

Chapter 2

Research on Classification of Highway Emergency Telephone System

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Abstract Emergency telephone system is the special symbol facilities of highway. It is the special equipment in highway for providing emergency rescue during the vehicle accidents and sending the information to the relevant manage departments. In this paper, the development history of the highway is first introduced, and a classification framework of the emergency telephone system is given. According to the transmission mode the system is divided into three types: cable type, optical fiber type, and wireless type, and subsequently the advantages and disadvantages of various types in the system are compared, end of this paper, the key issues of the system and the future trend of development is presented.

Keywords Emergency telephone system • Electric cable • Optical fiber • Wireless • Highway

2.1 Introduction

In the twentieth century European countries first adopt the highway emergency telephone system based on fixed communications technology equipment. Its purpose is to provide emergency rescue and dealing with special events, and the communication tools during the engineering maintenance [1–3]. On the wayside of highway emergency telephone system terminal equipment was set 1–2 km according to a pair of field. Special sections of the highway need to increase the

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equipment density appropriately [4, 5]. When the drivers need help, they can give an alarm through the emergency system. Finally, the staffs of the monitor center adjust the processing. Highway emergency telephone system is one important facilities of the highway; especially the user transfer information in special circumstances and solve the problems in time.

The development of national highway emergency telephone system can be classified in the following five stages [6–8]: (1) 1983–1985 the Tianjin Tanggu port road installed “highway phone box” in Tianjin, mainly provide the maintenance personnel management service, which can be considered as the prototype of the emergency telephone system in our country road; (2) With the Shanghai-Jiading, Shenyang-Dalian, JingJinTang, the capital airport highway and Guangzhou-Foshan highway open and operation in the 1990s, the emergency telephone system was introduced from abroad, such as Alcatel, Siemens and other products from Spain, France, Singapore, and so on. At the same time our country speeds up the research and development process of the emergency telephone system. The typical product is the cable type emergency telephone system; (3) The technical performance and the stability of nation produce emergency telephone system reached and more than imported products widely used in the national highway. This period cable type emergency telephone system is still mainly used; (4) At the beginning of the twenty first century, our country developed the optical fiber type emergency telephone system and wireless emergency telephone system by innovation and replaced the original system gradually; (5) Traditional emergency telephone system only provides the voice business. With the technology developed, the system provides transmitting voice, data business, and image business. Multi-function emergency telephone system has come out. Nowadays the fifth stage system is developed in stable.

The speed and size of national highway construction grow rapidly and enter the ranks of the developed countries. To improve the management level of highway operation, establish and perfect the basic highway facilities, reinforce the traffic management and legal consciousness, improve the highway safety relief rules, improve the service consciousness, and service level become more and more important [9]. Constructing the highway of the good society image is a significant task. In highway operation, reducing traffic accidents, casualties and property losses is priority of the traffic management department and a long-term strategic task. Emergency telephone system as the basic highway facilities and rescue system is necessary.

Nowadays, most national highway set up the emergency telephone. When the drivers need for help in a traffic accident emergency rescue, the emergency system can avoid causing great losses [10]. With the wide application of the emergency telephone, a good performance and lower price highway emergency telephone is in demand of highway development. Emergency telephone system can be divided into three kinds by Transmission mode: the first kind is the full length of the signal transmission cable; the second is the full length of the signal transmission Optical fiber; the third is to use wireless public network of signal transmission. The three transmission ways have different features, and the specific differences in subsequent chapters are expounded.

2.2 Cable Type Emergency Telephone System

Highway cable type emergency telephone system sets emergency call console generally placed in monitoring branch or tunnel station, at the same time sets the emergency telephone along both sides of highway or tunnel. The emergency telephone system is composed of telephone console, remote power amplifier equipment, remote control module, transmission cable, the loudspeaker and emergency telephone extension of roadside, and so on.

Cable type emergency call uses local cable as transmission medium [11]. It is widely used in domestic. It has many advantages such as low project cost, easy implementation, mature technology, and so on. The emergency telephones along both sides have high reliability, corrosion resistance, prevent noise performance requirements. Users can contact the monitoring center as soon as pick up the emergency telephone. And the monitoring center warning system is launched automatically; it can show geographical location of the user and deal with the procedure of events. Traditional landline telephone system usually uses the cable transmission pattern.

