Summer 2023

The Airflow Update

AIRFLOW SCIENCES CORPORATION

Using CFD Modeling to Design the HVAC System for the World's Most Advanced Radar

By: Jeff Everett

Image Credit: Lockheed Martin

An essential component to building design is the Heating, Ventilation, and Air Conditioning (HVAC) system. Comprised of fans, heat exchangers, ductwork, and diffuser panels, the HVAC system ensures that the building interior maintains acceptable temperatures, regardless of the climate or weather conditions outside.

While the function of HVAC design for personal comfort is well-known, it is also a necessary consideration for facilities using high-powered computers or other electronics. Waste heat generation from this equipment can be significant, often requiring specialized cooling air delivery to dissipate the heat and exhaust from the area.

The U.S. Air Force (USAF) and U.S. Space Force (USSF) developed Space Fence, a sophisticated radar system to detect and monitor space objects, primarily those in orbit around the Earth. The radar electronics are housed in two buildings which comprise the Transmit (TX) Array and Receive (RX) Array. As part of the facility's design, a complex HVAC system was engineered for the buildings to deliver cool air to each element of the array. The system ensures acceptable interior ambient temperatures are maintained during operation, even when heat loads from the array electronics range from 0.5 – 2.5 kW per element. Airflow Sciences was proud to partner with USAF and USSF to optimize the design of the HVAC system using CFD modeling techniques.

What's Inside

Edited by Courtenay Tooles

Using CFD Modeling to Design the HVAC System for the World's Most Advanced Radar

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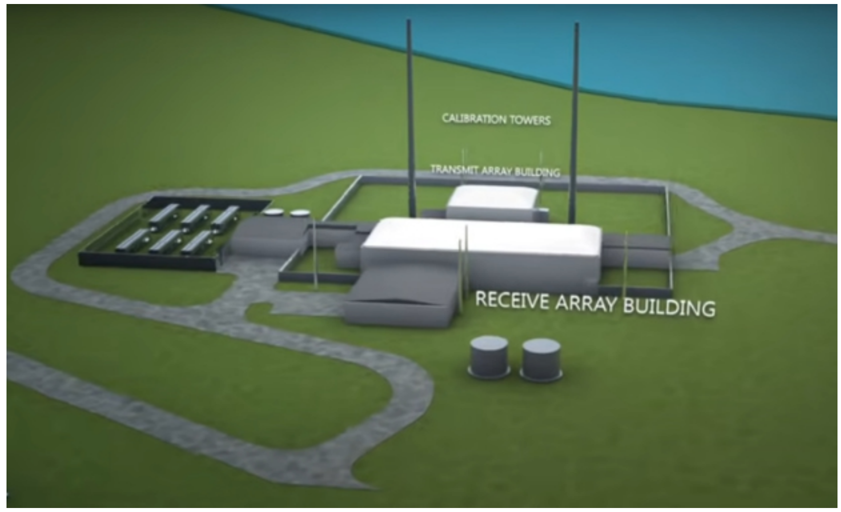
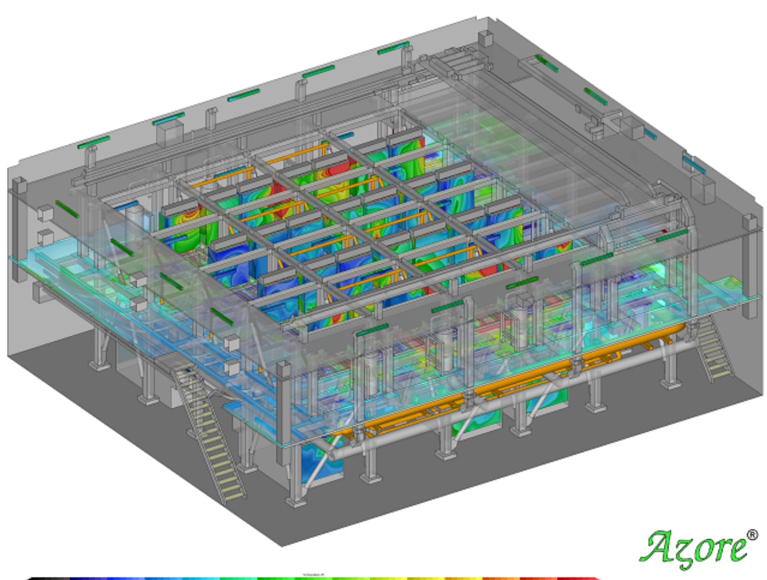


Image Credit: Lockheed Martin

To model the HVAC systems, a detailed CAD model was generated for each building using 3D geometry provided by the design team. We included crucial internal features, such as structural members, floor grating, piping, and electrical components, as well as HVAC elements like air handlers, ductwork, intakes, and exhausts, within the model domain. This comprehensive approach ensures an accurate representation of airflow patterns within the buildings. The internal duct flow was assumed to exit each outlet and return to each HVAC handler intake with a flow rate equal to the design targets. The heat load within the buildings was modeled using specified heat flux data provided by the design team. In addition to the radar electronics, surface heat fluxes were modeled for the building exterior walls, floor, and fabric roof to account for the high ambient temperatures and solar load at the facility site. The HVAC outlets were arranged in two primary groupings – one set arrayed underneath the radar electronics to deliver cooling air directly to the sensitive components, and a second set routed to the upper floor of the building designed to blow air downward.



