

**China's Mine Rescue System**  
**and**  
**Field Practice**

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# China's Mine Rescue System and Field Practice

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**Abstract:** Rescue is an important part of work safety in coal mines. China has got a history of carrying out mine rescue for nearly half a century. Rich experience has been collected in the course of the long-term mine rescue practice. In recent years particularly, the development of mine safety and technology has brought about rapid progress to mine rescue technology in China. The author sets forth the status and problems existed in the sector of mine rescue in China in conjunction with the mine rescue practice in Xinwen Mining Community.

**Key words:** Xinwen Mining Community · Mine Rescue · System · Practice

## 1. Occurrence characteristics of seams in China's coal mines and analysis on reasons for frequently-occurred disasters

The conditions of occurrence of coal seams decide the production conditions in coal mines and the existing natural disasters in China. Since buried depths of coal seams are rather deep, more than 95% of mines in China are underground mines. Generally speaking, coal seams in China have complicated geological conditions, comparatively big increase of mining depth and rather poor stability. Among the large and medium-scale coal mines, 33% approximately of the them have complicated or extremely complicated geological seams structures while in small-scale mines the figure is up to 20.4%. Among the large and medium-scale coal mines, 25% approximately of them have complicated or extremely complicated hydrogeological conditions. In China, the average mining depth in large and medium-scale coal mines is 411m and five mines are operating below 1,000m underground. Coal mines operating at the mining depth of more than 600m account for 23.4% of the total production capacity of the country. And every year the average mining depth is increasing by 10m approximately.

Coal mines in China have poor natural conditions because of such complicated

geological conditions. According to a survey to only 628 key state-owned coal mines, almost all mines in the country are gaseous ones. Mines with big reserves of gas and with hazards of coalburst and gasburst account for 49.2% approximately of the total. Mines with hazards of spontaneous ignition in coal seams account for 57.5% of the total. Mines with hazards of coal dust explosion account for 89.5% of the total. Mines with hazards of impact pressure account for 5.13% of the large and medium-scale coal mines. 37.1% mines of the large and medium-scale mines are being threatened by flooding. Under the extremely poor natural conditions, China's coal mines are facing great challenges in terms of work safety. For instance, 47.2% mines have coal seams with gas content of more than  $10\text{m}^3/\text{t}$ . 20.5% of the large and medium-scale coal mines have absolute gas emission of more than  $30\text{m}^3/\text{min}$ . and the max. can be up to  $338.67\text{m}^3/\text{min}$ . This proves that ventilation only will not be able to solve the problem of gas. Such hidden danger that may lead to accident is very serious. Therefore, the poor natural conditions of coal mines in China is one of the important reasons that has brought about frequent accidents.

Production faces in coal mines in China have been advancing to further depth year by year. With further mining depth downward, gas emission will be increased, temperature at the workplace will be gone up, ground pressure will be boosted and production conditions will be further worsened, too. In Xinwen Mining Community, for example, the bigger mining depth has produced some unfavorable influence, such as the higher ground pressure and rock temperature and more abnormal gassy zones that has increased the difficulty to maintain the roadway as well as the hidden hazards of impact pressure. The increase of the number of abnormal gassy zones and the exponent of coal dust explosivity have made it more difficult to control the coal dust. The high temperature, the severe thermal poison and the worsened operating circumstance are threatening the health and safety of the staffs working underground. The threat of flood is becoming more outstanding with the further mining depth. The pressure-bearing water inside the floor is strongly influenced by the high-pressure aquifer in the limestone of the Ordovician period. Small shallow coal mines are seriously flooded by the surface water. The short spontaneous ignition period of seams increases the hidden danger of coal spontaneous ignition. Many grave accidents and disasters of gas, coal dust, water inrush and impact pressure had occurred in the community. Taking Pingdingshan Mining Community as another example, it is only a community with low gas content at the early stage of mining. With the further mining in depth, the disaster of both coalburst and gasburst began to occur in one mine and then they occurred more frequently one after another. Currently, five mines in the community are being threatened by both coalburst and gasburst. Therefore, Pingdingshan has now become a high gaseous community with coalburst and gasburst hazards. In some mines with hazards of burst, it occurs the "phenomenon of delay" after mining very deeply. It is easy to have accident when natural conditions have made changes in a coal mine before we don't know well the laws

of the changes.

