The Calculation and Design of Fire suppression system in the proton accelerator research center

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1. Introduction

The fire protection system is composed of various fire suppression systems and fire detection and alarm systems. The primary function of the fire protection system is to protect life and property from a fire through detecting fires quickly and suppressing those fires that occur.

In this paper, we described the fire suppression system only. The fire suppression system capacity for fire hydrant, the water mist system, sprinkler system and clean agent system is calculated and designed in compliance with the applicable Korean Acts that are applicable to fire protection and the NFSC code.

2. The adapted components of Fire suppression system in the PEFP site

There area a lot of components bringing about fire accidents in the PEFP site. In table 1, Fire suppression system of each building in the PEFP site is categorized as fire ignition source.

Tab.1. Fire suppression system of each building in the PEFP

Bldg.	Comp.	Ignition source	FS System
A/T	RFQ, DTL, MEBT	General/ Electrical	Water mist
BARA	BTL/TR	General/ Electrical	Sprinkler
Kly. Gall.	VCB	Electrical	Water mist
	SCR&PLC Controller		
	HVS		
	Modulator Anode Power Supply		
	Transformer/Rectifier		
	Filter		
	Klystron		
Accel. Ass.	General Equip.	General	Sprinkler
Office	Office Equip.	General	Sprinkler
IBAB	Ion implanters	General/ Electrical	Water mist
IBAB experi.	Experimental Euip.	General	Water mist
Utility & Power supply bldg.	Transformers, batteries, switchgears	General/ Electrical	Clean agent (INERGEN)

2.1 Water-Mist system

Water mist system injected water as mist using high released pressure of water-mist head. It can extinguish fire by cooling and suffocation effects. As being non-electrical conductor, it has been used as fire suppression systems of transformers, electro-motors, cable trays and so on. It is composed of fire protection pump for supplying fire extinguishing water, linked pipe, automatic valve and water-mist head. As fire is detected by automatic fire detection system, automatic valve opened and water was released through water-mist head

2.2 Clean agent system

The clean agent system controlled combustion to restraint oxygen by chemical reaction. it might substitute halogen compound extinguishing agent inducing environmental pollution. As it doesn't damage to human beings and nature, it has been adapted to fire suppression system of electrical and control room. It is composed of INEGEN gas storage tank, driving equipments for gas opening valve, release nozzle and control systems. When the fire is detected by automatic fire detection system, driving equipments of fire-detected open. And then the valves of storage tank open to release the INERGEN gas(IG-541). It consists of Nitrogen 52%, Argon 40%, Carbonic acid gas 8%

3. The calculation of fire suppression water of each building in the PEFP

The Fire protection system in the proton research center should be designed up to NFSC(National Fire safety Criteria, ROK) and the standard and codes of NFPA(National Fire Protection Association) as follows

3.1 Design Criteria

A. Indoors Fire hose station(NFSC 102)
- Water release pressure at Nozzle end : $1.7kg/cm^2 \leq P \leq 7kg/cm^2$
- Water release flow rate : $\geq$ 130 lpm
- Quantity of simultaneous opening hydrant : $\geq$ 5EA

B. Outdoors Fire Hydrant(NFSC 109)
- Water release pressure at Nozzle end : $\geq 2.5kg/cm^2$
- Water release flow rate : $\geq$ 350 lpm
- Quantity of simultaneous opening hydrant : $\geq$ 2EA

C. Sprinkler system (NFSC 13)
- Water release pressure at head end : $1.0kg/cm^2 \leq P \leq 12kg/cm^2$
- Water release flow rate : $\geq$ 80 lpm

D. Water mist system (NFSC 104. NFPA Code 15)
- Water release pressure at Nozzle end : ≥3.5kg/cm^2
- Water release flow rate : 10 l/min/m^2 or 10.2 l/min/m^2(NFPA)

3.2 The Calculation results

Required flow rate for fire suppression pump is calculated to 3,910 lpm as shown in table 2. (maximum required flow rate at single area with single fire occurrence.) Each system required fire protection water flow in coincident with fire protection laws is calculated as follows :

