

Design and Application Issue: The Case For Tighter Temperature Control, Part 1

Design professionals must often specify the allowable variance in controlled environment room temperature for their client. This basic specification element has an impact on the client's beneficial use of the chamber which extends beyond the obvious.

Assume the client needs a cold room for storage of biologics. When queried about the temperature control requirement, he/she is likely to indicate that maintaining the space within the $+2^{\circ}\text{C}$ to $+8^{\circ}\text{C}$ range is sufficient. Temperatures outside this range result in stored product damage or loss.

You could specify a setpoint of $+5^{\circ}\text{C}$ with a maximum variation of $\pm 3^{\circ}\text{C}$ to meet the client's stated requirement, but enhancing the requirement to $\pm 0.5^{\circ}\text{C}$ provides tangible benefits in system operation and product protection.

A narrow variance range allows alarm points to be set close to the normal room operating condition, alerting the operator of an abnormal condition before the product is exposed to damaging temperatures. In our $+5^{\circ}\text{C}$ setpoint example, specifying $\pm 0.5^{\circ}\text{C}$ maximum control variance enables alarms to be set at $+6^{\circ}\text{C}$ and $+4^{\circ}\text{C}$, providing an alarm

on the high side with a margin of 2 degrees before exposure of the stored product to unsafe or unacceptable conditions.

An additional benefit can be derived from more accurate temperature control. In the same example with better temperature control, we can operate at a setpoint of $+3^{\circ}\text{C}$, still within the acceptable product range. Since this room's operation is primarily based on cooling, most failure conditions will send the temperature upwards. By maintaining the room condition near the low end of the acceptable product range and setting alarms close to the normal room condition, we can increase the length of time allowed to respond to an equipment failure. With a setpoint of $+3^{\circ}\text{C}$, you can have alarm points as low as $+4^{\circ}\text{C}$, providing more time to take action and protect the product from damage or loss. Working with the original $\pm 3^{\circ}\text{C}$ control specification provides no time to take any action to protect stored product from loss or damage because the alarm setpoints must be set outside the normal control range of the room, which in this example is the same as the safe range for the product.

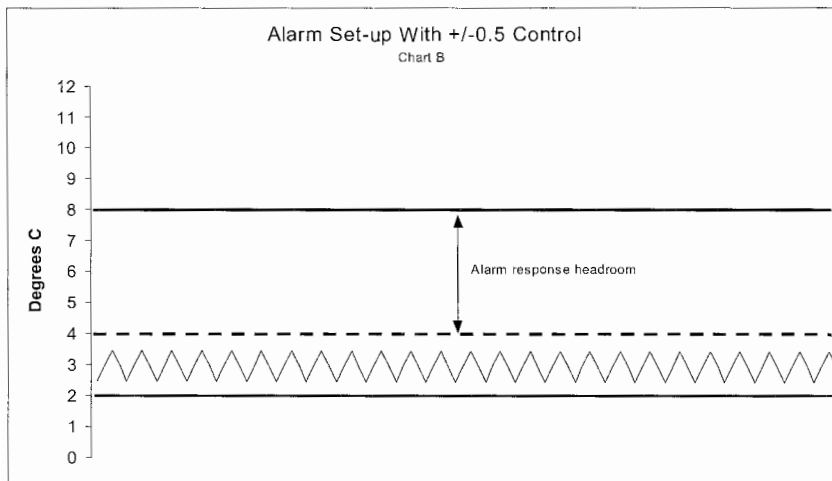
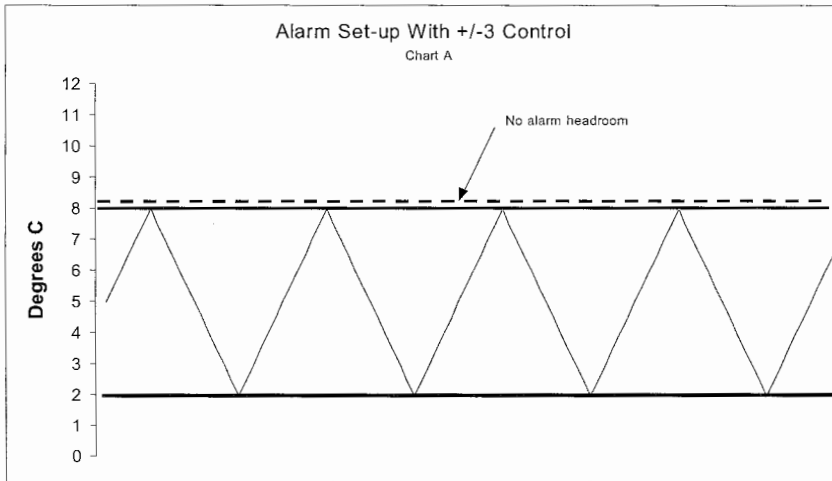
What does it take to get $\pm 0.5^{\circ}\text{C}$ control of the room

temperature? A microprocessor controller with accurate temperature sensors is required. However, the essential element is a careful examination of the heat loads for the controlled space and implementation of the appropriate mechanical system design. Installing a microprocessor controller on an improperly designed cooling system will not achieve the desired results.

What increase in control accuracy is appropriate? Certainly it can vary with each project. The client, when presented with the trade-off between additional cost and reduced risk, can make the selection. At some point, the costs to achieve incrementally better temperature control will balance with the client's tolerance for risk of loss. This is the level of control that should be specified for the project, with a requirement for documentation of the as built performance with multi-point testing.

A reduction in the risk of product loss or damage can be attained through the implementation of better temperature control with reduced variance from the setpoint. Enhanced alarm capabilities provide the operator more time to take action in response to an alarm.

More on tighter temperature control and alarms from previous page.



The two charts show how you can increase the alarm *headroom*, the difference between the maximum tolerable room temperature and the alarm setpoint, by reducing the normal room temperature fluctuation with better control.

The dashed line on both charts indicates the lowest alarm setpoint applicable to the level of temperature control indicated. Chart A shows room temperature control variation ranging over the span of acceptable product temperature, limiting the lowest alarm setting to a point which will notify the operator only that the stored product has already been exposed to damaging conditions. Chart B shows how increased headroom can be attained by controlling the room temperature within a narrower band and setting an alarm point further from the maximum tolerable room temperature.

Earlier notification of abnormal temperature variances, through the application of better temperature control, will lead to a reduction in the risk of product damage or loss.

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Future Topics:

The Case For Tighter Temperature Control, Part 2

Limit Control Application In Controlled Environment Room Design

Documentation Requirements For Controlled Environment Rooms

Risk Management: Refrigerated Storage of Critical Materials