Determine safety management level, using safety management checklist.
- (8) Determine Safety Grade of the plant:

Table 4 Safety Assessment Matrix of Chemical Plant

Safety Managment Level	Hazard Aeverity Classifiction						
	1	I	R	. IV	· v		
A	high risk	moderate risk	low risk	very low risk	very low risk		
В	very high risk	high risk	moderate risk	low risk	very low risk		
С	very high risk	very high risk	high risk	moderate risk	low risk		

### 3. Fire and Explosion Hazard Assessment

In 1991, a Project of major hazard control was sponsored by the state Science

and Technology Commission and Ministry Labour. This project was carried out by National Institute for Occuptional Safety and Health. The immediate objective of the project is to strengthen the national system for prevention of large fire and explosion accidents in industrial activities through the identification, evaluation and control of industrial activities invollving hazardous substances and processes which have the potential to cause large accidnets. A method of fire and explosion hazard assessment was developed. The hazard assessment model is shown in Fig. 1.

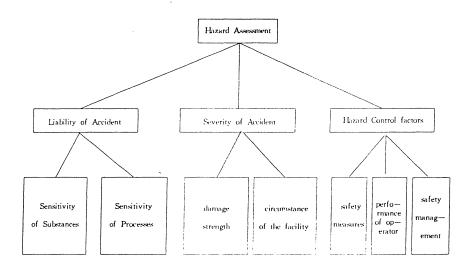


Fig. 1 Hazard Assessment Model

The Hazard Index can be expressed as:

$$A = \{ \sum_{i=1}^{n} \sum_{j=1}^{m} (B_{111})_{i} \ W_{ij}(B_{112})_{j} \} \ B_{12} \times \prod_{K=1}^{3} (1 + B_{2k})$$

where B<sub>111</sub>=accident sensitivity of hazardous substances

B<sub>112</sub>=accident sensitivity of processes

Wij=relatedness between the substance and the process

B<sub>12</sub>=severity of the accident

B<sub>2k</sub>=hazard control factors

# **DISCUSSION**

In China industrial fires and explosion accidents kill and injure a lot of people and cause tremdous economic loss each year. Because of the complexity of industrial activities concerned, fire prevention call for a system approach. Future action should facus on support for the establishment of national major industrual accident control systems. A first step is the identification of major hazard installations based on a national standard. Risk and hazard assessment, arrangements at the level of the enterprise and emergency planning should be progressively developed.

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