Cable type emergency telephone system is commonly the independent sub-system of highway private network, and later ally this transmission way has been widely used in domestic highway. But with time elapsing the cable type emergency telephone system also gradually revealed some drawbacks:

- (1) Due to the analog circuit design, components influence by the environment set-point drift, causing the fuzzy, large noise, low voice call quality, difficult maintenance, and high repair price;
- (2) Extension telephone has high failure rate and later the maintenance cost is high. Due to its own structure, roadside fault of few extension telephone will cause a large section of telephone cannot be used normally;
- (3) Initial large investment, large quantity, not easy to maintain, need to lay cable for the system, and take up pipe resources;
- (4) The lightning resistant ability of cable type emergency telephone system is weak, the equipment is easily damaged by the thunderstorm and lightning, especially in the serious lightning areas. When the bury cable is short circuit, breaks by hit, the whole emergency telephone system cannot be used;
- (5) The cable aging is serious when the environment is damp. The insulation resistance will decrease when the cable is in water for 1–2 years later, at the same time the call quality is affected.

2.3 Optical Type Emergence Telephone System

With the rapid development of optical communication technology, in recent years, optical fiber type call system in highway for help and rescue communication emergency fills the blank of highway emergency telephone. At present, the optical

fiber type emergency telephone system is mainly divided into two types: forwarding type self-healing ring structure and passive optical network structure. General use double fiber transmission, through the use of WDM technology, can transmit in the same optical fiber that contains both the receiving and sending light. Some products also increase a core optical fiber in order to transmit triggered or control signals, etc.

Forwarding type self-healing ring structure emergency telephone system is composed of emergency telephone extension of roadside, console of management branch and optical fiber transmission equipment. The whole system can be made of 1–8 two-way self-healing ring structure, every single fiber two-way self-healing ring needs to connect 32 emergency telephone extension, the whole system can accept almost 256 emergency telephone call at the same time. The system is controlled by computer and use the software to realize the man–machine dialog. The console of management branch controls the real-time emergency telephone of various states.. Phone calls of voice to be automatically record, print reports, can set multi-level management mode, and realize the whole province, the centralized management, and can provide many asynchronous data of highway channels for other information transmission.

This kind of optical fiber type emergency telephone system uses optical fiber self-healing ring transmission, improved the redundancy ability of the system, which makes the reliability of the system higher. Even breakpoint appeared in the transmission link, the system can still communicate normally through the reverse transmission instead of system interruption. The extensibility of the system is excellent; each master computer can link eight optical loops, accept 256 pairs of emergency telephone extension at most, and can connect the master computer through network. Each extension of the self-healing ring structure needs double optical transmitter and receiver, system transmission also need double transmission optical fiber.

Emergency telephone system of passive optical network structure is composed of emergency telephone extension of roadside, management center master console, optical fiber transmission equipment, and so on.. The system adopted the optical passive technology, making each extension in standby mode during the no communication state, in order to reduce the power consumption of the extension. Due to the use of optical passive optical technology, the system needs double optical transceiver and optical fiber to ensure the transmission reliability, each machine extension as a branch node of optical transmission link, so the failure of one extension will not lead to communication interrupt of other extensions.

Compared with the conventional emergency telephone system, optical fiber type emergency telephone system has the following features:

- (1) Small attenuation, long transmission distance, high system reliability;
- (2) Wide frequency band, low wastage, anti-jamming, high quality voice, no noise accumulation;
- (3) Strong ability of anti-jamming and lightning. The system uses optical fiber as a transmission medium, not by the electromagnetic interference and has the very

strong lightning protection performance, especially for the mountainous area and the lightning multiple areas;

- (4) Simple construction and small investment. The system makes use of optical fiber as the transmission channel, and the channel can be used as communication of optical transmission. The main construction can be finished at one time and need not additional cable, reducing the cable fees and the workload of construction;
- (5) Adopting the solar energy and battery to supply power, self-healing ring structure can provide 1 month electrical energy for work during the rainy days;
- (6) High integration and can be integrated well with the highway monitor system providing many asynchronous data channels. The system adopts full-duplex transmission, each extension machine of roadside can provide additional 1–2 RS422 interface. Other information such as low rate monitoring data can transmit through this system.

2.4 Wireless Type Emergence Telephone System

Wireless type emergency telephone system is developed by wireless mobile network. The reliability and speech quality is excellent compared with the cable type system and the optical fiber type system. As the development of mobile communication network and the improved quality of service, it becomes a development trend of using public wireless communication network to construct the wireless emergency telephone system.

