# UPDATE ON HVAC DESIGN FOR LABORATORY

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## 1 Introduction

Since the supply crisis of the Brazilian electricity sector in 2001 and 2002 there was a strengthening of national understanding of the need for rationalization of electricity. From this issue, programs and standards have been developed with the aim to guide and standardize best practices in the use of electricity. According to the national energy balance of 2015 [1], about 65.1% of electricity consumption is distributed between the industry, the trade and the public sector. A type of building that is present in these three sectors, are the laboratories. Therefore, as the HVAC system is about 40% of energy consumption of a building, good preparation of this type of design become essential for national energy consumption.

## 2 Design Methods

According to NFPA 45 (2004) [3], laboratory HVAC systems can not operate with air return, as it must be avoided the distribution of chemicals. Because of this assumption, the TSI Corporation (2014) [2] identifies four types of methodology for the preparation of HVAC projects for laboratories. The methods are:

- Method for constant air volume (CAV): estab that the flow of air blown in the laboratory is constant. And the whole supply air is exhausted by a dedicated exhaust system or equipment such as fume hoods.
- Method for two positions: establishing that the air blown in the laboratory varies with the use of ambient exhaust systems (open or closed).
- Method for Variable Air Volume (VAV): estab that the flow of air blown in the laboratory is variable. And that their demand varies according to the temperature control and the demand for exhaust equipment such as fume hoods.
- Diversity Method: establishes the use of an operating schedule to the VAV method. An example of schedule is shown below.

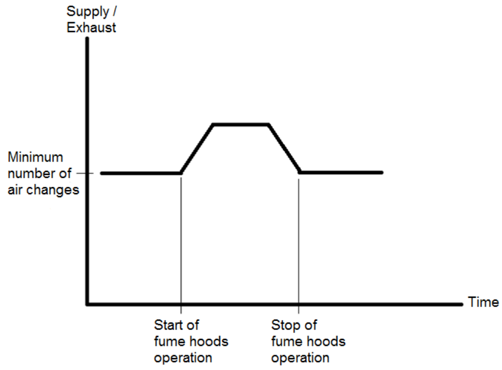


Figure 1: Schedule Example

Analyzing the four methods, it is concluded that the CAV is the methodology less expensive, because it has a smaller investment in automation. However, it is demonstrating the less flexibility and larger equipment, as these are designed for the maximum load of the system. Consequently this system has the highest consumption of electricity.

By contrast, the method of diversity is what has the highest cost of deployment. However, it is the one with the best flexibility and lower power consumption because it uses a sophisticated control system and variable frequency in the equipment.

## 3 Supply Air Design

The dimensions of the air to be blown in the laboratory is determined by the highest comparative value between:

- Air Changes: the standard NFPA 45 (2004) [3] establishes the minimum supply air should be 8 volume changes per hour for inhabited environments and 4 trade volumes per hour for uninhabited environment. This analysis is important to ensure the dilution of contaminants in the laboratory.
- Pressurization: establishes the minimum amount required air to direct the supply air between the environments. This method is important because it ensures that laboratory environments are always in depression in relation to administrative environments, so that it can be avoided possible contamination by chemicals.

- Thermal load: establishes the minimum air to be blown to combat the thermal load demand environment. The thermal load is the sum of heats from equipment, lighting, people, envelopment and outside air. And the analysis of this factor ensures room temperature control and thus the thermal comfort of the user.
- Exhaust Demand: the supply air is dimensioned for the need of air to be exhausted in each fume hood. To estimate the exhausted air flow is important to determine the opening area of fume hoods and their simultaneity. Another important factor to be determined is the face speed of the fume hoods, this factor depends on the material being handled. OSHA (2001) [4] recommended value of 0.5 $m/s$ for volatile and 0.7 $m/s$ to more dense substances.

## 4 Energy Efficiency

As the HVAC system uses a large volume of outside air, the use of energy recovery devices is interesting to minimize losses. Therefore, it is recommended to use the following equipment:

- Enthalpy wheel. This equipment uses an aluminum wheel with silica filler to do the heat exchange between the exaust air (dry and cold) with the outside air (hot and humid). Thus there is a primary combat of the latent and sensible heat;
- Air-air plate heat exchanger. This equipment uses the temperature difference between the exaust air (dry and cold) with the outside air (hot and humid). Thus there is a primary combat of the sensible heat;
- Heat tube heat exchanger. This equipment uses a capillary tube with titanium dioxide to do the heat exchange between the exaust air (dry and cold) with the outside air (hot and humid). Thus there is a primary combat of the latent and sensible heat.

## 5 Conclusion

From the analysis of the various assumptions that can be used for the preparation of the project, it is concluded that the best approach is to use the diversity method, sizing the supply air by the exhaust demand and use of enthalpy wheels as energy recovery.

## References

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