

STUDY ON THE METHOD OF THE HAZARDOUS CHEMICAL SECURITY RISK EARLY WARNING

Qi-Dong Yong¹, Zhan-BI Xu¹, Qi Zhang¹, Cheng-Ming Li², Jun Li³, Yang Chen⁴

¹ The department of POL application and management of Logistic Engineering University, ChongQing, 401311
² No.78315, KunMing, 650200, ³ No.78366, KunMing, 655102, ⁴ No.65523, DaShiQiao, 115100

ABSTRACT:

Hazardous chemicals safety risk early warning is the basic requirements of the realization of hazardous chemical safety production and operation, and the risk early warning can help the hazardous chemical safety prevention and emergency management. The key risk factors affecting POL depot safety are analyzed, and the multi dimension of hazardous chemicals early warning index system of safety risk and early warning mathematical model are established, which are based on daily management, hidden investigation, monitoring, emergency facilities and security education. According the index and the model, the risk score standard and risk classification method are put forward, which can provide a tool for emergency management, and the case application has been carried on. It plays an important role in the Hazardous chemical safety control.

KEYWORDS:

Hazardous chemicals, risk early warning model, index system, emergency management

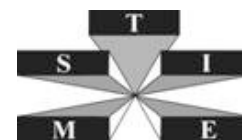
1. INTRODUCTION

Safety is a state of the pursuit of human society and the basic need of human survival. The production, storage, transportation, use of hazardous chemicals must be safe. The so-called hazardous chemicals refer to the hazardous materials and chemicals with high risk, such as petroleum chemical products, fireworks, easily made drug etc. Hazardous chemicals often is flammable, explosive and toxic characteristics, prone to accidents, the small will affect the normal operation of the units, the large will endanger personnel safety, and may even cause casualties and large for damage. Therefore, risk of hazardous chemicals for early warning and emergency management should be studied to save. there have been some achievements in dangerous chemical safety risk early warning aspects at home and abroad, which are mainly focus on the technology of single dimension evaluation, multi dimension in dangerous chemicals risk early warning index and modeling should be further studied^[1-5]. To this end, this paper presents a hazardous chemical safety risk early warning method based on the key element, which can provide a tool for emergency management, and then effective control of the risk of hazardous chemicals can be achieved.

2. THE CONSTRUCTION OF HAZARDOUS CHEMICALS RISK EARLY WARNING INDEX SYSTEM BASED ON THE KEY FACTORS

In the process of the production, storage, transportation, use of the hazardous chemicals, there are a lot of risk factors, which is closely related to the nature of hazardous chemicals, personnel, equipment, management, and environment. These risk factors can be attributed to 5 key factors, i.e. daily management, hidden investigation, monitoring, emergency facilities, safety education etc. Characteristics of these key factors can be analyzed and identifying, and then the risk early warning index system of hazardous chemicals will be established. As shown in Table 1 below.

Daily management focuses on responsible person qualification of the unit, personnel documented appointment rate situation, whether all kinds of production operation management rules and regulations are complete standard, whether safety organization explicitly is sound, whether the division of responsibilities is clear, whether emergency plan compilation is complete compliance, exercise is timely, accountability implementation is powerful; the hidden danger investigation focuses on whether hazardous chemicals storage facilities, structures, transportation condition, transceiver using, distribution facilities, fire facilities, the



surrounding environment, illegal hidden danger investigation thoroughly, and the rectification is in place; equipment monitoring focuses on whether investigate is complete and the equipment can play efficacy normally; operation accidents mainly count all kinds of accidents happened every quarter; safety activities focuses on whether the security situation analysis, safety education and safety knowledge contest etc. are regularly carried out.

Each index weight is obtained by AHP^[5], as shown in Table 1 above.

