Fire safety is an important component of the safe operation of nuclear power plant, and is an important aspect of the nuclear safety. There are multitudinous equipments and combustion in Nuclear Power Plants (NPP), such as: lubricating oil, fuel, cable isolation and some woods, papers, plastics etc. They spread all over NPP. Because of the source of ignition and combustible, there are a lot of fire hazards in NPP.

The fire is a serious threat to nuclear safety, and caused enormous economic losses of NPP. The frequencies of fire are high in NPP, and the losses of fire also are big. Protection against fire and fire-related explosions assumes importance in the overall design of NPP insofar as it forms a crucial part of the safety considerations, namely how safety systems and other items important to safety are protected from fire hazards. Items important to safety whose malfunction or failure could result in unacceptable release of radioactivity shall be protected, such as Reactor Coolant Pump, Diesel Generator, MCR, Electrical Equipment etc.

This would generally be accomplished by improved physical separation and greater use of Fire Detect and Alarm System and Extinguishment Systems. At first, redundant safety system equipment are physical separated in the building. Then fire protection systems are provided where required by the fire protection analysis, in accordance with some standards. The fire protection system detects fires and provides the capability to extinguish them using fixed automatic and suppression systems, manual hose streams, and portable fire-fighting equipment.

Fire Detect and Alarm System is the front components of the Fire Protection System, which plays a role in the rapid detection and alarm. Fire Detect and Alarm System automatically detects the character of fire, such as smoke and heat. If the area is on fire, system controller will send out the alarm and control fire extinguishment, emergency light, emergency broadcast and communication, smoke exhaust system.

So Fire Detect and Alarm System can affect the performance of the entire Fire Protect System. The Fire Protect System is related to the fire safety of NPP. The reliability and sensitivity of Fire Detect and Alarm System plays an important role in the safety of nuclear plants.
How the reliability and sensitivity of the Fire Detect and Alarm system can be improved?

Now a variety of advanced technologies used in Fire Detect and Alarm System improve the reliability and sensitivity of the system, for example, Distributed Intelligent Fire Detect and Alarm System. The fire detector of this system is intelligent, it will be embedded with CPU. Some algorithms and model are stored. They will be used to analysis the signals acquired, and judge fire from the analysis. Normally the detector only sent the order signal or fault signal to controller. Once detect the fire, the detector will transmit information and data to controller with interrupt mode. The controller will make further analysis and judgment. Some judgment by the controller return to the detector, thereby controller reduces the burden of processing the large number of signal. The controller can be easily accomplished fire equipment monitoring and management, networking. This increase system patrol speed. Data transmission is no longer subject to the restrictions of system patrol.

Intelligent detectors have the following characteristics:

- Containing a variety of algorithms, the detector is reliable.
- There are many self-diagnosis. The short circuit, open circuit and other fault monitoring, alarm of detector will sent to the controller at any time.
- Having the ability to work independently, as long as the electricity can be conducted independently fire detection.
- Soft coding, without dial-Switches
- Having an address on the bus
- New structural design and special measurement circuit, make detectors have a wider scope of application
- Having lower power consumption and a wide operating voltage range

The digital bus is for communication in system, and a warning signal is transmitted to the fire alarm controller. Now two-wire system is generally used for transmitting power and data. Data are sent through the modulation out, and controller will need to restore data demodulation. Signal transmission line is the nerve of Fire Detect and Alarm System, so we must ensure that the transmission of information is accurate, reliable and smooth. In general adding bus isolation module, in the event of malfunction automatic remove fault circuit, this method can not guarantee failure of communication with the controller. Thus a circular bus is created. But any point break in transmission loop, the detector also can communicate controller. The reliability of transmission can be improved.

In the fire alarm controller, analyze the transmission signal from detector by intelligent control technology. If the detector signal is divided into pre-alarm and fire alarm, and the detector sends out the pre-alarm, the controller will enhance real-time communication with the detectors, and receive nearby detector signals. If other detectors also detect the smoke, the fire is confirmed.

