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Constant Temperature and Humidity Environmental Lab Design: A Delicate Balancing Act

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Constant Temperature and Humidity environmental labs are often necessary components to a facility studying moisture - and temperature-critical personal care products. Yet in these laboratory spaces, maintaining the ideal conditions can be a complex balancing act: A steady throughput of test subjects entering and exiting the space often acts in direct opposition to the mechanical systems working to maintain the space's environment. Further complicating the issue is that if the space's environmental set points deviate too far from the test specifications, test results may be rendered unusable. When that happens, the time, money, and resources spent to recruit subjects, schedule trials, and administer the tests, are lost.

Fortunately, measures can be taken in the design of a Constant Temperature and Humidity environmental lab to minimize the potential for the room being out-of-spec, help it recover quickly when it does go out-of-spec, and record temperature and humidity points to provide verification that room integrity was maintained throughout the course of testing. In the following sections, we will examine three components of a properly designed Constant Temperature and Humidity environmental room: the envelope, the mechanicals, and the controls:

WHAT'S IN THE BOX?

Constant Temperature and Humidity environmental lab design begins with the thermal and vapor envelopes that encompass the space. The walls, ceiling, floors and penetrations all must be constructed to support the maintenance of constant and consistent temperature and humidity levels required. Conventional interior construction – using metal studs, stud cavities filled with fiberglass batt insulation, sheet vapor barrier and gypsum board – makes achieving an adequate temperature and vapor envelopes challenging. Maintaining the vapor seal around electrical junction boxes, mechanical and light penetrations, wall to ceiling joints, etc. can be inconsistent at best. Additionally, if the environmental lab will need to perform in intense hot or cold, walls can often grow to 6" or thicker to accommodate the necessary insulation thickness. Needless to say, conventional construction struggles to get the job done.

Best Practices Tip:

Particular attention should be paid to the box's door and frame details to maintain thermal readings and provide the best seal(s) possible.

Room cleanability may also need to be considered if studies are to occur that generate sweat, for instance, or other condition(s) that may adversely affect the hygienic condition of future studies. One design opportunity that addresses both the room envelope and cleanability is the use of Insulated Metal Panels for walls and ceiling(s), or even a turnkey environmental box. These high-performing building materials may seem costly initially, however they can frequently provide more flexibility to a facility owner in the range of temperature, humidity and product studies that can be accommodated.

THE MECHANICS OF A CONSTANT TEMPERATURE AND HUMIDITY ENVIRONMENTAL LAB

In the design of a Constant Temperature and Humidity environmental lab, mechanical systems are essential to the ability to maintain proper space temperature, and humidity levels and thus assure test integrity.

Environmental lab design must look at what the desired space temperature and humidity levels need to be for the specific tests being conducted, and the tolerances on those levels. How large is the potential temperature and humidity range of the studies that will be conducted? For example, mechanical systems that must support temperatures ranging from 60 degrees to 90 degrees, and maintain low humidity levels, will be more complex than systems with far smaller ranges.

Another factor that will influence mechanical system sizing and selection is the number of employees and study participants who will be in the room and their activity levels. Will they be seated at rest? Walking? Exercising? This information will help determine how much heat and moisture they will give off in the space.

How often people enter and exit the room, and at what intervals – must also be addressed. This information helps provide an understanding of how the temperature and humidity of the surrounding space will affect the Constant Temperature and Humidity environmental lab. A vestibule or airlock may need to be considered at the entrance to the environmental lab to minimize the impact of the surrounding space to the lab.

In addition, consideration needs to be given to the required level of air filtration needed in the mechanical system based on the studies being conducted. Room pressurization is also critical, since the space should be kept positive in relation to surrounding areas to

minimize any potential transfer of airborne particulates into the lab. This need, along with code requirements for ventilation, will necessitate the amount of outside air delivered into the space.

Best Practices Tip:

If temperature and humidity tolerances in the room are critical, the chilled water/glycol system and heating hot water system serving the HVAC system needs to be able to deliver consistent supply temperatures.

Once these factors are known, the specific type of mechanical system to be used can be determined. A traditional HVAC system using direct expansion (DX) cooling coils and gas heat may not work for Constant Temperature and Humidity rooms, which often have tight tolerances and may require low humidity. To achieve quicker response, more agility, and tighter control, consider using chilled water or glycol as chilling media in lieu of a DX system, e.g., packaged Freon cooling systems. On the heating side, using hot water for heating, rather than gas reheat, also delivers more flexibility, tighter control, and greater turndown capability. Also, desiccant dehumidification may need to be used to maintain low humidity levels in the lab.