Table 1 risk early warning index system of hazardous chemicals and weights

First-class index and weight	second-class index and weight	Basic need
R1.daily management 0.3	1.1 identification 0.2	the person in charge and personnel certification in accordance with the provisions
	1.2 management system 0.3	various rules and regulations in accordance with the provisions
	1.3 security Organization 0.2	agency personnel and responsibilities in accordance with the requirements
	1.4 emergency plan 0.1	plan prepared revised and exercise complete timely
	1.5 accountability 0.2	the illegal personnel have the responsibility
R2. the hidden danger investigation 0.4	2.1 storage facilities 0.2	the hidden danger investigation thoroughly, rectification in place
	2.2 the building structure 0.15	the hidden danger investigation thoroughly, rectification in place
	2.3 transportation condition 0.1	the hidden danger investigation thoroughly, rectification in place
	2.4 transceiver using 0.2	the hidden danger investigation thoroughly, rectification in place
	2.5 distribution facilities 0.05	the hidden danger investigation thoroughly, rectification in place
	2.6 fire facilities 0.1	the hidden danger investigation thoroughly, rectification in place
	2.7 the surrounding environment 0.1	the hidden danger investigation thoroughly, rectification in place
	2.8 illegal hidden danger 0.1	the hidden danger investigation thoroughly, rectification in place
R3. equipment monitor 0.1	equipment monitor	meet the requirements of monitoring
R4.operation accident 0.1	operation accident	operation less accidents, to meet the requirements
R5.safety activity 0.1	5.1 situation analysis 0.5	conduct regular safety education situation
	5.2 safety education 0.3	safety education meets the requirements
	5.3 safety knowledge contest 0.2	carry out safety knowledge to meet the requirements

3. THE SCORING CRITERIA OF THE HAZARDOUS CHEMICALS RISK EARLY WARNING

The scoring criteria of the hazardous chemicals risk early warning refers to the judgement scale for all levels of indexes of risk degree. Normally, it can be divided into four grades, namely, A, B, C, D. A refers the minor risk; B refers the little risk; C refers the medium risk; D refers the high risk. As shown in table 2. For example, A, B, C, D are respectively corresponding qualification certificates rate and fully meet the requirements, the rate of 80%, the rate of 60%, the rate of below 50%, the corresponding risk scores were 1, 3, 6, 10. The higher the score is, the greater the risk will be.

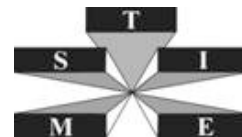
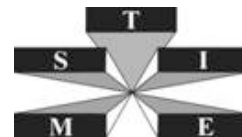


Table 2 risk early warning index system of hazardous chemicals criteria

First-class index	second-class index and judgement criteria	evaluation grade			
		A	B	C	D
R1.daily management 0.3	Risk judgement criteria	full meet the requirement	Rate of 80%	Rate of 60%	Rate of 50%
	1.1 qualification certificate 0.2	1	3	6	10
	1.2 management system 0.3	full meet the requirement	Short of 10%	Short of 30%	Short of 50%
		1	3	6	10
	1.3 safety organization 0.2	meet the requirement	Meet a little	Most do not meet	Do not meet
		1	3	7	10
	1.4 emergency plan 0.1	meet the requirement	Full and new	Short and old	No plan
		1	3	6	10
	1.5 duty 0.2	no accident	Direct and the relevant	The direct	No duty
		1	2	4	8
R2.hidden danger investigation 0.4	Degree of the hidden danger	Slight A	Little B	Danger C	very danger D
	2.1 storage facility 0.2	1	4	8	10
	2.2 the building structure 0.15	1	3	5	9
	2.3 transportation 0.1	1	3	5	9
	2.4 transceiver using 0.2	1	2	3	7
	2.5 distribution facilities 0.05	1	2	3	5
	2.6 fire facilities 0.1	1	2	3	7
	2.7 the surrounding environment 0.1	1	2	3	5
	2.8 illegal hidden danger 0.1	1	4	8	10
R3.monitoring equipment 0.1	Risk judgement criteria	normal	Only 1 substandard	Much substandard	substandard
		1	3	5	9
R4.operation accident 0.1	Risk judgement criteria	laborative	1 slight wound and more abortive	Many slight wound	Many people injured or killed
		1	3	5	10
R5.security activity 0.1	Risk judgement criteria	Plan and operate	Plan, implement	Part of plan, implementation	No plan, no implementation
	5.1 situation analysis 0.5	1	3	5	8
	5.2 safety education 0.3	1	3	4	7
	5.3 safety knowledge contest 0.2	1	2	3	5



According to the risk scoring criteria given in table 2, combined with the actual situation, the first-class index and overall risk early warning indexes and criteria will be obtained, as shown in table 3.

