CHAPTER 12

FIRE PROTECTION SYSTEM

12.1 OVERVIEW

Project: “VIETNAMESE-GERMAN UNIVERSITY (VGU)”

State 1, Project included: office area, factory, parking area, auxiliary area and security room.

- Water pump factory.
- Parking area includes car and motorbike
- Auxiliary area includes: Electrical room, water treatment area, pump room, ….

This is a large area, focus on many people and valuable assets. So in case of fire, evacuating people, protecting assets and fighting fire of professional firefighters have certain difficulties in the current economic situation of our country. Due to the above importance level, the investment in on-site fire protection equipment for the project is a very important and practical goal. In fact, in recent years, there have been many fires nationwide causing great damage to people and property, adversely affecting the economy and political security in our country.

Implementing the above idea, we selected the plan to design fire protection system for the project. Based on the nature and purpose of using Vietnam standards for fire safety to design fire protection systems of the project, we propose designing fire protection systems for the works including the following items:

1- Automatic fire system.
2- Wall hydrant fire system.
3- Fire extinguisher.

12.1.1 Design content

Design based on

Based on the architectural design of the project.

+ TCVN 9310-4:2011: “Fire protection - vocabulary - fire equipment”.

+ TCVN 9310-8:2011: “Fire protection - vocabulary - specialized term for fire protection, rescue and hazardous material handling”.

+ TCVN 3991: 2012: “Fire prevention standards in construction design - terminology and definition”.

+ TCVN 6379 - 1998: “Fire equipment - Fire hydrant - Technical requirements”.

+ TCVN 6102 - 1996 ISO 7202:1987 “Fire prevention, fire-fighting agent-powder”.

+ TCVN 5303:1990: “Fire safety - terminology and definition”.

+ TCVN 3254:1989: “Fire safety - General requirements”.

+ TCVN 4878:2009: “Fire classification”.

+ TCVN 4879:1989: “Fire prevention- safety signs”.

+ TCVN 2622:1995: “Fire prevention for houses and buildings - Design requirements”.

+ TCVN 5040:1990: “Fire prevention and fighting equipment - Figure symbol on fire prevention diagram - technical requirements”.

+ TCVN 5760:1993: “Fire-fighting system - General requirements for design, installation and use”.

+ TCVN 4513 - 88: “Internal water supply - design standards”.

+ TCVN 6305 – 1,2: 2007: “Fire protection automatic Sprinkler system part 1 and part 2”

+ TCVN7336 – 2003: “Fire protection - Automatic Sprinkler system - Design and installation required”.

+ TCVN 3890: 2009 “Fire protection equipment for houses and buildings - equipment, layout, inspection and maintenance”.

+ TCVN 7435-1,2: 2004: “Portable fire extinguishers and trolleys”.

+ QCVN 06:2010/BXD: “National technical regulations on fire safety for houses and buildings”.

12.1.2 Requirements for fire protection system

Based on the nature of use and danger of fire and explosion of the works, the fire protection system for the project must ensure the following requirements:

Fire prevention requirements

Fire prevention solutions must be applied to minimize the possibility of a fire. In the event of a fire, it is necessary to detect a rapid fire to cure in time so that the fire will not spread to other areas where big fires are difficult to cure, causing serious consequence..

Fire prevention measures must ensure that when fire occurs, people and property in the building are easily evacuated to safe areas quickly.

In any condition when a fire occurs in a place that is prone to fire, such as technical areas in the factory, it must be discovered immediately at the place of fire to help the organization promptly.

12.1.3 Solution for designing fire systems.

Fire extinguishing system including automatic sprinkler fire fighting system and wall hydrant fire-fighting system + fire extinguisher outside house

This is a modern fire-fighting system applied in the world at the same time implementing two basic functions that are:

Automatic fire extinguishing ability by automatic sprinkler nozzles. Automatic spray function when the temperature in the protected area reaches the working threshold without human impact.

Wall hydrant fire system is the basic fire fighting system required for current works and highly effective fire fighting capability. However, the fire fighting function is only implemented when there are human impacts.

