Analysis on the Four Areas and Three Lines Planning on Chemical Industry Park Periphery

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Abstract. Chemical industry park and its peripheral areas are important parts of urban construction land. By analyzing the potential safety risks of the park, planning the hierarchical structure of the peripheral space, exploring the way of harmonious coexistence between the park and city, useful guidance can be provided for the planning and construction of the chemical park.

1. Introduction
A chemical industry park is a gathering area of many petrochemical enterprises. Petrochemical enterprises are refineries, petrochemical plants, petrochemical fiber plants or their joint factories that are using petroleum, natural gas or their refined products as raw materials to produce, store and transport various petrochemical products. Its main production unit is composed of one or more correlated process units [1]. Most of the raw materials, intermediate products and end products of petrochemical enterprises are dangerous, including explosives, compressed gases and liquefied gases, flammable liquids, flammable solids, spontaneously combustible materials and dangerous when wet materials, oxidants and organic peroxides, toxic substances and corrosives. The production, transportation and storage of these dangerous chemicals may lead to safety accidents.

In recent years, some major accidents in the chemical industry park have caused severe damage to the surrounding facilities and environment. For example, the 11-28 major explosion accident in Hebei Province in 2018 and the 3-21 major explosion accident in Jiangsu Province in 2019 caused heavy casualties and property losses not only to its own company but also to the surrounding enterprises. In order to prevent and decrease the impact of potential safety accidents (fire, explosion, poisoning, etc.) in the chemical industry park on the protection targets outside, it is necessary to set up a safety space around the park.

2. Safety factors around the park

2.1 Two Key Points and One Major (TKPOM) device
TKPOM is the key regulated hazardous chemical process, the production and storage devices of the key regulated hazardous chemicals and the major hazard sources of the hazardous chemicals [2]. TKPOM is the main source of potential safety accidents in the chemical industry park, and also the object of key control.

The management and control of TKPOM start from the preliminary planning. Hazard and Operability (HAZOP) analysis shall be carried out in the planning and design stage, while automatic
control, safety interlock and monitoring system shall be equipped to improve the intrinsic safety level of the devices. Strengthening the management during operation, improving the post skills of operators, and conducting HAZOP analysis of the devices regularly are necessary for safety risk reduction.

2.2 Peripheral preservation target
The preservation targets are the facilities or places outside the chemical industry park where casualties may occur during safety accidents. The preservation target can be divided into three categories: high sensitive preservation target, important preservation target and general preservation target. The general preservation target can also be divided into three categories: preservation target I, preservation target II and preservation target III [3].

2.3 Peripheral safety space
The safety space around the chemical industry park refers to the space between the chemical industry park and the preservation target outside. Because the TKPOM in the chemical industry park are the places where potential major safety accidents happen, it is necessary to set up a safety space to prevent damage on preservation objectives by accidents. The peripheral safety space is not only the buffer and isolation space between the chemical industry park and the preservation target, but also the stretch space of the chemical industry park. The destruction of facilities outside a chemical industry park caused by a deflagration accident is showed as Figure 1. It can be seen that the accident-related storage tanks caused serious burning damage to the adjacent facilities.

![Figure 1. Scene of deflagration accident in a chemical industry park.](image)

3. Four Areas and Three Lines (FATL) around the park

3.1 Functional division of FATL
From the chemical industry park to the preservation target, there are four areas, i.e. the park, buffer area, isolation area and preservation area. These four areas are defined as follows:

3.1.1 Chemical industry park. Chemical industry park is a special area of construction land in urban planning. In view of the specificity of the land for chemical industry usage, it is necessary to set up a red line for the land, mark the peripheral coordinates, and restrict land scope adjustment strictly.

3.1.2 Buffer area. A buffer area is a disaster mitigation zone for preservation targets outside the chemical industry park. The buffer area is adjacent to the boundary of the chemical industry park, which is a high-risk zone hazard of potential safety accidents. According to the provisions of fire protection designing standards in force, the width of the buffer area must be equal to or larger than 100
In consideration of its adjacency to the chemical industry park along with the risk and facilitation management, the buffer area is generally planned as the public auxiliary area and supporting facilities construction land of the chemical industry park.

