

Research on Application of Risk Assessment Technology to 100,000-cubic-meter Crude Oil Storage Tanks

Fang Zhou^a, Xing Shu^b, Shen Gongtian^c, Li Guanghai^d, Yuan Yilin^e

Hazardous Chemical Substance Equipment Division, China Special Equipment Inspection and Research Institute, Beijing, P. R. China

^ae-mail: fangzhou@csei.org.cn, ^be-mail: xingshu@csei.org.cn, ^ce-mail: shengongtian@csei.org.cn, ^de-mail: liguanghai@csei.org.cn, ^ee-mail: yilin1988@126.com

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Abstract. Due to the large volume of storage tank at the national oil reserve base and its critical consequence of failure, its security issues are particularly prominent and are taken seriously by the government and the community. In this paper, the risk assessment technology is applied to 23 crude oil storage tanks whose nominal capacity are 100,000 cubic meters at a national oil reserve base. It is concluded that the wall plate and bottom plate of 23 storage tanks are expecting a certain period of risks at present and in the future. According to the acceptable level of risks of the reserve base and the damage mechanism and failure modes of different configuration items of storage tanks, the risk-based inspection strategy of 23 storage tanks is developed.

Introduction

In recent years, with the advances in the construction process of national strategic oil reserve bases in China, the safety of large atmospheric storage tank has become particularly important [1-3]. Due to its large volume and hazardous containing medium, the leakage will trigger major accidents such as fires and explosions, cause incalculable environmental damage and bring disastrous consequences [4-5]. Fig. 1 shows a photo of oil tank damage.



Fig 1 shows a photo of oil tank damage

At present, most of our inspection modes of storage tanks are still in the stage of periodic inspection, i.e., regularly test the dangerous chemical storage tanks according to periodic inspection plans. However, the periodic inspection has some drawbacks: on the one hand, the aging tanks which have greater risks cannot be tested in time, on the other hand, opening and inspection most of storage tanks with no serious defects will result in excess, which leads to unnecessary loss of production [6-7].

Therefore, the risk assessment of the storage tanks turns periodic inspection into risk-based inspection, which both ensures safe operation and has a great cost savings.

Project Background

23 storage tanks under the application of risk assessment are all aboveground atmospheric storage tanks. They are designed and constructed according to National Standards of P.R.C. for Design of Vertical Cylindrical Steel Welded Storage Tank SH 3046-92, National Standards of P.R.C. for Seismic Design of Steel Equipment in Petrochemical Industry SH 3048-99, National Standards of P.R.C. for Construction and Inspection for Vertical Cylindrical Steel Welded Storage Tank GBJ128-90, National Standards of P.R.C. for Construction and Inspection for Field Equipment and Industrial Pipeline Welding Engineering GB50236-98.

23 storage tanks are all floating-roof tanks, whose host materials include SPV490Q, 16MnR, Q235-B, and Q235-A; the containing medium for storage tank are crude oil, and time-to-use starts from August 2006 to April 2007. Basic information is shown in Table 1.

Table 1 Basic Information of Containing Medium (According to Tank No.)

No.	Name	Origin	Sulfur content m%	Acid mgkoh/g	Viscosity(50 °C) mm ² /s	Storage tank number with this medium
1	Iran light crude oil	Iran	1.50	0.12	6.10	T-19, T-20
2	Iran heavy crude oil	Iran	2.02	0.11	9.87	T-25, T-26
3	Basra crude oil	Iraq	2.92	0.14	10.63	T-36
4	Ural crude oil	Russia	1.4	0.06	6.76	T-41
5	Saudi light crude oil	Saudi Arabia	2.00	0.05	5.77	T-6, T-11, T-12, T-17, T-18, T-23, T-24, T-29, T-31, T-32, T-37, T-38, T-43, T-44
6	Xirui crude oil	Iran	1.90	0.07	6.35	T-30

The technical foundation of the risk assessment project in this paper includes: Safety Technical Regulation for Vertical Cylindrical Steel Welded Storage Tank AQ 3053-2015, Risk-Based Inspection and Evaluation for Atmospheric Storage Tank GB/T 30578-2014, Risk-Based Inspection API 580, Risk-Based Inspection Technology API 581, The Procedures for Operation, Maintenance and Repair of Vertical Cylindrical Steel Welded Tank SY/T5921-2011, and so on[8-10].