There is another marked difference between the coal mines in China and those of the world major coal producers. That is, China has a large number of coal mines and large, medium and small-scale mines are co-existing with each other. According to the statistics by the end of 1999, there were 561 large and medium-scale coal mines and 36,710 small coal mines in China while in the USA, there are 1,750 coal mines and the annual output of washed coal is 1 billion tons. The distributed and numerous coal mines in China have brought about inconvenience to safety control. Little training has been provided for the miners and their poor safety awareness are also the reasons of the repeated accidents. Although the Chinese government has taken a series of major measures such as closure of some unqualified mines and safety rectification in coal mines, serious accidents due to lack of work safety are occurring now and then in coal mines. The death rate per million t of coal produced has been kept to the high. In 1980, the death rate per million t of coal produced was 8.17. In 1989, the rate was 7.07. In 2002, the rate was reduced to 4.64. Although the death rate per million t of coal produced in coal mines in China has been decreasing year by year, the fatalities has been more than 6,000 persons annually. Therefore, it is really necessary to establish a complete set of perfect mine emergency rescue system in our country.

## **2. Status of mine emergency rescue system in China**

### **2.1 Developing status of mine emergency rescue system in China**

After New China was founded in 1949, the first mine rescue team was set up in Fushun in northeastern Liaoning province, composed of only 20 rescuers at that time. During the “First Five-year Plan”, each state-owned coal mine set up its own mine rescue team, becoming an internal organization of the enterprise. The *Rescue Team Trial Practice* was laid down accordingly. In 1979, the *Rescue Team Working Regulations* and *Fight Preparatory Standards and Inspection Methods for Mine Rescue Teams* were respectively formulated. Activities of establishing first-class mine rescue teams were carried out in the meanwhile. After eighties of 20<sup>th</sup> century, a group of local rescue teams came into being together with the vigorous development of local villages and towns. In 1987, rescue teams began to follow military administration routines according to the published *Acceptance Standards and Evaluation Methods for Military Mine Rescue Team*. After the former Ministry of Coal Industry(MCI) was re-set up in 1993, the complete rescue management system was established unified by MCI from the top to the bottom, composing of central brigades and detachments. In 1995, *Coal Mine Rescue Rules* was issued. With the growth of mines in China, mine rescue teams are becoming stronger and stronger. Currently, there are more than 120 (including independent detachments) mine rescue teams and more than 21,000 rescuers in China. China has possessed the capacity to conduct rescue operation both from

the surface to underground and from the mine to the society.

Basic equipments necessary for a mine rescue team include: personal protective appliances (respirator and self-rescuer, etc.), mine ambulance, communication devices (large power transceiver and rescue communication system), fire extinguishing equipment (inert gas generator and high foam generator, etc.), analyzing/testing/checking instruments and equipment tools, etc.

At present, all key state-owned coal enterprises in China have generally set up the comparatively perfect emergency rescue system. If an accident occurs, the government or the department of the provincial authority will assemble the rescue teams of the nearby key state-owned enterprises to conduct rescue work. Mine rescue teams follow military administration and ranking system and the government has stipulated regulations to the rescuer's clothing. From January 1, 1995 on, all recruited mine rescuers should serve their teams by the contract system. Rescuers are selected from among the underground staffs and graduates of technical schools. Only when they have received relevant training, passed the exams and probation and obtained the certification, can they carry out their job of mine rescue. It is specified in the *Coal Mine Safety Rules* of the 2001 version that each coal mine must have a rescue team at its service. Those coal enterprises without the condition to independently set up their own rescue teams should sign rescue contracts with the nearby rescue teams or set up joint rescue teams. Otherwise, these coal mines can't put into operation. Mine rescue teams must be certified by the State Administration of Work Safety (SAWS). Only when they obtained the certification, can they carry out their work on mine rescue.