Transmit (TX) building CFD model results - velocity patterns

Upcoming Events

Meet us in person at industry trade shows or attend one of our online webinars

Sept 21 — **Azore x Coreform Webinar**
Free | 11:00am EST
Register here

Oct 17-19 — **Heat Treat**
Detroit, MI

Oct 23-25 — **Process Expo**
Chicago, IL

Jan 22-24 — **AHR Expo**
Chicago, IL

Airflow Sciences Corporation

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The CFD model geometry was developed using the Ansys Spaceclaim software, and the model meshes were constructed using the Ansys Meshing software. The TX building model contains about 25 million computational cells, while the RX building model contains about 60 million cells. Model simulations were completed using Azore CFD software, and Azore's automated post-processing tools were utilized to generate simulation results for analysis.

In both buildings, baseline CFD analysis indicated that the preliminary arrangement of HVAC outlets underneath the radar electronics was not optimized. In the TX building, initially the outlets were spaced in eight rows across the interior, with some of the rows located far away from the radar electronics. This resulted in the development of hot spots near some of the array elements where there was insufficient cooling air. To address this, the HVAC ductwork was re-designed to concentrate the outlets mostly within the radar array, with some outlets retained outside of the array to provide cooling air to auxiliary electronics cabinets. Air circulation and convective cooling was greatly improved by this re-design, as illustrated by model temperature plots and histograms of the temperature distribution within the area.

Staff News

We recently welcomed two new engineers to the team: **Ahmad Fakhari, Ph.D.**, Project Engineer, and **Evan Drake**, Engineer. We're excited to have them aboard!

Airflow Sciences has a long standing tradition of mentoring summer interns. This year we welcomed three University of Michigan students into our office: **Ashay Arora**, Marketing Intern, **Ben Epstein**, Engineering Intern, and **Maggie Stephens**, Engineering Intern. We are grateful for their contributions and wish them the best as they head back to school!

We'd like to recognize **Matt Gentry, P.E.** for obtaining his Michigan Professional Engineering license. Congratulations, Matt!

Airflow Sciences has been awarded $250K in funding from the U.S. Department of Energy to develop a subterranean CO_2 monitoring system. We'd like to give a special shout out to **Jacob Morrida**, and **Rob Mudry, P.E.** for their contributions in securing the SBIR award, and continued work bringing the system to life. Read the full press release here.

Congratulations to **Brian Dumont, P.E.**, **Jim Paul, P.E.**, **Matt Fleming**, and **Paul Harris, Ph.D.** for being awarded not one, but two US patents this year: US Patent 11,541,921 for "Systems and Methods for Measuring Wind Velocity for Vehicles Traversing a Curve", and US Patent 11,543,426 for "Systems and Methods for Communicating Information Associated with Wind Pressures".

