Design Planning (standard design) for air conditioning and ventilation of a TBC – S3 Laboratory

1 Generally

This report covers the preliminary design of the HVAC equipment for the standard design of a TB Diagnostic Laboratory. The ventilation systems, necessary for the laboratory areas are shown and explained.

Basics
The following considerations, calculations, explanations and the total processing are based on the following documents.

- floor plan laboratory 1:50
- WHO guidelines :
  - Laboratory Biosafety Manual, Third Edition
  - Use of Liquid Culture and Drug Susceptibility Testing (DST) in Low and Middle Income Settings“ Summery report of Expert Group Meeting, Geneva, 26th of March 2007
- European standards (American Standards):
  - EN 12128 laboratories for research development and analysis
  - EN 12469 performance criteria for microbiological safety cabinets (BSC) (or American Standard NSF 49:2002)
  - Environmental Controls: Ventilation, negative pressure isolation room, tents and booths, air filtration and UVGI; Interdepartmental working group on tuberculosis in United Kingdom

1.1 Ventilation and Air Conditioning

1.1.1 Basics

The laboratory rooms will be supplied with pre-conditioned (heating, cooling) fresh air by a mechanical ventilation system. An additional air conditioning via a secondary cooling system will not be provided. Additional heat gains from laboratory technology, people and humidification are not considered. The calculations are based on the following temperatures:

- room temperature (winter): ca. 20°C
- room temperature (summer): ca. 24°C

- supply air temperature (winter): ca. 22°C
- supply air temperature (summer): ca. 18°C – 20°C

In the design of ventilation and air conditioning are the nationally applicable standards, rules and regulations to comply. The outside air conditions are determined according to each country and region.

The boundaries of fire protection sections, such as walls and ceiling, will be protected by fire dampers. All fire dampers are considered with a 90-minute fire rating.

1.1.2 Design of supply air device

The dimensioning of supply air devices for the laboratory areas are based on estimates of the designer and the current guidelines and standards.

It is considered that the volume of supplied rooms is approximately 189 m³. It is required 12-fold air change per hour. It gives total air volume of 2265 m³/h.

To ensure 100% redundancy of all equipment components of the supply air system two supply air devices are planned. They are installed above the other. Both supply air devices are planned with following treatment steps:

- air filtration (F7 outside air side ; F9 supply air side)
- air cooling
- air heating
- humidification (steam humidifier)

All components (filter; fan; cooling coil and electrical heater unit; steam humidifier) are redundant. If one device fails the other one takes 100% of the supply air provision for the laboratory areas.

For the installation of the supply air device and for additional components, such as duct silencers and flow controllers, a technique area of about 75m² and a clear ceiling height of 3.0 m is required.

The required outside air is drawn through a weather resistant louver in the facade and will provide the supply air devices over the outside air duct. To avoid the allowed noise pressure level sound absorber will be installed on the outside air and the supply air side of the devices. The filtering of the supply air takes place in two stages, firstly a F7 on outdoor air side and an F9 on the supply air side of the devices.

For each supply air device integrated refrigeration is planned to cool the outside air in summer case. The cooling units consist of a direct evaporator and a compressor unit. The required re-cooling is occurred by an common outside unit (condenser). For the cooling cycle, a refrigerant is used.

To heat the air in the winter, an electrical heater unit on each supply air device is planned. This unit is also used to dehumidify the air during cooling case.

The distribution of air is planned via air inlets in the laboratory rooms. To control the air volume flow variable volume boxes in the supply air ducts are planned.

1.1.3 Design of exhaust air system

Exhaust Air Bio Safety Cabinets (BSC)

According to the current design, two BSC are in the laboratory rooms used.

Above each of BSC 550 m³/h (in operation) will be extracted through a hood. The amount of exhaust air is controlled by an downstream variable volume box. Under full load (all BSC are running) it is totally 1100 m³/h of exhaust air.

Downstream for each BSC there will be a non-return valve and a H14 filter.

The two speed-controlled roof exhaust fans for the exhaust air of the BSC´s are each designed for 100% of the air volume (2 x 1100 m³/h; 100 % redundancy). In order to prevent the intake of outside air each fan is equipped with a non-return valve on the intake side.

Room exhaust air

To ensure of 12-fold air change per hour and an over pressure in the laboratory area, in addition 1365 m³/h have to be extracted via room exhaust air system. For this purpose, two additional variable speed roof fans with an upstream non-return valve are planned. Each fan is designed for the whole air volume of 1365 m³/h (100% redundancy)

The air extracting of the room exhaust air is planned via air outlets with integrated H14 filter and a down streamed variable volume box.

1.2 Annex

- Annex 1 : Floor Plan Standard Design Ventilation 1:50 and Schematic Diagram Standard Design Ventilation
- Annex 2 : List of ventilation components
- Annex 3 : Detailed specifications of ventilation components