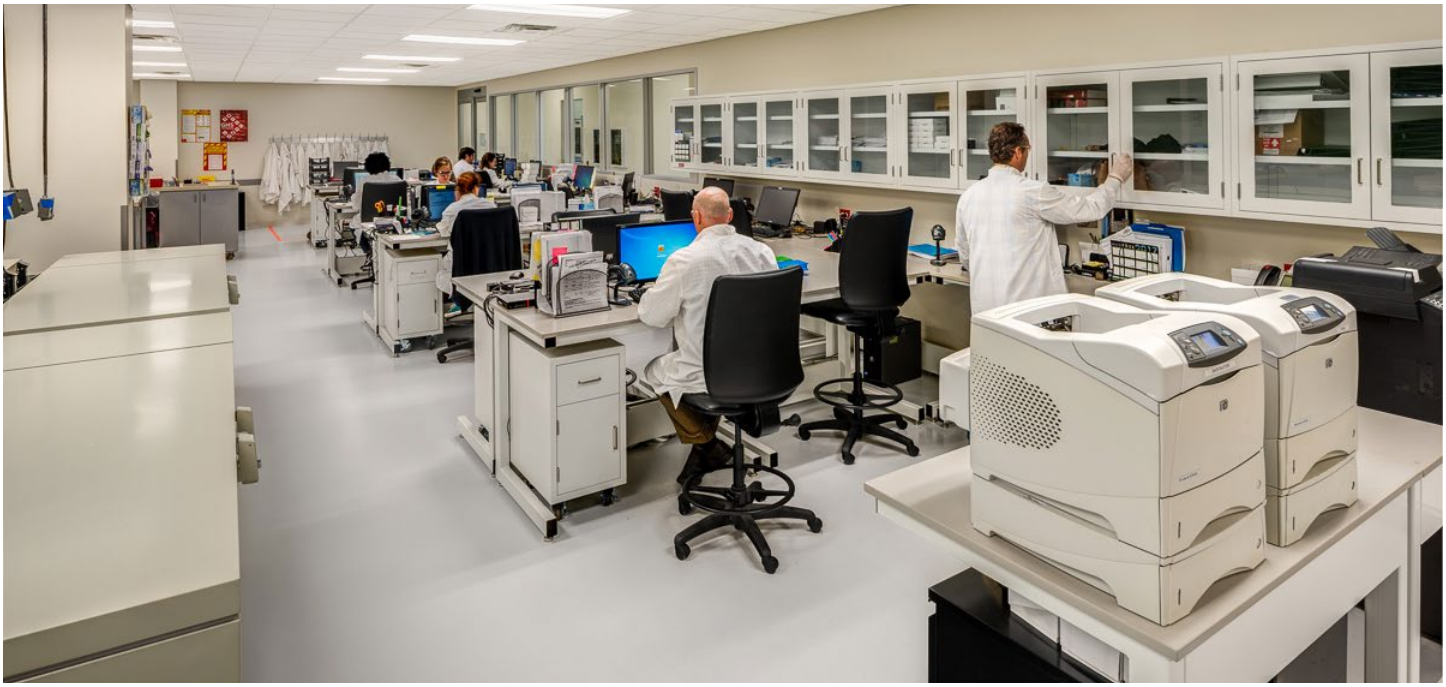
PLACING PEOPLE IN CONTROL

Automation and controls are an important part of any modern lab design. The complexity of Constant Temperature and Humidity environmental labs though leads to even more challenges in the design of those controls.

Consider system reaction time. Traditional devices used in HVAC systems may not have the reaction time required to maintain tight tolerances required. Proper Instrumentation is an additional concern. Most traditional HVAC instruments are built to gradually change – being off by a one or more degrees either up or down is not generally problematic in most On/Off HVAC applications. Obviously, this is not true for environmental labs. Using more industrial type of instrumentation may be necessary to get the specificity that is required.

Best Practices Tip:

Controls should be able to alert personnel when the system is in and out of tolerance. Installing indicator lights in all rooms can provide personnel with an instant visual clue as to system status.



One of the most critical aspects of control for a Constant Temperature and Humidity environmental lab is the screen design of the Human Machine Interface (HMI). In many of these labs, those running the system may be non-computer savvy personnel, such as nurses, technicians, and other lab workers. The HMI must provide a balance between covering the ranges that need to be controlled, but have a simple, effective screen design so that lab personnel can operate it and know what they were doing quickly and easily. Remember, these are not standard commercial grade controls: A Programmable Logic Controller (PLC) with an HMI is required to troubleshoot any out-of-tolerance situations. Most normal commercial grade PLCs will not allow this.

Finally, with any Constant Temperature and Humidity environmental lab, data gathering will be necessary to prove that systems remained within tolerance during testing. Consider incorporating a separate video graphics recorder with removable SD card. During testing, data can be captured as frequently as required and sent to a system to be seen in real time. The removable SD card can also be given to the client immediately at the conclusion of the test. Such a system can also be tied into the building automation system, and that system can send an alarm if there are any deviances from the required tolerances.

THINK BEYOND TRADITIONAL

When it comes to Constant Temperature and Humidity environmental lab design for testing of personal care products, there is no one-size-fits-all answer. Each aspect of the design, from envelope to controls, plays an important part in the balance of the room. Issues like poorly sealed penetrations or doors in the envelope will cause the mechanicals to be out of spec, which will create problems in the controls. And the more complex the room is – or if multiple rooms are part of the environmental lab – the more complicated these issues become. The answer is not just to go out and build a big enough mechanical system, or to throw in all kinds of bells and whistles in the overall design: Beyond the sheer costs involved with this, doing so would necessitate having a highly technical engineer to operate the system, rather than the lab operators. Instead, take the time to carefully consider your environmental lab requirements and create the right mix of envelope, mechanical systems, and controls to address your company's specific needs and goals.

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