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**SPECIAL REPORT**

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## Monitoring Environmental Conditions in Operating Rooms

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Environment of Care Standards emphasize the need to maintain environmental conditions in ORs within acceptable limits. The following parameters are considered especially important:

	<u>Key Parameter</u>	<u>Acceptable Range</u>
1.	Temperature*	68 and 73 <sup>o</sup> F (typical)
2.	Relative Humidity*	30 to 60%
3.	Ventilation Rates*	> 15 ACPH** on supply, > 3 ACPH fresh air
4.	Pressure Differential	> 0.01 inches water column
5.	Air Filtration Efficiency***	> 95% for all particle sizes (> 0.3 microns)

\* American Institute of Architects, Guidelines for Design and Construction of Healthcare Facilities, 2006 edition.

\*\* Air changes per hour. In some states, the minimum is 20 ACPH on supply.

\*\*\* Air filtration efficiency can be approximated by comparing indoor and outdoor counts. The minimum efficiency reporting value that is commonly used today is MERV 14.

JCAHO and other professional associations have specified the acceptable ranges for each of these parameters. Under Environment of Care Standards, facilities are "encouraged" to verify, track and document these parameters.

To our knowledge, there is no one monitoring system available that continuously records and displays all of these parameters inside each OR and in the Engineering Office at the same time. Only temperature and relative humidity are required to be monitored under the terms of most facility licenses, but the accuracy and the periodicity of the monitoring are unspecified. The other parameters are generally assumed to be assured by the design, operation, maintenance and monitoring of the HVAC systems.

OR managers, infection control practitioners and engineers are now asking to continuously monitor these important parameters. They realize that continuous monitoring is better for both patient safety and staff comfort than conducting periodic spot checks. Otherwise, how can they be assured that these parameters are within acceptable ranges all the time?

A periodic check is not necessarily representative of the entire day. For example, humidity checks made early in the morning before cases begin may not represent the humidity by late afternoon. How can these important parameters best be monitored?

### **Ideal Solution**

The best way to track these parameters is to use calibrated monitors that continuously provide a visual display both in the OR and an alarm in the Engineering office. The monitors also must have continuous recording capability to demonstrate compliance and help troubleshoot HVAC systems. Temperature and relative humidity (the required parameters) should be displayed simultaneously in each OR.

Is it necessary for the OR to have a visual display of parameters 3, 4 and 5? No, not in our opinion at this time. But engineering should have a record of these parameters. Thus, engineering needs the necessary hardware and tools for this task.

### **Automation Systems**

Some hospitals have energy management systems that monitor and display these parameters at a computer terminal usually located in the Engineering office. These systems can also generate historic summary reports on a regular periodic basis, or on demand. They can also automatically alarm or alert the Engineer when a limit has been exceeded. Unfortunately, such systems exist mostly in large healthcare facilities, and some do not always function properly.

Some energy management systems have the capability to monitor these parameters, but may not be hooked-up to do so. They might lack necessary sensors. In many cases, displayed readings do not agree with actual conditions. We find a wide range of situations from place to place.

### **Wall-mounted Devices**

Small temperature and relative humidity monitoring devices with digital displays are commonly mounted inside most ORs. These devices are usually inexpensive and may not be sufficiently accurate. (See our March '06

newsletter, copy available.) These devices have no recording or alarm capability and cannot be easily calibrated. We recommend using only accurate devices for measuring temperature and relative humidity in ORs.

Pressure differentials and ventilation rates are never displayed in ORs. The absence of these displays often leads to concerns and questions by medical staff and inspectors. People feel uncomfortable when there is insufficient air movement and may complain, and some inspectors check relative pressures by holding a tissue paper near the door.

Air filtration efficiency is assumed to meet minimum requirements based on the type of filters that are used, and on the visual integrity of the filter housing and seals. During the past few years, hospitals have begun to check filtration efficiencies using particle counters periodically and after filter-changing.

### **Suggested Accuracy**

All monitors require some kind of periodic calibration check, adjustment and re-calibration. Readings must agree with the actual conditions. We recommend the following accuracy specifications for monitoring devices:

<u>Key Parameters</u>	<u>Recommended Accuracy</u>
Temperature	+/- 1°F
Relative Humidity	+/- 2%
Ventilation	+/- 5% of ACPH
Pressure Differential	+/- 0.001" W.C.
Air Filtration	+/- 5% of counts for all particle sizes

Calibration is necessary upon commissioning the system. Annual calibration checks and documentation are recommended.

### **Considerations**

Does your facility need to monitor these basic parameters?

Temperature and relative humidity monitoring are most likely required.  
How often are the other parameters checked?

Would your facility like the ability to monitor all of these parameters?

Is the value of continuous, real-time monitoring recognized?

Is continuous monitoring planned with the next upgrade of the HVAC systems?

Where should these parameters be displayed?

In the OR where too many displays may be confusing, or in Engineering?  
Does your Engineering Department have the people and equipment to monitor these parameters?

### **Recommendation**

For years, Pharmaceutical and Biotech companies have been monitoring temperature and humidity as part of their validation procedure. As an example, one vendor, Veriteq Instruments, has been providing such companies with 24/7 monitors and alarms that provide early warning for out-of-spec conditions.

Veriteq's solution is to connect a temperature and humidity monitor and data logger to a PC which sends a message via Email to other PCs, cell phones, pagers, or a wide variety of external displays and alarms. This system stores the data, which are accessible to OR staff and engineering. The system appears easy to install and meets our suggested accuracy requirements. It is affordable at around \$1,000 per OR, plus software at \$1,500 for an unlimited number of ORs. The company is ISO and ANSI accredited and provides references.

Each monitor plugs into an Ethernet outlet and is assigned an address. The system is compatible with any Windows network. Typically an in-house IT person performs the installation and Veriteq provides phone support. For more information go to: <http://www.veriteq.com/temperature-monitoring/index.htm>  
Using such a system can achieve the following:

- OR staff will no longer have to call engineering to complain about high humidity or temperature, postpone cases, or throw away supplies subjected to extreme conditions.
- Engineering will be able to be more proactive; not reactive.
- There will be no ambiguity about actual conditions or measurement accuracy.
- Questionable spot-checks and tedious record keeping are not necessary.
- The long-term performance of the HVAC systems will be tracked and recorded.
- A record of actual conditions during each case will be available, if there is ever an infection control issue.

Once a year, the calibration of each monitor needs to be checked. Thus, a calibration program is necessary. Unfortunately, this system does not monitor parameters 3, 4 and 5. These parameters may be tracked by other automated systems or by periodic testing. We expect that eventually all five parameters will be monitored and that continuous monitoring will become a standard feature in all ORs.