Risk Calculation

For risk calculation, DNV GL Onshore 5.3.2, a risk assessment software, is adopted to calculate the respective likelihood of failure and failure consequences of bottom plate and wall plate of tanks. According to the pattern of damage and failure mechanism, the injury parameter shall be determined in accordance with relevant regulations of API 581 and GB/t 30578 in order to calculate the likelihood of failure for each storage tank; in terms of the establishment of failure consequences, the main characteristics of medium and release rate, the environmental damage caused by the leakage of medium, groundwater pollution, losses of business interruption, personal injury and other factors should be taken into consideration; the levels of risk are determined on the grounds of the likelihood of failure and failure consequences.

The risk matrix for the bottom plate and wall plate of 23 storage tanks at present (September 2016), in 5 years (September 2021) and in 10 years (September 2026) is shown in Fig. 1, Fig. 2 and Fig. 3.

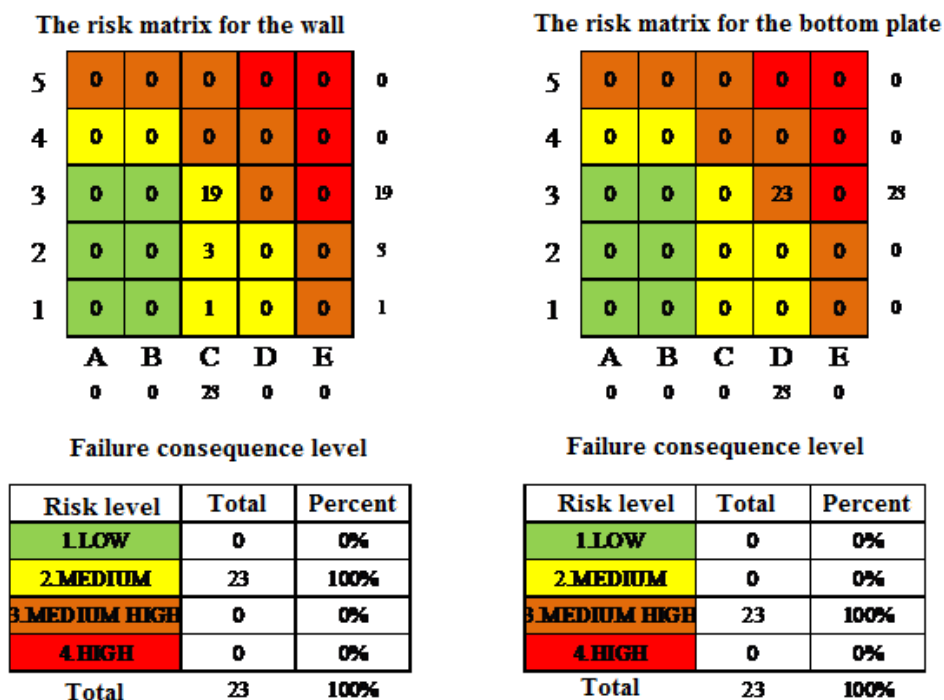