## 2.2 China's mine rescue organizational system

China is a big country of energy production. More than 80% of raw industrial materials and more than 95% of energy resources come from mines. As the key industry of our national economy, coal plays the especially important strategic role in the development of the national economy of China. Since mineral mining is a complicated process with high hazards and severe natural disasters, the Chinese government has been attaching great importance to mine rescue. Through long-term practice in mine rescue, the mine rescue system at each level from the State to the enterprise has been gradually set up and perfected.

China's mine rescue system is divided into three levels: the State Mine Rescue Center, the provincial mine rescue center and each city, county and enterprise's rescue management department.

The State Mine Emergency Rescue Commission (SMERC) and the State Mine Rescue Center are of the State mine rescue organizations. On February 26, 2003, the Mine Rescue Center of SAWS was established. As the administrative body of the SMERC, the Mine Rescue Center is responsible for the organization,

coordination of mine rescue and emergency rescue over all China and undertakes the daily office work of the SMERC. Its major functions include the construction of the State mine emergency rescue system, the formulation of rules, regulations and technical standards for the State mine rescue organizations, the certification for mine rescue departments, the national mine rescuers technical contest, the investigation and handling of serious accidents, the promotion of new technology and equipment in terms of mine rescue and the acceleration of mine rescue exchanges and cooperation internationally.

Guided by the Mine Rescue Center of SAW professionally, the provincial mine rescue center is responsible for the organization, guidance and coordination of mine rescue and emergency rescue within its jurisdiction.

The city, county and key enterprise's rescue management department is the regional department responsible for the rescue operation of complicated mine accidents within its region. If necessary, cross-regional rescue work can be carried out yet it needs to be coordinated and commanded by the Mine Rescue Center of SAW. Each enterprise must set up and perfect its mine rescue team and strictly implement the *Coal Mine Safety Rules* and *Coal Mine Rescue Rules*. Enterprises without independent mine rescue teams must set up joint mine rescue teams or sign rescue contracts with nearby teams. The rescue principle for the accident occurred in an enterprise is that the enterprise's rescue team should be the dominant body to conduct rescue operation and the regional mine rescue management department should provide its due support.

### 2.3 Constitution of China's mine rescue system

China's mine emergency rescue system is composed of five sub-systems, which are respectively rescue management sub-system, organization sub-system, technical support sub-system, equipment sub-system and communication and information sub-system.

The mine emergency rescue management sub-system is composed of the SMERC, the Mine Rescue Center of SAWS, the provincial mine rescue center and the city, county and mine enterprise's rescue management department.

The mine emergency rescue organization sub-system is composed of two parts: the rescue teams and the medical teams, responsible for the rescue and medical care when accidents occur in the mine. The rescue teams are composed of regional mine rescue base, key mine rescue teams and mine rescue teams. The first-aid medical teams include the mine medical rescue center of SAWS, regional and key medical rescue center and the enterprise's medical rescue station.

The technical support sub-system, responsible for the service of technical support and training for mine emergency rescue nationally, includes the state expert

groups of mine emergency rescue, the research and experiment center of mine rescue technology of SAWS and the training center of mine rescue technology of SAWS.

The mine emergency rescue equipment sub-system mainly includes the rescue equipments and instruments & meters, which are stored at the regional mine rescue base and supposed to be comparatively advanced technically. The equipments are used to assist the rescue and relief of grave and complicated disasters. The regional mine rescue base should be equipped with facilities according to the relevant regulation and speed up the renewal and technical renovation of the existing rescue equipments. Key mine rescue teams are responsible for the emergency rescue of serious and special serious accidents in mines occurred within the province (municipality or autonomous region). They should be equipped with routine rescue equipments according to the regulation and keep them in good conditions.

The communication and information sub-system is centered on the SAWS Central Website. The perfect mine rescue communication and information network system has taken shape. Among the Mine Rescue Center of SAWS, the provincial mine rescue center, the mine rescue teams at each level, the mine medical rescue center at each level, each research and experiment center of mine rescue technology and training center, the city, county rescue management departments and mine enterprises, open communication and information channels has been set up. The remote rescue consultation video system is also working on the channels. Through the mine emergency rescue communication and information sub-system, direct phone and information exchange can be realized between the Mine Rescue Center of SAWS and the Dispatch Center of SAWS.

