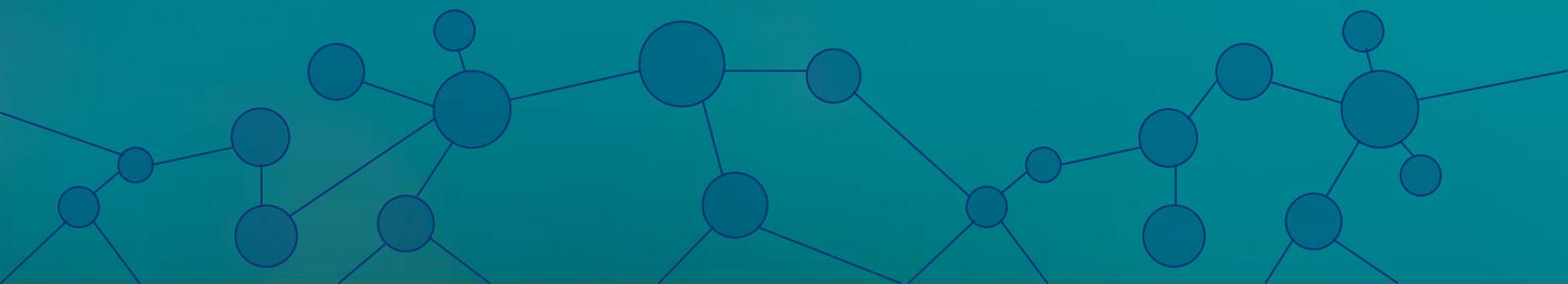


# CLEANROOM TECHNOLOGY

Exploring Solutions Across  
Industries and Applications

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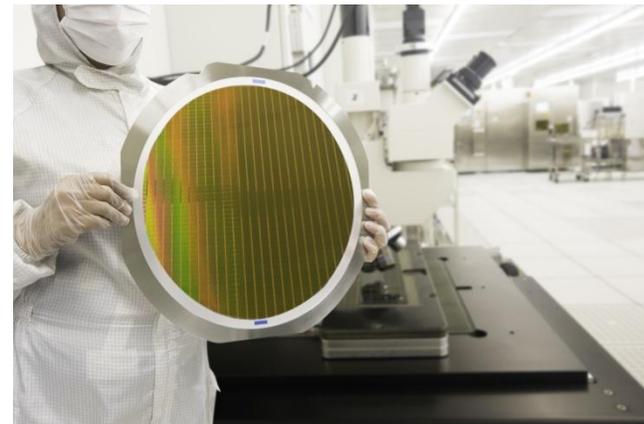
**Cleanroom technology has become so advanced that it can serve spaces of virtually any size in any industry around the world**

Behind every cleanroom is a sophisticated environmental control unit (ECU). Cleanroom technology has become so advanced that it can serve spaces of virtually any size in any industry around the world, regardless of the specific challenges that may arise. From the medical tech harvesting samples in the lab, to the aerospace engineer sending components into space, ECUs can be adapted to fit nearly any objective.

Without this kind of highly specialized technology, cleanrooms would not be able to do their job correctly. And that job is to maintain sterile, controlled, consistent environments in which people, processes and machinery can work to the best of their ability.

While the cleanroom contains the air, it's the ECU that controls the variables in that air, such as particles, temperature, pressure and humidity, all within the confines of the precise settings required for the application.

These settings can change drastically from one cleanroom to the next, even within the same industry, which is why there can never be a one-size-fits-all ECU. Thankfully, there are plenty of flexible solutions available today to solve nearly any problem and accommodate almost any requirement. All it takes is partnering with an experienced environmental control company, like Air Innovations, to get the products your facility needs.



## EXTREMELY TIGHT TOLERANCES

When dealing with high stakes and complex systems, there can be serious ramifications if environmental conditions are off by even one degree. In particular, we see clients trying to control humidity to very tight tolerances within their enclosures. High levels of humidity can corrode and short circuit metal computer components, influence bacteria growth and cause moisture condensation, all of which can destabilize sensitive systems in devastating ways. And yet, when humidity levels are too low, facilities run the risk of electrostatic buildup, creating the potential for dangerous sparks in areas where flammable materials are used and stored.



It's easy to see why humidity is such a universal concern for cleanrooms. Every industry, from defense to the healthcare field, relies on processes that demand strict adherence to stated tolerances, and these are often extremely precise. For example, if blood work becomes contaminated in the lab, the resulting misdiagnosis has serious consequences for patients and practitioners alike. Similarly, when electrical currents in a semiconductor are compromised, the entire system can fail. That's why cleanroom engineers work tirelessly to create products that can maintain optimal conditions with minimal intervention 24 hours a day, 365 days a year.

