

Filtration, Ventilation and Air Conditioning (FVAC) System in a Nuclear Installation

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Extended Abstract

Function of Filtration, Ventilation and Air Conditioning system is to make:

- Conditioned summer and winter temperature
- Conditioned relative humidity
- Required relative pressure (in comparison with ambient pressure)
- Required cleanliness degree for personnel or equipment
- Possible exhausted indoor radioactive, chemical or dust contamination
- Filtered exhaust air to release clean air to the atmosphere
- Required fresh air.

Design Basis

Active control of all the systems and after any event/accident or natural catastrophe is required. Thus, two design bases are identified:

normal design basis

safety design basis

The normal design basis covers the normal operation mode and normal shut down mode, it includes fulfilling indoor temperature, relative negative pressure and contamination control for outside, radioactive contamination control shall be concerned. A safety design basis must be defined if the facility cannot readily be shut down and isolated to an inactive state anytime during and after an accident or natural catastrophic event. The safety design basis covers plant emergency operation. It establishes the special requirements by establishing a safe working environment and by ensuring that the public is protected from exposure to radioactivity.

The following requirements are imposed on any safety related systems and components:

- System redundancy
- Seismic qualification
- Environment qualification
- Emergency power

Design Criteria

In a research reactor, zonification is basic control of radioactive contamination. In conventional and clean areas, there is not radioactive contamination, but dust contami-

nation shall also be considered. a combination of these two parameters leads to the following zonification:

High Contamination Areas(zone1)

They include hot cells interior and hot containments:

zone1 areas are free of operators. Temperature control and humidity is related to the need of system and component. Contamination control is the most important parameter. Relative negative pressure is high. Air handling unit supplies ordinary conditioned air, number of air change per hour is relatively high.

Filtration steps are as follows:

- Fiberglass prefilter
- Demister
- Hepa filter
- Silver plated copper mesh filter
- Charcoal filter

Intermedite Contamination Areas(zone2)

They includes hot cell and hot containment operation areas. In this zone, high radioactive contamination is present sometimes and usually is free of operators. In the case of necessary being of operators full body protective clothing and respirators of full-face gas masks need. Air handling unit supplies ordinary conditioned air. Relative negative pressure is lower than zone 1. Number of air change per hour is also lower than zone 1. Filtration steps are as zone 1.

Low Contaminated Areas (zone3)

In these areas, operators work. Conditioned air is required but contamination control is more important. A low level cleaning of entering air is recommended. Air handling unit supplies conditioned (temperature, humidity, and cleanliness) air, supply air is mixture of fresh air and recirculated air. Fresh air is in order of 25 to 50% of total entering air. Filtration steps are as zone 1.

Conventional Areas (zone 4)

Administration building, offices, service buildings and mechanical rooms are noncontaminated area, therefore, in the areas where personnel work in a longtime, conditioned air (temperature and humidity) as supplied air needs. Exhaust air is not controlled, some is exhausted out and remain is exhausted through return channel for reprocessing.

In chemical laboratory, if there is toxic gases which may release to the room, a local ventilation system is used to make local negative pressure and to transfer the contaminated air to the atmosphere. If the concentration of toxic gases is high and harmful for outside people, special filtration system will make it clean.

Clean Rooms (zone 5)

They include the following areas:

- Control room
- Radioisotope production room

In an area where dust contamination is against the system or products, clean room system makes a suitable condition. air handling unit supplies conditioned air including three stages of filtration. The last step is HEPA filter and will be installed at the ceiling of room. Relative pressure is positive unless in radioisotope production room where is

negative. Air change per hour is related to the degree of cleanliness and varies from 10 to 500. Return air is controlled and can be 80% of total supply air.

Exhaust System

the exhaust system shall be designed to clean radioactivity, toxic and noxious chemical from the discharge air, to safely handle products of combustion, and to maintain the building under negative pressure relative to the outside and adjacent spaces and remove contaminated gases from equipment.

- Hot Off-Gas system (HOG)
- Special Building Hot Exhaust system (SBHE)

References

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3. HVAC Handbook, 1987, chapter 40
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