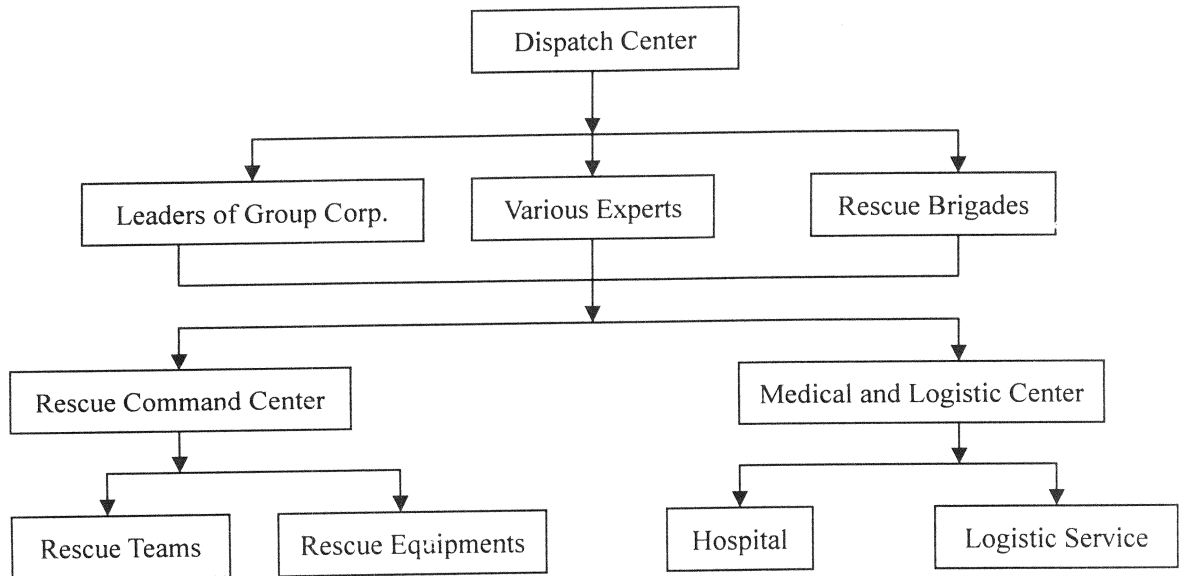
### **3. Development of mine rescue technology and equipment in Xinwen Mining Community**

Xinwen Mining Community is an enterprise that established its mine rescue setup at a rather early stage in China. With the development of nearly half a century, the community has gradually developed its rescue setup from the former one rescue detachment with only 8 officers and men to the current one command center, one training section for preparedness against fight, one section of logistic equipment, three rescue detachments, two fire detachments and 159 officers and men. The rescue setup undertakes the task of disaster rescue and relief in coal mines subordinated to the Xinwen Mining Group Corp. and more than 100 local mines in Tai'an and Laiwu City as well as the task of safety and technical service for the said mines.

#### **3.1 Setup form**

As long as an accident occurs in a coal mine, the mine unit should immediately report the accident to the dispatch center of the Group in the course of arranging

self rescue operation. The dispatch center will immediately report to the leading members of the Group, the rescue command center and medical rescue center composed of various professionals will be set up. At the same time, the rescue detachments, the training section for preparedness against fight and the section of logistic equipment will be dispatched to go for the mine unit to practise rescue operation. The setup form of the rescue detachment, equipment, training and rescue procedures have been arranged according to *Coal Mine Rescue Rules*. Please the chart below.



