



# Study on Remote Coordinated Emergency Response Mode of Typical Petroleum and Petrochemical Accidents

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**Abstract.** On the basis of analyzing the emergency response process of typical petroleum and petrochemical accidents, this paper analyzes the emergency rescue cases of four typical accidents, concludes the deficiencies existing in the current rescue process, and puts forward the development requirements for the future remote collaborative emergency response mode. Through the above analysis, in combination with the current communication and the development of intelligent equipment, remote collaborative emergency mode based on integrated communication scheme for refinery plant emergencies and visual remote assistance emergency mode based on AR for well control emergencies are proposed. Respectively, the technical framework and system functions of the two are described, and the future development direction is given.

**Keywords:** Emergency Disposal · Emergency Model · Communication System · AR Technology

## 1 Introduction

In the field of petroleum and petrochemical emergency response, the current development trend is to further apply 5G, Internet of Things technology, big data and cloud computing technology based on the existing emergency management information construction to transform the emergency management and emergency rescue process to digital transformation and intelligent upgrade, in order to improve the level of specialization and refinement of emergency management. At present, the integrated application of intelligent technology and emergency technology [1–3], in addition to the application of artificial intelligence technology and Internet of Things technology to develop emergency response equipment and intelligent emergency system [4, 5], also uses intelligent early warning and data analysis technology to improve the ability to accurately prevent accidents.

To sum up, in order to eliminate accidents in the embryonic stage and improve the emergency handling capacity of petroleum and petrochemical accidents, it is urgent to improve the data processing capacity and emergency rescue capacity in the initial stage and during the occurrence of accidents. In the basic emergency rescue procedures

of typical petroleum and petrochemical accidents, Prediction and early warning, alarm reception, response level determination, emergency start-up, rescue operation, emergency expansion, emergency recovery, emergency termination and other processes are relatively complex, and the degree of inter-departmental coordination in rescue is not high, so the expected results cannot be achieved. In view of the development status of comprehensive intelligent emergency response, “remote collaboration technology” combining big data, mobile Internet, AR, VR and other technologies has gradually been widely used. As a new technology system integrating various technologies, remote collaboration technology has strong correlation and mobility between subsystems and technologies. With the development of 5G technology, information can be transmitted with low time delay. The introduction of remote collaboration technology can make up for the shortage of current emergency work and play a more efficient role. This paper analyzes the emergency rescue situation of typical petroleum and petrochemical accidents in China, analyzes the emergency treatment process, summarizes the rescue capacity defects of various accidents, and prospects the remote cooperative emergency rescue mode of petroleum and petrochemical accidents by introducing the remote cooperative emergency technology.

## **2 Overview of Typical Emergency Rescue Procedures for Petroleum and Petrochemical Accidents**

In the treatment of petroleum and petrochemical accidents in China, the allocation and definition of basic tasks in the pre, middle and post accident stages and the setting of emergency treatment organization corresponding to the response link need to follow the regulations, which has formed a set of typical accident disposal process [Fig. 1]. By analyzing the accident disposal process of petroleum and petrochemical accidents, we can find out how to allocate and define the basic tasks in the pre, middle and post accident stages and how to determine the corresponding emergency handling organization, so as to explore the application and development of intelligence in the current petroleum and petrochemical accident disposal.

### **(1) Prevention and Preparation**

In the daily management stage without accidents, petroleum and petrochemical enterprises should do a good job in risk control, accident prevention and preparation for all possible accidents. In this stage, it mainly focuses on the risk assessment of plant construction and production projects, the investigation of emergency resources, the preparation of emergency plans and other aspects. Meanwhile, the reserve of emergency resources should be well implemented, and accident drills and safety emergency training should be carried out regularly. Risk analysis and emergency classification of certain event objects are mainly carried out in two parts: risk identification and hazard degree assessment, focusing on the identification of hazard sources in the scene, which can effectively control risks in advance and create primary conditions for the emergency rescue construction of petroleum and petrochemical accidents.

After the completion of the risk assessment operation, it is necessary to carry out a complete emergency plan to ensure that emergency and rescue operations can be

effectively carried out after the occurrence of the accident and reduce the loss of the event. The emergency plan needs to clarify the organization, corresponding responsibilities and resource preparation before, during and just after the emergency, so as to organize and dispatch all aspects of rescue forces and social resources to the greatest extent after the event, and implement disaster prevention, monitoring and emergency disposal, rescue, disaster relief, recovery and reconstruction as quickly, effectively and orderly as possible, and not just post-disaster relief and rescue.

Enterprise daily safety culture construction is essential. In daily management, petroleum and petrochemical enterprises carry out emergency drills and training, safety culture and education, and safety knowledge training and publicity. Such actions can effectively improve the risk resistance ability of enterprises and the self-rescue and disaster relief ability of employees.