The network mode of wireless type emergency telephone system can be divided into GSM public network mode and custom wireless network mode.

In the wireless type emergence call system based on the GSM public network, each pair of roadside emergency telephones in call pavilion installed a set of the main communication controller and solar battery power supply system. General control device of the call processing center installed a set of communication controller and wireless emergency telephone system host, in order to communicate the call processing center through the wireless telephone extension after the SIM card registration of the roadside emergency telephone extension. All of these formed a complete set of emergency telephone system.

Special wireless type emergency telephone system of ultra short wave radio generally uses full-duplex working way. Its working band is generally divided into 150, 450, 800, 900 MHz. The working band needs to be approved by the committee of national radio before the construction. At present, this type of emergency telephone system barely appeared in the highway application.

The best advantage of wireless emergency telephone system is without laying transmission cable, convenient construction, simple maintenance, and reducing the initial construction period. Due to wireless emergency telephone extension with no long wires, lead the possibility of lightning and thunder damage small and the

maintenance is simple, not affected by the transmission cable faults. At the same time each extension has a unique address, so each extension is independent, not affected by others. The extension density of each host control zone can be increased gradually according to actual situation, suitable for staging investment and gradually improvement.

Compared with cable transmission system, the speech quality of the wireless type emergency telephone system is influenced by the coverage of radio and weather conditions, and vulnerable to interference. Adopting the GSM public network, emergency telephone system is not independent system, which service quality is restricted by the public network, and later need to pay communication fee for the public network. At the same time wireless emergency telephone had a fatal flaw: communication quality of the wireless signals will be discounted greatly in the blind remote mountainous areas.

2.5 Critical Issues in Emergence Telephone System

There exist several key questions in the emergency telephone system:

- (1) System control software: An advanced emergency telephone system must have the corresponding control software support. The system control software includes the host management program of control center, which controls the automatic recording of multimedia voice signal, information storage and output, management of extension communication. In addition the software requirements contain the solar battery management of the extension, etc. ;
- (2) Use the different frequency duplex working way of transmitter and receiver to solve the full-duplex call problems between the host and extension;
- (3) The case structure: emergency telephone extensions are set out-field, so they need to adapt different weather conditions. As design and manufacture the case, rainproof, dustproof, high temperature and low temperature prevention, and other factors must be considered. In addition transmitter and receiver are taken security protection in order to prevent man-made destruction.
- (4) Component: all key integrated circuits use the foreign temperature standard. The products must meet the $-40\text{--}+60\text{ }^{\circ}\text{C}$ temperature standard in order to ensure the system work stable.

2.6 The Future Development Trend

Emergency telephones will be replaced by mobile phones in good wireless coverage area. Opening the emergency services is a developing trend through wireless expanded network service in the highway.

Cancelling the emergency alarm facilities does not mean reducing the level of social service. However, it means reinforcing the emergency alarm facilities and making more economy, convenient, promptly, and humanized.

Emergency telephones are necessities in the tunnel and wireless network coverage poor areas, which are still one significant rescue method in highway.

Using the mobile phone instead of the emergency telephone in the new constructed highway, the relevant mileage pile number sign, and direction sign must be set properly. Finally, the managers make relevant department coordinate of the work.

Adopting the mature technology and equipment, in order to develop and expand the rescue service constantly, improving highway multiple service level.

As mobile phones popularizing step by step, the mobile phone brings a lot of convenience when the accident happened in the highway. But mobile phone cannot instead of the emergency telephone; the main reasons are shown as follows:

- (1) Both mobile phone and emergency telephone can give an alarm, both can provide rescue services for highway emergency, but each one has its advantage along with the shortage;
- (2) An emergency telephone is a special communication rescue tool, which is not restricted by any condition. Finally the emergency telephone is waiting for rescue every moment;
- (3) An emergency telephone as a special communication rescue tool has the strict process of emergency alarm rescue.

2.7 Conclusion

Emergency telephone system is one important component of the highway traffic engineering. Due to the fully enclosed highway, emergency rescue system becomes particularly important. Nowadays problems of the emergency telephone system should be solved step by step according to the need. Summarizing the experience scientifically and objectively in order to gradually improve the expressway monitoring system and emergency call center system. The application of national highway emergency rescue system is developed and innovated gradually, which becomes an important part of the intelligent transportation system. It will provide a safe, reliable, economic, efficient, harmonious traffic environment for the society.

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