### 3.2 Construction of rescue detachments

In order to strengthen the fight capacity and solve the aging problem of rescuers, rescuers in Xinwen Mining Community began to follow the contract system for their service in the rescue detachments in 1997. Detailed requirements were strictly specified in the *Practical Scheme for Mine Rescue Detachment Service* and the *Contract Text for Mine Rescue Detachment Service*, which were respectively formulated in the same year. New rescuers must be healthy high school graduates engaging in mining work for more than three years. After physical examination, training and probation, they will sign the service contract and be organized into teams. When their contract expires, they'll go back to their original units and be arranged with appropriate jobs. Every year rescuers need to take part in comprehensive exams and if they violate the terms specified in the contract or fail to pass the exams within the period of service, they'll be sent back to their original units. The practice of the contract system has brought into play the initiative of rescuers to improve their professional skills. The capacity of overall rescue operation and independent capacity of rescue operation of the rescuers have been greatly improved. In addition, the terms of arrangement

specified in the contract system have eliminated the worries behind the aged rescuers, laying foundations for their full concentration on training and rescue work.

Xinwen Mining Community carried out the integrated management of mine rescue and fire fighting for the first time in China in 1998 and set up its professional rescue and relief organization which is good at many things and expert in one.

### 3.3 Equipment

Over the last 47 years since its establishment, the rescue detachments in Xinwen Mining Community have been persisting in the principle of laying equal stress on “equipment, management and training” and the rescue means is becoming modernized day by day. Its rescue detachments have been provided with various equipments and instruments, such as ambulances and fire fighting trucks, extinguishers with high and medium expansion of foam, inert gas generators, 4h positive pressure respirators, 4h negative pressure respirators, phones for disaster areas, resuscitators, 2h respirators, separation self-rescuers, etc. When dealing with a spontaneous ignition fire in a local mine in 1984, extinguishers with high expansion of foam were adopted and, economic losses of more than RMB20 million yuan were retrieved. Please see the attached equipment table below.

**Rescue Equipment Table**

Item	Type	Qty.(set)
Command car		3
Shift car		7
Fire fighting truck		5
Extinguisher with high expansion of foam	BGP-400	4
Positive pressure respirator	BIOPAK-240	72
Negative pressure respirator	AHY-6	63
2h respirators	AHG-2	22
Automatic resuscitator	ASZ-30	19
Inert gas generator	DQ-500	1
Phone for disaster area	PXS-1	8
Oxygen detector	ALM450	8
Infrared ray thermometer	PT303	8
CO detector	Dexunge	8
Flameproof tools		3

### 3.4 Training for preparedness against fight

In order to ensure that the rescue detachments can be on call at any hour and always already for triumphant fight as well as carefully carry out the principle of “Strengthening the strict training for preparedness against fight and actively taking preventive measures and rescue operation”, we stress on three key points in the course of training.

- i) Since serious disastrous accidents always happen with the sudden, catastrophic, destructive and secondary nature, we focus on training the command personnel to properly handle the explosion accident, open fire accident, flooding accident, roof collapse accident in terms rescue and relief strategy and analysis on specific cases. We intend to cultivate the command personnel with good psychological state, to calmly, reasonably and fully think over the problems when encountering the serious accident. We aim to improve their command and decision-making ability so that they can make the right decision, reduce the loss of the accident and prevent it from expanding;
- ii) We lay stress on the general principle rescuers should follow when conducting rescue operation and investigation, the operative norm when handling disastrous accident and the knowledge of self-rescue, mutual rescue and first-aid on the spot so that they can practise effective, rapid and safe rescue operation in the disaster area;
- iii) We have continuously brought forth new training patterns and measures such as the All Staffs Professional Contest and the comprehensive training in a simulated disaster area of 2,000m<sup>2</sup>. Through hard training in quantity in various items and forms, all rescuers become physically strong and professionally skillful to deal with rescue and relief operation. For instance, to fit in with the rescue and relief operation in thin seam faces with complicated geological conditions, rescuers have been sticking to crawling training in low-height roadways. In 1985, a large area roof-fall occurred in a face of a certain coal mine and the inclined length of the roof-fall was up to 21m. Five persons were in distress and most of them were located close to the rib. According to the site situation, measures were decisively taken to approach the persons in distress by developing a zigzag pass of 15m long, only big enough for the rescuer to crawl. At last, four persons still alive and one victim were successfully rescued out of the scene.