In addition to the two fire-fighting systems on the project, it is also equipped with portable, portable fire extinguishers for extinguishing newly arising fire, not enough parameters for automatic fire-fighting system to work.

12.2 INITIAL FIRE EXTINGUISHING FACILITIES AND WATER FIRE SYSTEM

12.2.1 Initial fire extinguishing facilities

Fire extinguishers initially used ABC portable fire extinguishers of 8 kg, 5 kg CO2 cylinders.

12.2.2 Sprinkler automatic fire extinguishing system

Automatic fire extinguishing ability by automatic sprinkler nozzles. Automatic spray function when the temperature at the protection area reaches the working threshold of the nozzle.

The fire-fighting system uses upwards sprinkler heads installed for non-ceiling areas, downward sprinkler heads are installed for ceiling areas. The distance between the nozzles is 2.8 to 4 m, the distance to the wall is 1-2 m (Design drawing).

Areas with ambient temperature t <550C arranged spray nozzles with working temperature of 680C.

This is a water pump manufacturing and assembly plant. Look up the appendix A TCVN-7336-2003 medium risk fire plants, group III. Table 2 TVCN-7336-2003 Spray intensity is 0.3l/m2.s; The area protected by 1 sprinkler is 12m2; The area to calculate the water flow is là 360m^2; The duration of fire fighting is 60 minutes. The maximum distance between sprinklers is 4m.

The height of the nozzle depends on the installation location, but the distance to the ceiling and roof must not exceed 400 mm “TCVN-7336-2003”.

So Q_{sp} = 0.3x360 = 108 l/s = 6480 l/min = 388,8 m^3/hr.

Water volume for fire fighting and cooling for 1 hour, so $V_{Sprinkler}$ = 388,8 x 1 = 388,8 m^3.

12.2.3 Method of layout and design of wall hydrant fire fighting system

This is the basic fire fighting system that is required for the current works by the roll of hose, spray nozzle combined with fixed fire fighting and highly effective fire fighting. . However, fire fighting function is only performed when there are people.

- Calculated with two simultaneous fire hydrants.
- Design flow per nozzle : 2.5 l/s.
- Pressure at each nozzle : 25 m.c.n / 2,5 at
- Water volume for fire fighting and cooling for 3 hours with a flow of 5l /s
- The radius of each nozzle ensures that at any point in the building there must be two spraying nozzle

12.2.4 Method of layout and design of fire extinguishing system outside the house

Calculated according to “TCVN 2622:1995 - Table 13”

Limit fire resistance: II (TCVN 2622:1955 – Appendix D)

Dangerous level of fire in production areas: Level D (TCVN 2622:1955 – Appendix B)

- The number of simultaneous fires : 1
- Water flow for fire : 15 l/s
- Pressure at the nozzler : ≥1 at (10 mH20)
- Water volume for fire fighting and cooling for 3 hours with flow 15 l/s
- MVT = 15 x 3 x 3,6 = 162 m^3

12.2.5 System structure and principles of fire fighting system with water

Pump system and operating principle:

+ Pump system

The supply of water and pressure for each fire fighting system by pump combination has the following structure

+ 01 Conventional electric motor fire pump (7750 l/min@100mH_20)
+ 01 Redundant diesel fire pump (7750 l/min@100mH_20)
+ 01 Pressure booster pump to maintain pressure on the pipe network (200 l/min@110mH_20).

Under normal working conditions, the fire protection system maintains hydrostatic pressure with the pressure equivalent to the fire pressure of the system. In order to maintain regular pressure in the system, there must be pressure compensation pump and pressure vessel. Pressure compensation pump only works when the system's maintenance pressure drops due to pipe leak, simplify the pipe due to temperature and air bubbles in the system. The automatic compensation pump runs in its own set pressure range and has a minimum runtime control relay attached to the control system to prevent the pump being replaced from being started continuously.

The fire pump will be started when the pressure in the system drops to the setting level. When the main fire pump is started pressure in the system still falls down because the pump is not running or the pump runs without water, the system automatically starts up the spare pump.

In manual mode it is possible to start at the pump control cabinet.