## (2) Emergency handling process

When an emergency occurs, the on-site staff and production personnel of petroleum and petrochemical enterprises give an alarm by pressing the alarm button and telephone, and get in touch with the central control room through multiple telephones set in the plant. At the same time, the production facilities are monitored 24 h a day by monitoring personnel. When an emergency occurs in the production facility, the on-site automatic detection equipment will monitor and alarm, and the on-duty production supervisor will report the accident information according to the company's reporting process, thus entering the stage of emergency treatment and rescue. At the same time, after reporting to the relevant superior department from the incident unit, the superior department will continue to report to the superior according to the accident rating, and send rescue forces to join the rescue. During this period, the relevant departments and relevant enterprises need to do a good job in coordination, linkage and timely feedback of information.

The stage of emergency rescue is the most critical stage in the whole emergency process. At this stage, there are many tasks, including setting up the emergency leading group, directing the entire emergency rescue operation, sending experts to the rear of the scene, determining what kind of on-site detection method is needed for the leakage and explosion of hazardous chemicals, and selecting which detection point and other technical issues. The rescue team shall be equipped with compliant protective clothing, and the rescue equipment shall comply with explosion-proof standards. Relevant departments are required to carry out traffic control and medical support near the site. The government and the media are generally responsible for directing people's resettlement and controlling public opinion.

## (3) Recovery and reconstruction

In the process of emergency response, the recovery and reconstruction after an accident is an important link between the preceding and the following. When the emergency rescue stage enters the closing stage, the local enterprises, governments and relevant responsible units shall timely evaluate the reconstruction capacity and available on-site resources, cooperate with relevant emergency management departments to investigate the accident, estimate the loss, further formulate the recovery and reconstruction plan

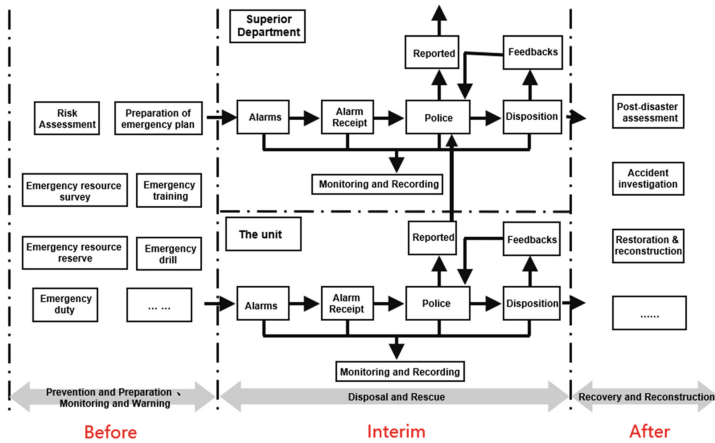


Fig. 1. Existing emergency rescue process of petroleum and petrochemical accidents

and implement material and technical support. The actions at this stage affect the reputation and impact evaluation of enterprises and governments in local society, as well as the orderly development of local economy and related industries.

### 3 Problems Existing in Emergency Rescue of 4 Typical Accidents

After research and analysis, the deficiencies of the emergency rescue of the four typical accidents were mainly reflected in the defects of emergency supplies and equipment, information reporting and other communication problems. In the rescue process of the accident, there was a shortage of fire trucks and well control materials, which led to the suspension of the rescue operation and low efficiency. The situation of joint fire service and untimely information sharing led to the failure to maximize the use of information. Among the typical accident treatment cases, the problems related to insufficient equipment capacity were the most, reaching 24 cases. However, the main problems in the emergency disposal process of different events were different. Among them, there were 16 accidents in refiners and storage tanks, which were mainly reflected in emergency equipment. For long distance pipeline accidents, there are problems such as lack of information sharing and command communication in emergency treatment. The handling of well control emergencies is mainly reflected in the lack of professional quality of emergency personnel and insufficient equipment and materials.

### 4 Remote Collaborative Emergency Mode Based on Integrated Communication Scheme for Refinery Plant Emergencies

In the remote cooperative emergency system, complete integrated communication and data transmission are the key to ensure the efficient operation of the cooperative emergency system. Therefore, we design a set of integrated emergency communication system. Based on the principles of wireless bridge, relay transmission and signal amplification, a signal relay amplification system for mobile and wired networks is built [Fig. 2].