Practice in various and numerous rescue operations has proved that the success or failure relies on the following four points, which are respectively whether the plan is accurate, whether the command is proper, whether the operations of the rescue team are correct and whether the information is sufficient. Obviously, the accurate rescue plan and proper command are up to the quality of commanders, the amount and correctness of the information about the disaster area and the familiarity of the officers and men to the circumstances underground. Therefore, in the course of strengthening training and learning of professional knowledge,

we persist in combining safety supervision with getting familiar to and checking the conditions underground. We not only actively examine the danger that may lead to accident and get rid of it timely but also get to know well each of the big system of mine ventilation, compressed air, drainage, lifting and transportation, etc. in order to lay the foundation for timely handle the accident.

The rescue and relief operation is restricted by many factors, such as the complicated and changing situation, the high danger, the strong technicality and timeliness. They all require that mine rescue teams must accomplish quick response, accurate reply, coordinated fighting and centralized command as well as the powerful support of technology and equipment. Xinwen Mining Community therefore made a breakthrough in the construction of its rescue detachments in terms of the system of labor power employment, the paid service and the mode of training for preparedness against fight. We set up and perfected the incentive mechanism for training-examination and safety rescue, the associate paid service mechanism and the rescue technology innovation mechanism. The new rescue pattern integrating the rescue dispatch, rescue command and logistic service into one has been gradually established.

Over the last 47 years since its foundation, Xinwen Mining Community has handled more than 1,800 various disastrous accidents of water, fire, gas, coal dust and roof, conducted rescue operations of more than 100 serious and exceptionally serious accidents, rescued more than 1,500 persons in distress or victims and saved state property of more than RMB200 million yuan. The Community has realized safe rescue operations for 45 years in succession.

#### **4. Major problems existed in China's mine rescue operation**

In respect to China's mine rescue system, there are still some problems that can't meet the needs of the development of work safety in mines. They are reflected specifically in the following points:

- 4.1 Although the key state-owned coal enterprises have generally established the comparatively perfect mine emergency rescue system, most of the medium and small-sized coal mines have not set up their mine rescue teams basically and most of the village and township-owned and individual coal mines have no contracted rescue teams to be at their service. For the key state-owned coal mines, no matter how big the region is and how far the distance between them is, each enterprise considers to set up its own rescue team only and the situation of regional service has not yet taken shape. It is not only a waste of resources but also unfavorable for the optimization, perfection and healthy development of the mine emergency rescue system. From a long-term point of view, mine rescue teams affiliated with the state-owned coal enterprises are unfavorable not only for the enterprises' active participation in the market competition and getting rid of their additional burden of running a socialized community, but also unfavorable for strengthening

the market competitiveness of the state-owned enterprises.

- 4.2 Insufficient input of funds in emergency rescue equipment. In recent years, coal enterprises have had poor economic benefits and they generally invest less funds in mine rescue teams, thus rescue teams have been in difficult financial situation. Most of the equipments in rescue teams have low technical performance and poor stability. The rescue teams are slow to update their equipments. The current equipments are only able to maintain the basic rescue operation and difficult to meet the needs of work safety in mines.
- 4.3 The technology and training standards for rescue teams need to be improved. When they are on their own to conduct rescue operation, the rescuers have not sufficient skills to analyze the situation and handle the problems existed. Some of the rescue teams don't have enough manpower or the members are aging. The quality of the overall rescue teams is not high and injuries and deaths of rescuers happen now and then when carrying out rescue operations.
- 4.4 The imperfect rescue charging system has brought about difficulties to collect charges for emergency mine rescue operation. One reason is that the capital turnover in some mines is in difficulty. Once the accident occurs, they even couldn't pay the basic rescue expenses. It happens often that the units where accidents have occurred are in arrears with the rescue payment. Another reason is that the insurance cover rate against injury at work in enterprises is low. Small and medium-sized mines have no insurance against injury at work basically and the rescue expenses can't be paid via the insurance against injury at work.
- 4.5 The delayed construction of emergency rescue information network. Because of its industrial characteristics, the work of mine enterprises on emergency, rescue and information in the mining sector has fallen far behind other sectors. To eliminate the restraints on mine rescue operation, measures need to be taken to further improve and perfect the current situation.