Further, humidity is inversely related to temperature, making it even more difficult to control. If temperature increases, the air inside the cleanroom can hold more moisture, thus decreasing the relative humidity (RH) and affecting the dew point. Given this relationship, environmental control technology must be able to keep both humidity and temperature within the user's accepted ranges.

## SPECIFIC SOLUTIONS

Recently, we partnered with a semiconductor firm to create an environmental control unit for their semiconductor lithography tool. Due to a semiconductor's distinct electrical characteristics, temperature needed to remain at a steady 68°F – 75°F  $\pm 0.36^\circ\text{F}$ . Additionally, the equipment could not experience more than a 2°F change in temperature in any one-hour period. When presented with the challenge, the Air Innovations team recommended the AdvancAir environmental control unit.

AdvancAir units are fully customizable and extremely powerful, able to accommodate temperature control as tight as  $\pm 0.02^\circ\text{C}$  and humidity control as tight as  $\pm 0.5\%$  RH. When designing the custom unit, we installed a 5kW electric reheater to minimize temperature change in any given hour. The final ECU also featured a water-cooled system with temperature sensor and Poron® microcellular closed-cell insulation and was compliant with SEMI standards.



## PARTICLE FILTRATION

The threat of airborne particles calls for environmental control units with powerful filtration capabilities. Airborne particles, including everything from skin cells and hair to dust and dirt, can be exceptionally damaging, especially when it comes to biological matter. For example, if human tissue samples and blood vials are exposed to contaminants in a research lab, they usually have to be thrown out and recollected.

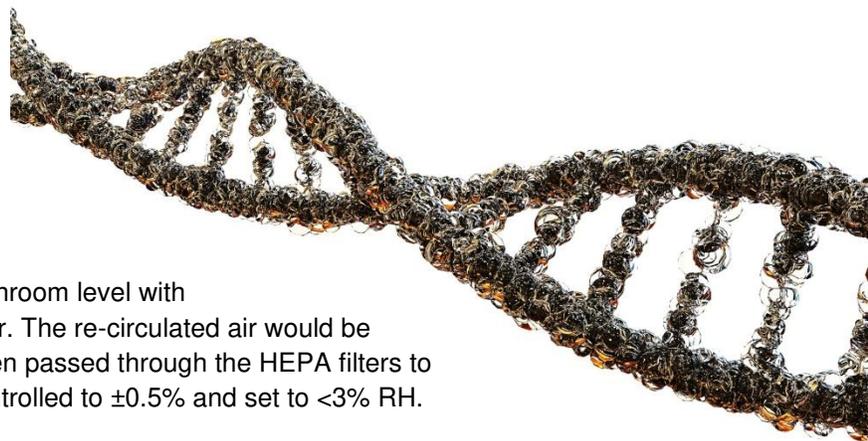
The presence of particles can be equally damaging to metals and machinery. As salt travels from the ocean in the air, it can eat away at even the toughest grades of stainless steel. In some cases, salt proofing can help protect individual parts and wires, yet even then, these components may still be vulnerable to corrosion. The salt has to be filtered out of the air using HEPA filters. Oftentimes, these filters must be able to remove 99.99 percent of all particles, including ones as small as 0.3 microns, in order to fully protect the equipment.

### SPECIFIC SOLUTIONS

Knowing how important filtration is to medical environmental control units, we weren't surprised by the challenges presented by a recent client in this field. A design engineering firm needed a cleanroom for its automated biotherapy reagents packaging system. The enclosure had to meet ISO 8 cleanroom standards for maximum humidity, temperature and particulate control.

In an ISO 8 cleanroom, filters have an average of 10 to 25 air changes per hour. They have to remove millions of 0.5 micron-size particles, as well as thousands of 1 micron- and 5 micron-size particles at once. This would help protect the integrity of the reagents by keeping them free of dust, skin cells, mold spores, bacteria, smoke, dander and more.

The ECU we built for the client achieved the ISO 8 cleanroom level with HEPA filtration and a desiccant dryer with pre-filtered air. The re-circulated air would be returned to the acceptable ambient temperature and then passed through the HEPA filters to keep the environment stable. Relative humidity was controlled to  $\pm 0.5\%$  and set to  $<3\%$  RH. Temperature was controlled to  $75^{\circ}\text{F} \pm 2^{\circ}\text{F}$ .





## CLEANROOM MOBILITY

Mobility is another requirement for many of our clients. In some cases, ECUs have to be portable or reconfigurable to fit through doorways. In other situations, operators simply need easy access to controls for maintenance.