Table 3 the scoring criteria of the hazardous chemicals risk level

classification and overall risk criteria	Acceptable risk		Unacceptable risk	
	Slight risk	Little risk	Medium risk	High risk
	A	B	C	D
R1.dairly management	1	2.8	5.8	9.6
R2.hidden danger investigation	1	2.85	5	8.1
R3. monitoring equipment	1	3	5	9
R4. operation accident	1	3	5	10
R5.security education	1	2.8	4.3	7.1
Overall risk score	1	2.86	5.17	8.73

The risk radar image can be drawn according the risk level criteria l in table 3, as shown in figure 1. A refers slight risk, with green; B refers the small risk, with blue; C refers the medium risk, with yellow; D refers the high risk, with red. Obviously, the risk score curve falls on A - B area is acceptable; Fall in the B - C area need to alert or rectification; fall in the C-D area must immediately stop their operations.

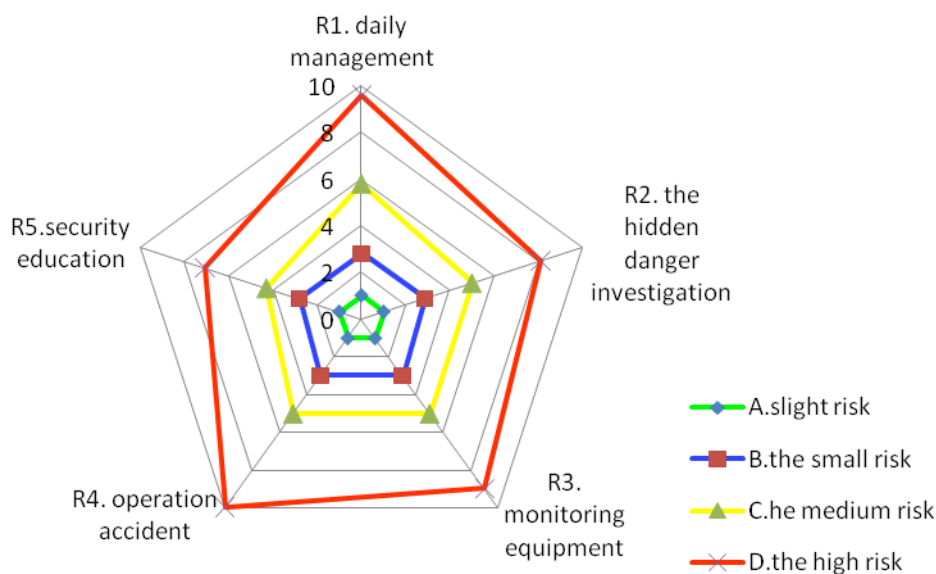
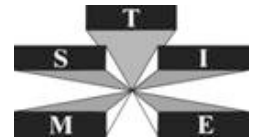


Fig.1 radar image of the scoring criteria of the hazardous chemicals risk level

4. HAZARDOUS CHEMICALS RISK EARLY WARNING MODEL AND DATA PROCESSING

Using the given level of risk judgment, the risk index values of daily management, hidden investigation, monitoring equipment, operation accidents and safety education can be got in Table 2.

The risk index value of the hidden danger investigation will be got by the formula (1), which focuses on the hidden investigation number and rectification number. The calculation formula is as follows



$$R_{ij} = \begin{cases} \sum_{k=1}^4 (Y_{ij}^k - Z_{ij}^k) \cdot F_{ij}^k, \sum_{k=1}^4 (Y_{ij}^k - Z_{ij}^k) \cdot F_{ij}^k \leq \max_k F_{ij}^k \\ \max_k F_{ij}^k, \sum_{k=1}^4 (Y_{ij}^k - Z_{ij}^k) \cdot F_{ij}^k \geq \max_k (F_{ij}^k) \end{cases} \quad (1)$$

In the formula(1), R_{ij} refers the risk value of the first-class of i and second-class of j; Y_{ij}^k refers the hidden danger number of the risk value of the first-class of i and second-class of j according with the k-level; Z_{ij}^k refers the hidden danger rectification number of the risk value of the first-class of i and second-class of j according with the k-level; F_{ij}^k refers the risk criteria value of the first-class of i and second-class of j.

$$R_i = \sum_{j=1}^m w_{ij} \cdot R_{ij} \quad i = 1,2,3,4,5; j = 1,2,3,\dots,m \quad (2)$$

In the formula(2), R_i refers the risk value of the first-class of i; w_{ij} refers the weight of the risk value of the first-class of i and second-class of j; m refers the number of the indexes first-class of i and second-class of j.

