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Technical Article

Infrastructure & Cities Sector
Building Technologies Division

Zug (Switzerland), June 12, 2012

Integrated cleanroom solutions: maximizing safety and compliance, and optimizing energy

An integrated approach to cleanroom solutions can enhance the safety and security of people, assets and the environment, ensure regulatory compliance and also do so while reducing life cycle costs. Environmental conditions are often interrelated: for example the controlling of temperature will directly affect humidity levels, while the rate at which air is exchanged can affect particle counts. By integrating the monitoring of these parameters with the systems responsible for controlling them, the benefits can be optimized, such as achieving more precise control by balancing heating and cooling with humidification and dehumidification.

When you appreciate that an estimated 65% of energy costs are related to HVAC systems, it is easy to see why focusing on this can bring real cost and environmental benefits. By adopting an integrated system for GMP monitoring and HVAC controls, significant energy savings can be made. Varying air change rates based on the level of airborne particulates by integrating particle counters into the HVAC system is an example of how energy usage can be optimized, while also ensuring control of room cleanliness. If the fire detection system is integrated, an increase in toxic gas concentration levels can automatically increase the volume of air extracted from the room, or exterior window blinds can be raised in the event of a fire being detected. Integrating access control functionality can ensure that the lighting and temperature of a room is based on actual usage. Extending this ‘demand controlled’ approach beyond using just occupancy detectors, in a laboratory, for example, it is even possible to set the conditions based on the person that has entered. An access control reader identifying cleaning personnel entering will know it is for a relatively short period of time. The temperature comfort set point could therefore be lower but with an increased constant air exchange rate than say, for a chemist or technician entering for their daily work.

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Reference number: ICBT201206e TA

Integrated fume hood control

If you adopt a similar integrated approach with laboratory fume hoods, again benefits can be gained. Employing variable air volume controls for fume hoods is the most effective method of maintaining the negative air pressure so important to the safety of the hood operator while also saving energy. By reducing the air flow rate when the hood is closed and dynamically increasing it when the window of the hood is opened, this ensures that the hood always works in an energy efficient manner. Obviously, in a laboratory environment that employs this approach, it is highly advisable that the volume of air entering the room is adapted in the same manner. When the demand for air increases with the opening of the fume hoods, so the room supply and extract air volume controls adapt the flow of air into and out of the room accordingly. Optimization of both safety and efficiency is achieved by using fume hood controllers that communicate air flow demands to the primary room air supply, with a complete air circulation system that operates as one continuously balanced system.

Lower validation costs

By adopting a system from a single supplier it can also reduce the cost of validation. Each system installed in a GMP area must be validated, with a requirement for auditing of the supplier of that system to ensure compliance. A single supplier that is able to deliver multiple disciplines rather than having to source a number of different suppliers, each offering a single discipline, therefore reduces costs. It also provides additional efficiencies brought about through common project execution teams and established expertise in understanding the wider requirements of cleanroom environments rather than just those relating to a specific technology.

At Siemens, while we promote the benefits of integration, we recommend a physical separation of the GMP and the non-GMP systems i.e. one for environmental monitoring (temperature, humidity, laminar flow velocity, airborne particulate count values etc) and the other for the HVAC controls. In certain cases, this can mean duplicating the sensor hardware if, for example, the supply air temperature is both GMP and HVAC relevant. In such cases, solutions can be adopted whereby the signal is split from a single sensor, supplying data to the different systems.

Supporting the auditing process

Auditing is obviously an important part of the regulatory compliance of cleanrooms. In this respect, an environmental monitoring system primarily focuses on two areas: demonstrating the accuracy of real-time monitored data and providing timely access to the raw data from quality relevant critical measured values. Modern systems have built-in self diagnostic functionality, plus back-up and archiving facilities to securely store long term the data used to compile audit reports should they be required.

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Cleanrooms are subject to extensive regulation to protect public health. By adopting integrated solutions, compliance can be more readily achieved, while also reducing life cycle costs.

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