- Indoors Fire hose station : 130l/min x 5ea x 20min = 13,000l =13m^2
- Outdoors Fire Hydrant : 130l/min x 2ea x 20min = 14,000l =14m^2
- Watermist system : 2,000l/min x 20min = 4,000l = 40m^2
- Sprinkler system : 80l/min x 30ea x 20min = 48,000l = 48m^2
- Total required fire protection water flow : 13m^2 + 14m^2 +40m^2 +48m^2 =115 m^2
- The volume of INERGEN gas storage tank : 12.6 m^3

Tab.2. The calculation results of fire water flow rate in each building of proton accelerator research center

	Area	Water quantity	Remark
1	Accelerator and beam application Bldg.	Fire hose station : 130 lpm × 5ea = 650 lpm Fire hydrant : 350 lpm × 2ea = 700 lpm Water mist nozzle : 20 lpm × 8ea = 160 lpm	Total : 1,510 lpm
2	Ion beam application bldg.	Fire hose station : 130 lpm × 5ea = 650 lpm Sprinkler head : 80 lpm × 30ea = 2,400 lpm Fire hydrant : 350 lpm × 2ea = 700 lpm Water mist nozzle : 20 lpm × 8ea = 160 lpm	**Total : 3,910 lpm**
3	Utility bldg.	Fire hose station : 130 lpm × 5ea = 650 lpm Sprinkler head : 80 lpm × 30ea = 2,400 lpm Fire hydrant : 350 lpm × 2ea = 700 lpm	Total : 3,750 lpm
4	Power Supply bldg.	Fire hose station : 130 lpm × 5ea = 650 lpm Fire hydrant : 350 lpm × 2ea = 700 lpm Water mist nozzle : 20 lpm × 8ea = 160 lpm	Total : 1,510 lpm

4. The configuration of Fire suppression system in PEFP

The piping and Instrument Diagrams of fire protection systems in PEFP site are shown in Figure 1. According to calculation results, The fire protection system design of all systems are completed.

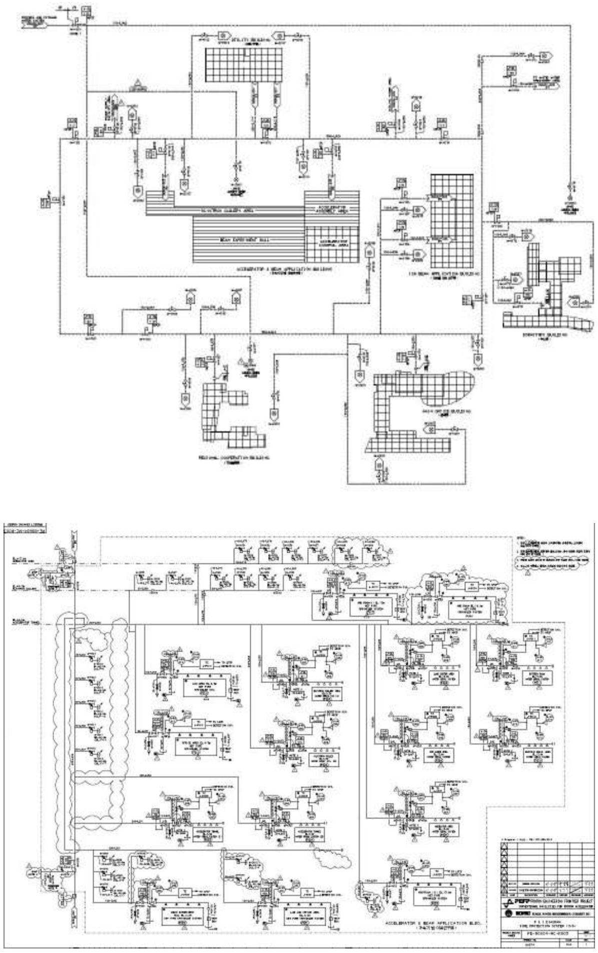

Fig. 1. P&ID of Fire protection system in the proton accelerator research center

4. Conclusion

There area a lot of components bringing about fire accidents in the PEFP site. In this paper, Fire suppression system of each building in the PEFP site is categorized as fire ignition source. The capacity of fire suppression system for fire hydrant, the water mist system, sprinkler system and clean agent system is calculated and designed in compliance with the applicable Korean Acts that are applicable to fire protection and the NFSC code.

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