12.2.6 Calculation steps of hydraulic piping system

❖ **Determine fire-fighting flow:** (Table 5 TCVN 7336 – 2003)

Calculating from the main tap is the tap at the highest and farthest position on the pipeline network.

Select the fire fighting area for fire is 360 m^2, we calculate for 1 fire.

+ Basic sprinkler parameters

Select the diameter nozzle Φ 17.

The protection area of a nozzle is 12 m^2.

Flow coefficient through nozzle is KV = 0,92.

H_{min} = 5 m.

Spray intensity Ib = 0,3 $l/m^2.s$ (Based on TCVN 7336 – 2003)

Table 1: Number of nozzles depends on pipe diameter and pressure in the road

Pipe diameter	25	32	40	50
Number of nozzles	1	2	3	6

+ Hydraulic calculation

Main pressure column:

$$H_{CĐ} = \left(\frac{F_V.I_B}{K_V}\right)^2 \geq H_{min} = \left(\frac{12.0,3}{0,92}\right)^2 = ((12x\ 0,3)/0,92)^2 = 15.3\ m > 5\ m$$

$\rightarrow$ Ensure

The flow escapes from the main tap $q_V = k\sqrt{H_{CD}}$ =3.6 l/s

+ Flow of fire fighting water for buildings: $Q_{CC} = Q_{VT} + Q_{SP} + Q_{Trụ}$

Inside:

Qcc : Flow of fire water needed

Q_{VT} : Flow of fire-fighting water in wall system

Q_{SP} : Flow of fire sprinkler system

$Q_{Trụ}$:Flow of fire-fighting water outside the house

- $Q_{VT} = n_l * q_l$

Inside:

n_l - number of fire extinguisher spray simultaneously.

q_l - Water flow of a fire extinguisher.

Table based on "12 TCVN 2622-1995", for this project, we count for a fire, so:

$\Rightarrow Q_{VT}$ = 2 x 2,5 = 5 l/s.

Q_{SP} = Sbv * i (l/s)

S_{bv} - protection area of the system, m^2

i - Standard water spray strength, $l/m^2.s$

Table based on: "Table 2, TCVN 7336 -2003" – Automatic Sprinkler system, requires design, we define as follows:

The project belongs to the medium fire risk, Group III, the injection intensity is 0.3 l / m^2.s; The area protected by 1 Sprinkler is 12 m^2; The area for calculating water flow is 360 m^2; The duration of fire fighting is 60 minutes. The maximum distance between sprinklers is 4m

Replace the number we have:

Q_{SP} = 0,3 * 360 = 108 l/s.

$Q_{Trụ} = n_2 * q_2$

Inside: n_2 – number of fires.

q_2 – Water flow for outdoor cabinets.

With the scale of the project, According to TCVN 2622-1995, we calculated

$Q_{Trô}$ = 15 x 1 =15 l/s

So the water flow of the wall system and Sprinkler for fire fighting is:

108 l/s + 5 l/s + 15 l/s = 128 l/s = 7680 l/min

So we choose flow

So the total flow of fire pump is:

Q = 7680 *l/min*

The calculation details are shown in the following table:

Fire flow spreadsheet for wall fire-fighting system:

	Number of fires	Number of fire hydrants for each point	The amount of water calculated for each nozzle (l/s)	QVT (l/s)
Wallfire-fighting system	01	02	2,5	2 x 2,5 = 5

Fire flow spreadsheet for Sprinkler fire fighting system:

	Spray intensity ($l/m^2.s$)	Area is protected by 1 Sprinkler (m^2)	Area to calculate water flow (m^2)	Time of fire fighting (min)	Maximum distance between the Sprinkler (m)	QSP (l/s)
Sprinkler fire fighting system	0,3	12z	360	60	4	0,3*360 = 108

Spreadsheet for fire-fighting outside the home fire fighting system:

	Number of fires	Number of fires	The amount of water calculated for outdoor cabinets (l/s)	$Q_{Trụ}$ (l/s)
Fire extinguishing system outside the home	01	01	15	1 x 15 = 15

* Determining pressure column of fire pump:

$H_B = H_{CĐ} + 1,2 \sum h_d + H_{van} + Z_{cđ}$

Inside:

$H_{CĐ}$ - Main pressure nozzle $H_{CĐ}$= 15.3 m

$\sum h_d$ – Total loss of pressure column according to pipe length

$$\sum h_d = \sum_{i=1}^{n} \frac{q^2_{oi}.l_{oi}}{K_{it}}$$

Inside:

q_{oi} – flow through of i^{th} pipe

l_{oi} – Length of i^{th} pipe

K_{it} – Friction coefficient of the i^{th} pipe

Calculate: $\sum h_d$ =56.8 m

Calculate H_{van} = 3m

$Z_{CĐ}$ = 12 m

H_B = 15.3 + 1,2 x 56.8 + 3 + 12= 98.53 mH_20

We choose the pump with the following parameters:

$Q_B \geq$ 128 l/s= 7,680 l/min

$H_B \geq$ 100 mH_20

Select the booster pump:

H $\geq$ 110 mH_20

Q $\geq$ 200 l/min

Table select pump:

Pump cluster	Main pump	Booster pump
Fire pump cluster	H = 100 mH_20 Q = 7750 l/min	H = 110 mH_20 Q = 200 l/min

12.2.7 Calculate the volume of the fire fighting tank

With the scale of the project, according to TCVN 2622-1995, we calculate for 01 fire

Determined / $V_{Sprinkler}$:

+ The project belongs to the medium fire risk, group III, the injection intensity is 0.3 l / m^2.s; The area protected by 1 Sprinkler is 12 m^2; The area to calculate the water flow is 360 m^2; The duration of fire fighting is 60 minutes. The maximum distance between sprinklers is 4m

So : Q_{SP} = 0,3 * 360 = 108 l/s. = 6480 l/min = 388,8 m^3/h

Fire fighting time is 1 hour, **So $V_{Sprinkler}$ = 388,8 x 1 = 388,8 m^3**

Determined $V_{Trụ}$:

The flow of outside fire hydrants is 15 l/s = 54m^3/h

Fire fighting time is 3h

So: $V_{Trụ}$ = 54 * 3 = 162 m^3

Determined $V_{vách\ tường}$:

Based on table “12 TCVN 2622-1995”, for this project, we calculate for a fire with 02 nozzle , So: $\Rightarrow Q_{vách\ tường}$ = 2 x 2,5 = 5 l/s = 18 m^3/h

Fire fighting time is 3h

So : $V_{vách\ tường}$ = 18 * 3 = 54 m^3

Determined $V_{Nước\ cấp}$:

Continuous water flow for water tank size 100DN, water velocity at outlet of 1m / s, for 3 hours

$V_{Nước\ cấp}$ = 28.26 m^3/h x 3 hr = 84.78 m^3

So the tank's fire fighting capacity is

$V_{Sprinkler} + V_{vách\ tường} + V_{Trụ} - V_{Nước\ cấp} = 388,8 + 162 + 54 - 84.78 = 520\ m^3$

=> Choose a water tank with volume: 550 m^3

12.3 DESIGNING THE AUTOMATIC FIRE ALARM SYSTEM

12.3.1 GENERAL DESCRIPTION

The design plan includes:

- Design and installation of fire alarm system for the entire project.
- Design and installation bell system, fire alarm button for the whole project.
- Design and install the emergency exit lamp (Exit) lamp incident when the incident occurred.

12.3.2 AUTOMATIC FIRE ALARM SYSTEM

The fire alarm system includes the following basic parts:

- The detector detects fire.
- Fire alarm button.
- Analysis modules, signal processing.
- The control center handles the information from the sensor and the hand-held press button.
- Fire alarm: horn, bell.
- Conduit system: including signal wiring and power supply wiring.
- Electricity supply.

Peripheral control devices such as fire alarm data recorders, control panel cabinets on computers, fire alarm control cabinets, elevator systems, as well as on-off devices. wind, escape door.

12.3.3 DESIGN OPTIONS

The design of the fire alarm system for the building was selected as intelligent fire alarm system.

The fire bell push button on the floor is arranged in the position of many people like the area near the elevator and stairs to facilitate the observation of troubleshooting in the event of a fire. . The fire button on each floor is the fire alarm button usually associated with the address module and is mounted on a single address for each floor.