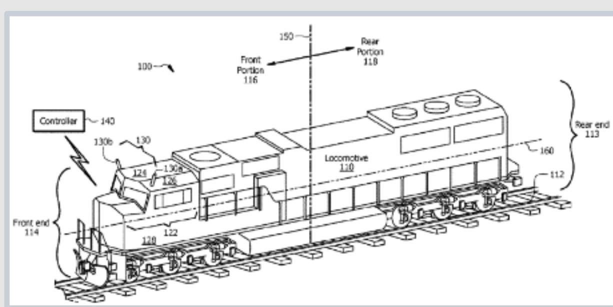

Image from US Patent 11,541,921

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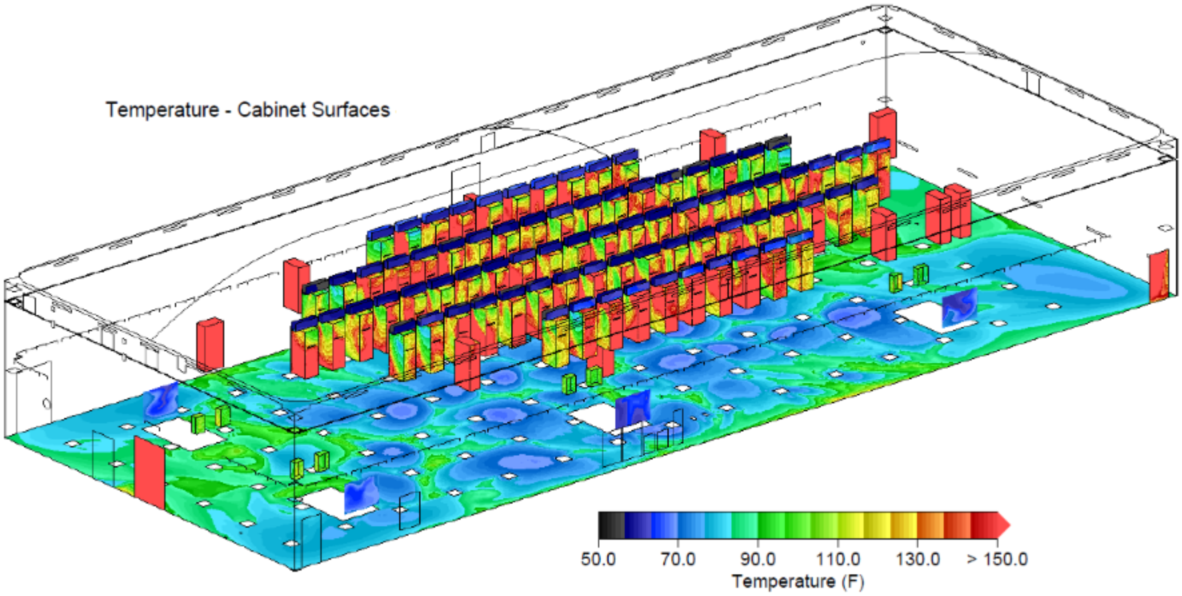


CFD model showing temperature of cabinet surfaces in the RX

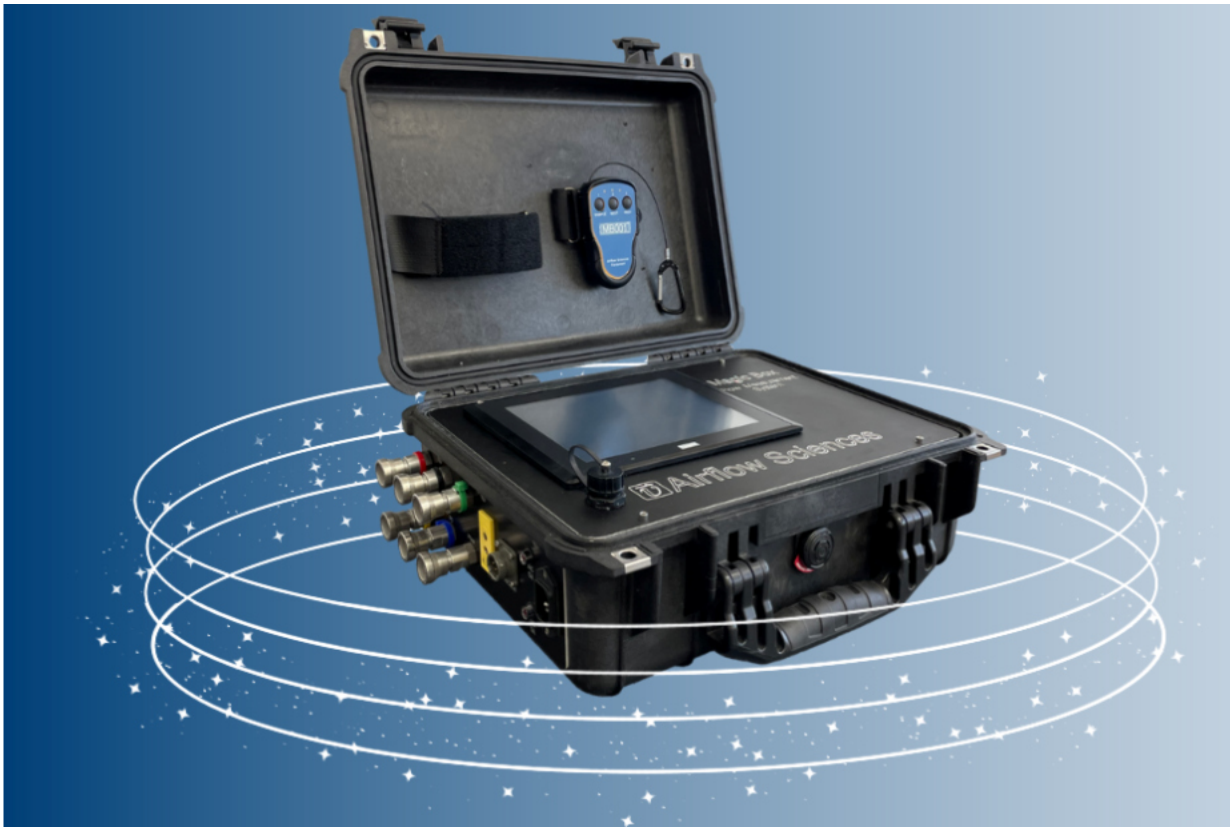
In the RX building, the heat load of the radar electronics was less of a concern, as the average output is significantly less than the transmit array. The primary challenge here was that the RX building is much larger, and there are fewer HVAC outlets per unit volume due to the lower heat dissipation requirement, which made it more difficult to position the outlets in close proximity to the electronics. In the design analysis, the HVAC outlets were re-positioned to promote maximum air circulation near the radar equipment, which resulted in an improvement in the local air temperatures near the array.