Some products, like the ArrayAir ECU, are designed with portable, lightweight bodies to make movement easier. Larger units can also be outfitted with a set of wheels or otherwise customized to accommodate this need. Other ECUs, such as AdvancAir, are made up of modular building blocks, giving them the flexibility to take any shape required. After all, every building, room and structure has its own unique dimensions, and cleanroom technology has to adapt to them, not the other way around.

Just as not all cleanrooms are meant to be stationary, not all of them are intended for dry land either. We've worked with clients who needed ECUs for spacecraft, airplanes and ships. In these situations, a whole new set of challenges can emerge. In addition to any unique climate conditions that may be present, such as higher humidity levels, changes in atmospheric pressure and salt air, we also have to consider how the unit is going to be secured to the structure.

### SPECIFIC SOLUTIONS

These concerns came into play when an aerospace and defense corporation needed help with the calibration system for their airborne laser defense system. The modified Boeing-747 had two kilowatt-class Target Illuminator Lasers that needed to remain precisely calibrated at all times. If calibration failed, there was a risk that incoming missiles could get through defenses undetected. As such, the calibration process required highly controlled environmental conditions and we were happy to accept the challenge.

Hydrocarbons, gasses, salt air particles, humidity and temperature can all corrupt the controls, sensors, optics and payloads on an aircraft. The client worried these factors might damage the delicate parts involved in the laser calibration process.

So, we set out to design, manufacture, test and eventually deliver a custom, portable, self-contained cleanroom system that met all the client's required specs. It was made to sit on the outside of the plane, connected via flex duct to the avionics that carry the laser-guided missiles. The cleanroom was also equipped with wheels and high-static blowers that successfully push through HEPA filters and extensive ducting. Upon completion, the cleanroom technology was able to achieve both the air quality requirements and the structural requirements set forth by the client.

## CUSTOM PRODUCTS

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## STANDARDIZED PRODUCTS

From biotech and spacecraft development, to lithography and semiconductor wafer processing, cleanrooms have to meet a spectrum of demands. Manufacturers come to us with unique problems, and we work out the solutions to address each of them. There is no one-size-fits-all product. It takes careful research and planning to figure out exactly what the environmental control system needs to do and how it's going to do it.

There are two main types of cleanroom technology solutions. The first is a ready-to-ship standard unit designed specifically for cleanrooms. The second is a custom ECU made to order. With both options available, we can best serve the needs of every client who approaches us, regardless of their specs, size, functionality and budget needs.

If you choose a custom solution, the Air Innovations multidisciplinary engineering



team will work with you to make sure all specifications are exactly right. How much load does it have to hold? Should it be crafted from stainless steel, aluminum or polycarbonate? Will the unit need to be assembled vertically or horizontally? These are all factors that help the team piece together the bigger picture of what the space demands.

Even standardized products, such as ArrayAir and HEPAir (see below for details), can be tailored to accommodate specific requests. About 90% of the components come standard, with about 10% open for personalization should you need to make any adjustments for air quality, power requirements or compliance regulations. Whatever you need, whether it's a small standard unit or a large custom one, Air Innovations is here to help. The diversity of what's possible ultimately helps resolve any environmental control problems clients may face, no matter how complex.

### ArrayAir

- Portable and lightweight
- Fits enclosures up to 30 cubic feet in size
- Quiet operation
- Cools and heats 5°F below/above room temperature



### HEPAir

- Self-contained 2-in-1 unit
- Designed to match to most existing fan/filter units
- Excellent "do-it-yourself" solution saves time and money
- Best in softwall, single-pass air cleanrooms



### AdvancAir

- Tight temperature control as low as  $\pm 0.02^{\circ}\text{C}$
- Humidification control to  $\pm 0.5\%$  RH
- Chilled water or DX-based systems
- Computer-managed, system-wide control



Air Innovations is the only company to offer fully integrated modular environmental systems specifically created for cleanrooms. Our ability to customize products gives clients from all types of industries the option to ensure total adherence to their exact specifications and performance needs. No matter which ECU solution best serves you, some degree of customization is always available.

All of our cleanroom products are produced and tested in our 40,000 square foot state-of-the-art facility in Central New York. While ECUs may look like simple air conditioners on the outside, they're extremely complex. Clients from 50 different countries have trusted Air Innovations to overcome any challenges with maintaining the clean, controlled environment their business needs.

For additional information about flexible ECU technology for cleanrooms and more, please contact Air Innovations or visit us online. If you're interested in purchasing or designing your own environmental control unit for a cleanroom, you can find product datasheets and design forms on our website to help you get started. Questions? Give us a call today.

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