The alarm is selected as the fire alarm. Fire alarms are installed in the fire alarm knob. The bell is mounted on the same power line and sends the addressing module to the fire alarm to control the operation of all the bells on the same floor.

The signal conductor for the address fire detector is a dedicated anti-interference cable with a cross section of 1.2 mm^2.

12.4 SMOKE DETECTOR

It is a direct monitoring device, detecting smoke signals to transfer smoke signals to the treatment center. The time the smoke detectors receive and transmit information to the fire alarm no more than 30 seconds. Environmental density ranges from 15% to 20%. If the concentration of smoke in the environment exceeds the permitted level (10% -20%), the equipment will send an alarm signal to the center for processing.

Smoke detectors are usually located in the study rooms, halls, warehouses, areas with densely populated areas and pre-existing fumes.

Smoke detector is divided into two main categories as follows:

12.4.1 SPECIFIC ROUND DETECTION

Installed in areas where the scope of supervision is small, low ceilings (offices, apartments,…).

- Ion Smoke Detector: The device generates positive and negative ions that move in the presence of smoke and smoke, which interferes with the movement of positive and negative ions. mind processing.
- Photo smoke detector (photovoltaic): The equipment consists of a pair of detectors (one transmitter, one receiver) arranged opposite, when there is smoke between the two alarm, smoke will obstruct the transmission. the signal between the two alarms, from which the alarm will send a fire signal to the central processing.

12.4.2 BEAM TYPE REQUIREMENTS

Include a pair of equipment installed at both ends of the area to be monitored. The projection device emits an infrared beam through the area of the surveillance area and

then to a receiving device containing a photosensitive cell that monitors the signal balance of the light beam. This detector operates on the principle of blurring the light as opposed to the principle of scattering light (smoke in the head).

Beam smoke detectors have a very wide range (15m x 100m), suitable for use in areas where photoelectric smoke detectors are unsuitable, such as in places where smoke is present. Will there be black smoke?

In addition, the Beam head can withstand extreme temperatures, dust, excessive humidity, impurities, etc. Due to the Beam head can be placed behind the glass window. , it is easy to clean, preserve.

Beam detectors are usually installed in areas with large monitoring range, too high ceiling can not install point detectors (factories ...)

12.5 HEAT DETECTORS

The heat detector is used to detect the temperature of the environment within the protection range, when the temperature of the environment does not meet the requirements of the manufacturer's prescribed heaters, it will signal The alarm sent to the processing center.

Heat detectors are installed in places where smoke detectors can not be installed (where appliances, garages, kitchens, factories, kitchens, etc. are installed)

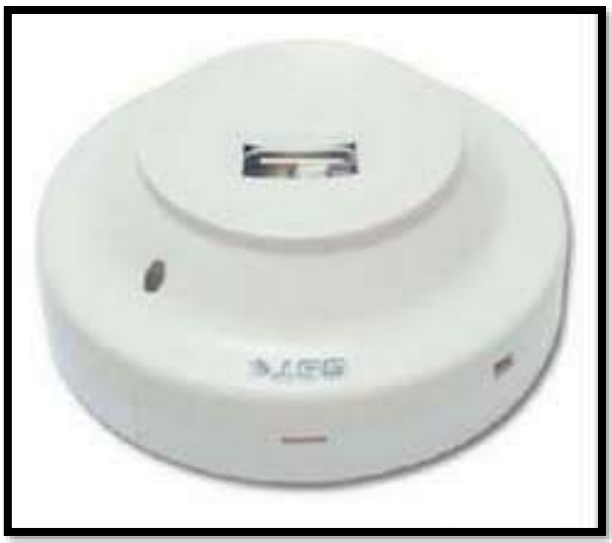


Figure 11.1 Heat detector

12.5.1 FIXED THERMOSTAT

This type of alarm is triggered and the alarm signal generated when the temperature in the air around the alarm head increases to the manufacturer's specified level (57^0, 70^0, 100^0 ...).