3.1.3 Isolation area. An isolation area is the area between the chemical industry park and the surrounding environment-sensitive targets, e.g. residential areas, schools, hospitals. According to the provisions of the fire protection designing standards in force, the width of the isolation area must be equal to or larger than 300 meters\(^1\). However, when conducting environmental impact assessment, the width is generally required to be equal to or larger than 500 meters. No school, hospital, residential or other environmentally sensitive targets shall be planned and constructed in this area\(^5\). In fact, the isolation area contains buffer and transition area. As a part of the isolation area, the transition area is between the buffer and the preservation area.

3.1.4 Preservation area. A preservation area is the area where the preservation targets are located outside the isolation area. It is the planning area for the important infrastructure and sensitive facilities of the city.

The functional division of FATL is showed as Figure 2.

![Functional division of FATL](image)

3.2 Land classification of FATL
The buffer area is adjacent to the chemical industry park. It is planned to be the public auxiliary and supporting facilities construction land of the park. It is defined as third type land for industrial usage and land for non-sensitive place. As a part of the isolation area, transition area is planned as first or second type land for industrial usage and land for non-sensitive place. The preservation area is planned to be first type land for industrial usage and land for sensitive place. All the above areas are urban construction land.

The land type classification of FATL is showed as Figure 3.
Figure 3. Land classification of FATL.

3.3 Boundary control of FATL
The external safety protection distance is a distance or risk control line set between the devices or facilities and the preservation target in order to prevent and mitigate the damage of potential safety accidents from hazardous chemical production devices and storage facilities[4]. The external safety distance should meet the distance requirements of fire protection, explosion protection and health protection. It is determined according to the standard specifications, and verified by accident consequence act and quantitative risk assessment according to the actual situation[4].

The boundary of FATL is the limitation of land development and utilization, also known as the safety control line of land planning. There are three types of control lines - red line for chemical park land control, orange line for buffer area land control and yellow line for isolation area land control. These three lines are defined as follows:

3.3.1 The red line for chemical park land control. The red line is used to delimit the scope of the chemical industry park. Chemical enterprises outside the red line shall move into the park according to the requirements of relocation and improvement of industry. Chemical project contraction or extension that crossing the red line is forbidden.

3.3.2 The orange line for buffer area land control. The orange line is used to delimit the adjacent area to the chemical industry park. The buffer area can be planned to build comprehensive management and service facilities, general step-down substations, heating plants, parking lots for hazardous chemical transport vehicles and maintenance depots, etc.

3.3.3 The yellow line for isolation area land control. The yellow line is used to delimit the boundary between the chemical industry park and the environment-sensitive targets. The yellow line ensures the safety of environmental-sensitive targets. Environmental sensitive targets such as schools, hospitals and residential buildings must be planned outside the yellow line of the isolation area. The boundary control of FATL is showed as Figure 4.
4. Conclusions
The planning of chemical industry parks is an important part of urban planning, and the peripheral space planning is critical in park planning. Due to the risks of TKPOM, the FATL should be arranged in the periphery of the chemical industry park when planning. In turn, the threat from chemical industry parks will be minimized after the layout of FATL. The following factors shall be taken into account in the planning of FATL:

- Characteristics of projects in the chemical industry park. For special chemical projects such as phosgene, the peripheral safety preservation distance is required to be larger, and the scope of FATL is required to be wider.
- Total amount of hazardous chemicals in the chemical industry park. The larger the amount of hazardous chemicals storage, the severer the impact on the preservation target. The scope of FATL will also be wider.
- Protection level of peripheral preservation targets. The higher the protection level of the peripheral target is, the wider the safety protection distance is required. The scope of FATL will also be wider.

Acknowledgments
I would like to express my very great appreciation to Ms. Zhu Cuiqin, the senior safety engineer, for her valuable and constructive suggestion in identifying TKPOM and its hazard degree. I would also like to thank Ms Chen Heqing for her advice on the structure of the thesis.

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