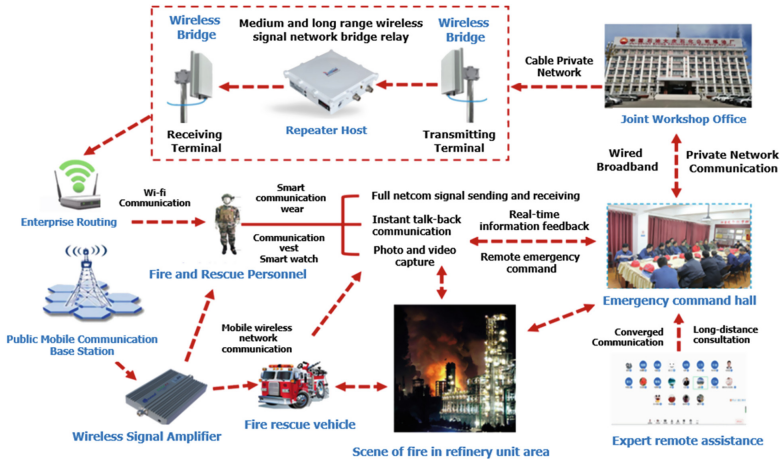


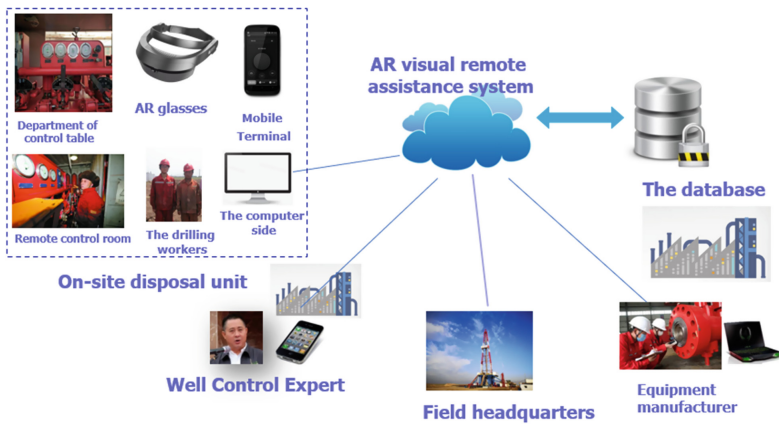
Fig. 2. Overall architecture of emergency broadband integrated communication system

The system has various capabilities, such as providing supporting intelligent communication wearable devices (communication vest, smart watch, etc.) for fire emergency personnel, realizing image information acquisition and instant communication feedback, forming a public-private complementary and man-machine interactive integrated communication scheme, and solving the problems of unsmooth communication, unstable signal and single communication mode. Its technical architecture is shown in Fig. 2.

### 5 Visual Remote Assistance Emergency Mode Based on AR for Well Control Emergencies

Previously, some scholars have studied the safety monitoring methods in the process of drilling and mining accidents. But there are various problems. Combined with the development of AR technology [Fig. 3], AR technology can not only solve the data security monitoring in the process of accident handling, but also realize field personnel utilization of intelligent AR glasses, fixed cameras, smart phones and other terminals for video shooting, so that experts can understand the scene situation in real time. Through the smart terminal, front-line personnel can receive real-time guidance and assistance from experts, including video and voice guidance, virtual paintbrush marking, and even video push guidance.

The design of AR visual remote assist well control emergency disposal system can make up for the shortage of digitalization in the process of well control emergency disposal, and improve the sharing and support of rescue and disposal information with the help of AR virtual technology. Director can query and retrieve information and data through a variety of channels. Information and data can be text, image, audio, video and other forms, because the current commonly used remote rescue assistance is mostly with the help of mobile terminals, mainly including mobile phones and mobile computers, through the 4G network to connect and communicate with the rear support personnel. Even so, there are still some problems. For example, there are too many equipment and



**Fig. 3.** AR visual remote assistance system

a long distance on the site of accident disposal, which easily leads to low disposal efficiency, rapid consumption of human, material and financial resources, and high disposal cost of one emergency. Therefore, the development of a set of portable visual remote assistance system can avoid the above problems, provide timely support, and improve work efficiency. Based on AR smart glasses, the rear supports can analysis and process the data collected by AR glasses to provide visual information support for the front. This can completely free hands and improve disposal efficiency in replacement of the complicated operation manual, flow chart, intercom and other work equipment; Realize the information exchange, enhance the handling experience of practical problems. System design through the drilling operation and maintenance of remote assistance service function design, remote cross-platform multi-party video call, fault experience database to achieve video connection, voice call, AR enhanced display, remote support, multi-party consultation, desktop synchronization, video storage and other functions.

## 6 Conclusion

On the basis of analyzing the current overall accident emergency process and the deficiency of emergency rescue in four types of petroleum and petrochemical typical accidents, it is concluded that this kind of accident cause of bad consequences mostly concentrated in the shortage of collaborative efficiency for remote communication command and intelligence for emergency rescue equipment. In order to solve this kind of problem, respectively from these two aspects, combine the emergency technology with remote collaborative technology. Design the refining device remotely emergencies emergency mode based on fusion communication scheme and visible remote assistance system scheme based on AR technology, provide suitable application mode in order to achieve a unified command and unified scheduling, efficient communication and data transmission, and the front and rear coordinated remote assistance rescue command in the process of the accident for the future.

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