12.5.2 ADDITIONAL HEAT TUBE

This type of alarm is triggered and emits an alarm signal when the ambient air temperature sensor is suddenly increased by approximately 9°C/min.

12.6 FIRE ALARMS

It is a device that senses ultraviolet light emanating from the flame, receives a signal, and sends an alarm signal to the processing center when it detects fire.

Used mainly in places where there is a high risk of fire, where the light of the fire is a sign of fire (eg, flammable liquid storage).

The fire detector is very sensitive to ultraviolet light and has been investigated to avoid false alarms. The probe only sends an alarm signal to the fire control center when there are two ultraviolet induction pulses after two intervals, each period of 5 seconds.

12.7 EMERGENCIES

Installed in the visible areas of the corridor for use when needed. This device allows the user to actively transmit fire alarms by pressing or pulling on emergency switches, emergency alarms for anyone present in the area known to have fire-fighting measures and Move out of danger area by emergency exit.

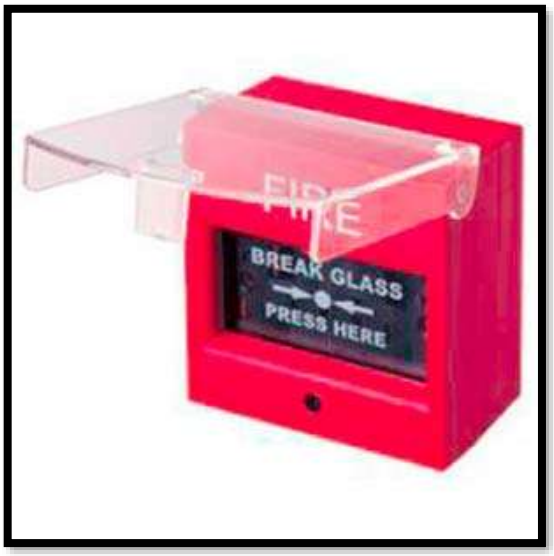


Figure 11.2 Emergecy switch

The following types of emergency switches are included:

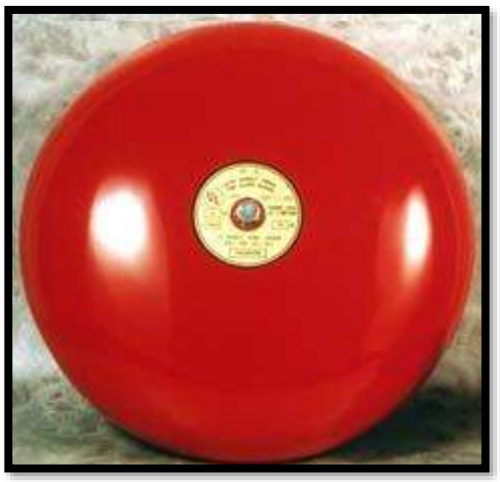
- Urgent, round
- Urgent broken
- Urgent

12.8 ALARM BELL

Installed in a security room, rooms with concierge staff, corridors, stairs, or crowds of traffic are available to inform those around you who may be experiencing the problem. timely evacuation.

In the event of a fire incident, the alarm will sound an alarm that will allow the security guard to identify and by means of a fire alarm monitor (the secondary display panel), which area will be exposed to the fire. from time to timely notify the staff responsible for fire prevention and fighting to overcome the problem or take appropriate measures.

Figure 11.3 Alarm bell



12.9 FIRE ALARM

It has the same features and installation location as the fire alarm, but the whistle is used when the distance between the place of notification and the place where the alarm message is received is too far away.

Figure 11.4 Fire alarms

12.10 LAMP

There is an alarm signal, each type of lamp has different functions and is installed in the appropriate position to maximize the features of this device. Composed of lamps:

12.11 LIGHT SWITCHES

Placed near the stairs of each floor, indicating the exit in the event of a fire. Automatic illumination in case of AC power loss.

12.12 FIRE ALARM

Placed above the emergency switch of each floor. The fire alarm will light up when the emergency works, and this is also an emergency light for those present in the building. This is important because, during the confusion caused by the fire, the user needs to clearly distinguish the emergency work that has triggered the fire pump.