Fig.1 The bottom plate and wall plate of storage tanks and risk maps in 2016

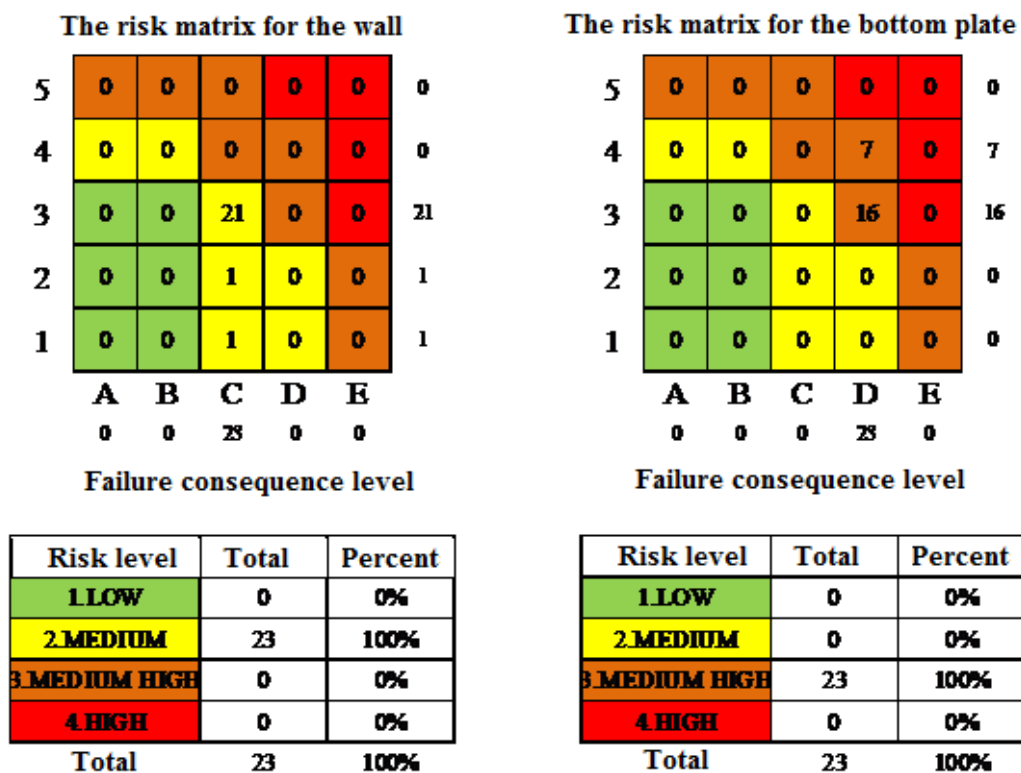


Fig. 2 The bottom plate and wall plate of storage tanks and risk maps in 2021

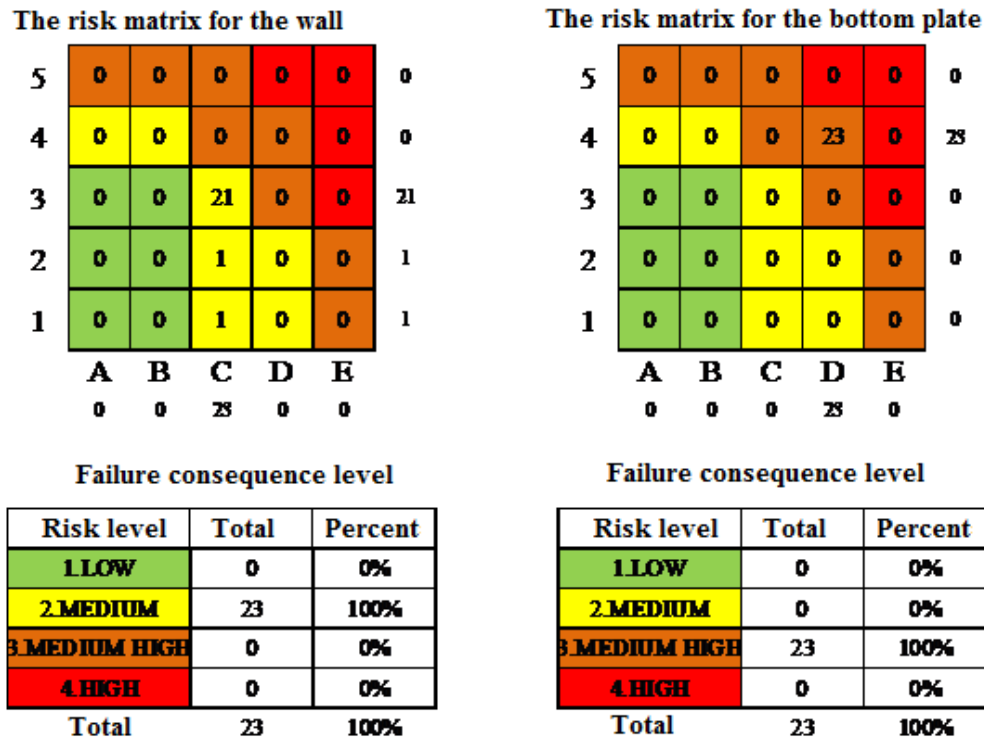


Fig. 3 The bottom plate and wall plate of storage tanks and risk maps in 2026

Summary

(1) The risk analysis involving a total of 23 units of atmospheric storage tanks, the current risk calculation results show that devices of the medium risk level are almost wall plate, and devices of the relatively high risks are mainly the bottom plates.

(2) According to the risk calculation results of the next 5 years and the next 10 years, devices of the medium risk level are almost wall plate, and devices of the relatively high risks are mainly the bottom plates

(3) After completing the assessment, online inspection can be done as planned according to the risk levels of storage tanks; and based on the online inspection results, the overall downtime inspection of storage tanks by opening the tanks can be properly arranged.

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