5. CASE ANALYSIS OF THE HAZARDOUS CHEMICALS RISK EARLY WARNING

The M POL depot has been investigated for the daily management, the hidden danger investigation, monitoring equipment, operation accidents and safety activities to obtain the relevant data. According with the evaluation index system and evaluation model, the results are calculated by the formula (1) and formula (2), as shown in Table 4 and Figure 2.

Table 4 the calculated risk early warning value of the POL depot

Risk index	the calculated risk value
R1. daily management	2.30
R2. the hidden danger investigation	3.75
R3. monitoring equipment	1.00
R4. operation accident	3.00
R5. security education	1.60
Total value	2.75

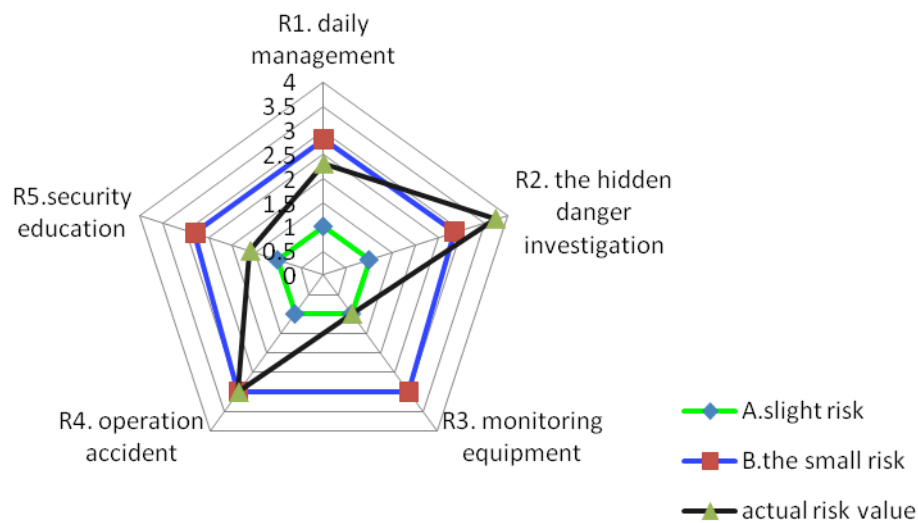
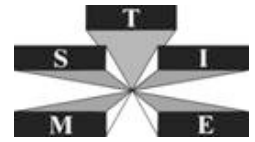


Fig.2 the radar image of the depot early warning evaluation



Combined with table 3, table 4 and Figure 2, it can be seen that the overall risk of the depot is between slight risk and small risk, which belongs to the category of acceptable; but the value of the hidden danger investigation index is higher beyond the blue line, and then individual rectification is should be done. Tracing the source, a POL storage facility has a high risk hidden danger has failed to eliminate timely.

6. CONCLUSIONS

- (1) According to the key factors that influence the risk of hazardous chemicals, a hazardous chemicals risk early warning index system consists of 5 first-class indexes and 18 second-class indexes are established to provide scientific basis for hazardous chemicals risk early warning;
- (2) The scoring criteria and the mathematical model of the hazardous chemicals risk early warning are constructed to provide a scientific method for the implementation of hazardous chemicals early warning;
- (3) It is shown by the application results that the early warning method can supply effective early warning of hazardous chemicals risk level, find out the high risk areas and factors, so as to provide practical guidance for management of hazardous chemicals risk.

ACKNOWLEDGMENTS

This thesis is supported by the Chongqing city project of CSTC2012GG-SFG00002 and the soft science project 2014YBGL126 & 2013YBSH044, and the headquarters of YX213L032.

REFERENCES

- [1] International Conference and Workshop on Reliability and Risk Management. September 15~18, 1998. Adam's Mark Hotel San Antonio River walk, Texas.
- [2] Muhlbauer W K. Pipeline Risk Management Manual(2nd Edition). Gulf Publishing Company,1996:34-37.
- [3] Kai lang chen. Hazardous goods transportation risk comprehensive evaluation model of [J].logistics technology,2007,(6):68-70.
- [4] Yong Qidong,Wang Yao,ding zezhong. Tank quantitative risk analysis and early warning [J]. Journal of Institute of Logistics Engineering,2012,28(5):16-20.
- [5] Yong Qidong,Chen Yang,Wang Yao. Study on risk analysis and control of oil tank based on environmental safety[J].Applied Mechanics and Materials,2013,260-261:882-886
- [6] Yong Qidong. POL supply security and warning [M].BeiJing: Petroleum Industry Press,2010:147-174.