Following the completion of ASC's HVAC model study, the Space Fence complex design was finalized and the facility was constructed. In operation since 2019, the Space Fence has become an important part of ongoing military and commercial space operations for the United States and its allies.

Image Credit: Lockheed Martin

Unveiling Our Latest in Flow Measurement Technology: Magic Box

By: Kelly Hile



We've made flow testing even more portable and affordable with our latest product, Magic Box. It's a new briefcase-sized flow measurement system that punches above its weight in both capability and accuracy, and can be used anywhere you need to measure flow velocity.

Affordability

The most enchanting part of the Magic Box is its price tag. We've included all the accuracy you've come to expect from Airflow Sciences Equipment, at a fraction of the price. If a flow system with automated data acquisition has previously been out of your price range, it's time to look again. Along with modest base pricing, we always keep our customers in charge – you have plenty of options to boost or pare down your system to meet your budget and testing plan. But don't let the price tag fool you; this system is highly accurate, incredibly easy to use (some might even say magical), and packed with cutting-edge flow measurement technology.

Unveiling Our Latest in Flow Measurement Technology: Magic Box

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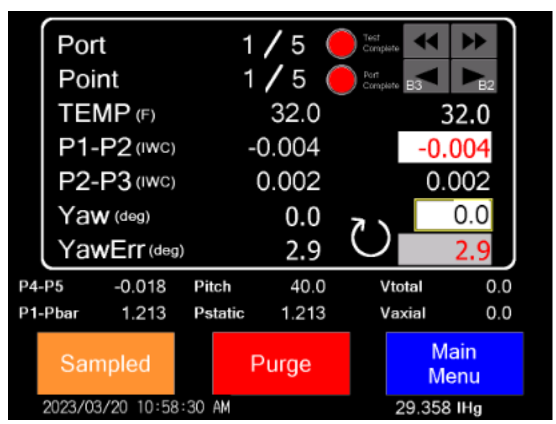
Portability

Flow testing can take you to some pretty extreme places. Wherever you go, the Magic Box can handle it with grit. We built it to withstand cold weather and harsh industrial heat, because we know that you work in the real world. Weighing in at just 14 pounds (6.4 kg), the flow box is easy to transfer to any testing location, and can be configured for either 120V or 240V power.

Simplicity

As flow testing engineers, we know all the details that go into a successful test. We intentionally design our systems to make flow testing easier and faster for technicians, while at the same time safeguarding results from human error. The Magic Box leads the user through a step-by-step test protocol, integrated with a 3D, 2D, or standard S-type or pitot velocity probe. The complete testing process is executed from a user-friendly touchscreen and remote control.



For power generation facilities, the Magic Box is the expert on compliance so that you don't have to be. Our test protocols are perfectly lined up with EPA Method 2, 2F, and 2G, guiding you from probe set-up to final report. Test data is easy to export, and our automated reporting templates equip you with the information you need to meet regulatory requirements.

We've also incorporated the technology for automated line purging, to provide you with the ultimate solution to probe pluggage issues that threaten to derail your test. With this upgrade, a probe can be purged in place without having to repeat the set-up process.

Unveiling Our Latest in Flow Measurement Technology: Magic Box

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Is the Magic Box right for you?

The Magic Box is a flow testing system that works for many applications and industrial settings. You can use it for stack or RATA testing, fan testing, mill inlet or secondary air testing, or general ductwork. Ask us about options for high temperature industrial equipment (over 1000°F/500°C), automatic purging, and non-nulling test methods.

We're here to help you find the perfect measurement equipment for your specific needs. [Contact us today](#) to request a quote.

Contacting ASC

ascinfo@airflowsciences.com

www.airflowsciences.com
www.airflowsciencesequipment.com
www.azorecfd.com

Corporate Headquarters
12190 Hubbard Street
Livonia, MI 48150
+1.734.525.0300

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