Meanwhile, the controller adopts multi-CPU model and modular structure, solving real-time and multi-task management, such as: data processing, LCD display, print, communications and control task, in between the CPU through \( \text{I}^2\text{C} \) bus for communication. The uses of main CPU are to monitor and control the functional components, data processing, network communication and information preservation. It is the core of the whole controller. Secondary CPU module is for addressing the detectors and gathering the information. The information includes smoke analog data of smoke and temperature, other status messages. Then
Secondary CPU analyses the information, and transmits the results to the main CPU. Because there are many CPU in the controller, the real-time and reliability of the system is improved.

Distributed Intelligent Fire Detect and Alarm System makes intelligent functions in the detector, in signal transmission and controller and also adopt a variety of technologies, which fundamentally improve the system stability and reliability.

Meanwhile, there are a number of new fire detection techniques, such as Air Sampling Fire Detection, Fiber Temperature Detection System, Prism Flame Detector, Laser Fire Detectors and so on. If the advance detectors are used, the fire will be detected as early as possible. And environmental factors minimize the impact on the detector. The reliability and sensitivity of fire detectors can be improved. The operations of nuclear power plants have adequate time for extinguishing the fire. In the early stages of the fire, it will be controlled using artificial means, and to reduce the fire hazard.

Detectors are installed on fixed-points in fire detection area. The type of detectors adapt to the amount, character of flammable matter and feature of the occurrence and development during the beginning of the fire (such as: temperature, flame, smoke and combustion body). Also the room construction feature and installation condition (approachability, environment, temperature, humidity, ionization radiation, corrosive gas and ventilation) should be considered. In addition, influence of the interference source which should cause spurious alarm should be considered.

Improvement in response rate and reducing false alarm fire is the core of system. Detector choice must fully consider the impact of the above factors, choice appropriate detectors. This can fundamentally improve the detection results, and reduce false alarms. With complex condition of NPP, detectors should be tested at first, such as: strong electromagnetic
interference testing, ionizing radiation experiments, strong airflow test, the limit temperature test, vibration test etc. The reliability and stability of detectors are ensured by these tests.

Conducting extinguishing of the fire, we must consider the effect to avoid unnecessary losses. It is necessary to consider the effect in some important place, for example: cable layer, safety-related equipment room and electrical switchgear room. In cable layer, cable insulation layer is aged after long-run. There may be localized cracking phenomenon. If the sprinkler system moves in where fire occurs, water can cause other cables incidents. The affect of entire incident will be extended. In electrical switchgear room, the operation of fire protection system could cause the failure of electrical equipment. The resulting consequences will expand. The failure could adversely affect safe shutdown capabilities. So if the fire extinguish system move, the secondary effects is impossible to make accurate judgment. Fire extinguish system can’t move, but only the fire is already detected and confirmed.

And the plant fire safety must be assured, thereby, in the early stages of the fire should be discovered. Moreover, the quickly detect of fire is helpful for fire extinguishing. So fire alarm systems send the alarm signal, using manual suppression. This meets the fire requirement, fire losses can be reduced to the minimum. So how to improve Fire Detect and Alarm System sensitivity and reliability, and the significance of it is very important. Consider fire effects, reduce fire losses and ensure the safety of the nuclear power plant, safe operation of the most effective and convenient means to improve reliability and sensitivity of Fire Detect and Alarm System.

After the Fire Detect and Alarm System in the plant construction period is in place, the alteration of system is relatively easy. As long as the system cables are accorded with requirements and have sufficient space core, cables can not be replaced. Only upgrading the host software, selecting the new detectors, the system function will be improved.

Fire Detect and Alarm System must be reliable linkage action with Fire Protection System. System considers "Pre-action", logical is triggered, but fire protection system is of no act. If the fire can’t be controlled by manual actuation, the Fire Protection System automatically moves. Therefore, control fire in early, this will reduce the fire hazard, and also the secondary effect of the fire.

REFERENCES