Underfloor Air Distribution in a Commercial High Rise: The New York Times Headquarters

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Synopsis

The New York Times Company has embarked on a revolutionary new facility. Equipped with some of the most innovative building features to be integrated into new construction, the new 1.6 million square-foot headquarters has incorporated both dimmable ballasts and automatic shade control within the 900,000 plus square feet of interior space.

The conditioned air is being distributed via an underfloor air distribution system (UFAD). This system has been perceived as one that has been difficult to install as well as commission. The New York Times construction team took a proactive attitude with commissioning and approached the testing procedure with an educational dynamic.

About the Authors

Glenn D. Hughes has been with The New York Times Company for over half of his 30+ year career. Currently Mr. Hughes holds the position of Managing Director of Construction and is responsible for overseeing the design, construction and commissioning of the company's new headquarters building in Manhattan, as well as other commercial office buildings and printing plant projects around the country. He has been a proponent of energy efficient systems throughout his career which has led to the inclusion of a cogeneration plant, underfloor air distribution system, automated shades and a dimmable lighting control system for The New York Times headquarters building.

Michael English, a Founder and Senior Partner of Horizon Engineering Associates, LLP, has over 15 years of extensive experience in the leadership and performance of building commissioning and related services for commercial, educational, cultural, healthcare and residential facilities. Mr. English served a two year term from 2005 to 2006 as President of the Building Commissioning Association after serving as a Vice President for a number of years, and has spearheaded the organization's Certified Commissioning Professional (CCP) program. A LEED Accredited Professional, he has been active in developing commissioning guidelines for LEED-NC Version 2.2, and served on the New York City Chapter Board of Directors of the U.S. Green Building Council.

New York Times Headquarters

The New York Times Company is one of the most popular newspaper printing companies in the world with an average circulation of over 1.1 million readers during the weekday and 1.6 million Sunday readers. The New York Times Company owns newspapers and printing facilities all over the world and their in-house construction team manages a multitude of projects.

The journey of the new corporate headquarters began a long time ago in 1999, when the conception of a new home was developed. The goal was to have the building, which would be home to over 2,000 employees, be user friendly and incorporate sustainable ideas that both made sense and created comfort for the occupant and end users.

Research Begins

Flack and Kurtz was brought on as the mechanical, electrical and plumbing designer and is one of the most prominent authorities of UFAD and Computational Fluid Dynamics (CFD) Modeling and Analysis. Engineer Dan Knoll of Flack and Kurtz began his research and visited locations that had the system, such as the Alcoa Corporate Center in Pittsburgh, with decision makers of the New York Times. They also looked into a European type of system, similar to a displacement ventilation system, in London and Berlin. In their review, they analyzed some of the potential problems during construction and engaged in detailed design discussions. They used the masterful implementation of a UFAD system at the Berlin Chancellery to model their work after.

The New York Times Company needed facts to ensure the implementation of a UFAD system was cost effective. A full cost analysis was made including everything from the raised floor, sheet metal work and power to data and voice cabling and furniture wiring. After the cost of installing the UFAD system was analyzed, it was discovered that the system would be cost neutral. In installing the UFAD system, furniture wiring no longer was an issue because the electrical wiring could be installed under the floor.

Cost was not the only factor weighing the decision making. The New York Times Company was concerned about occupant comfort. A major complaint at any building is that people are too hot or too cold. Most present day overhead systems create columns of hot or cold air that causes these problems. The UFAD system delivers a stratified space in terms of temperature, leaving little room for these hot and cold pockets of air, therefore creating a comfortable environment.

Benefits of an Underfloor Air Distribution System

The concepts of air delivery were especially critical and the team was leaning towards using the UFAD system. Many of the benefits of the UFAD system were important for The New York Times Company.

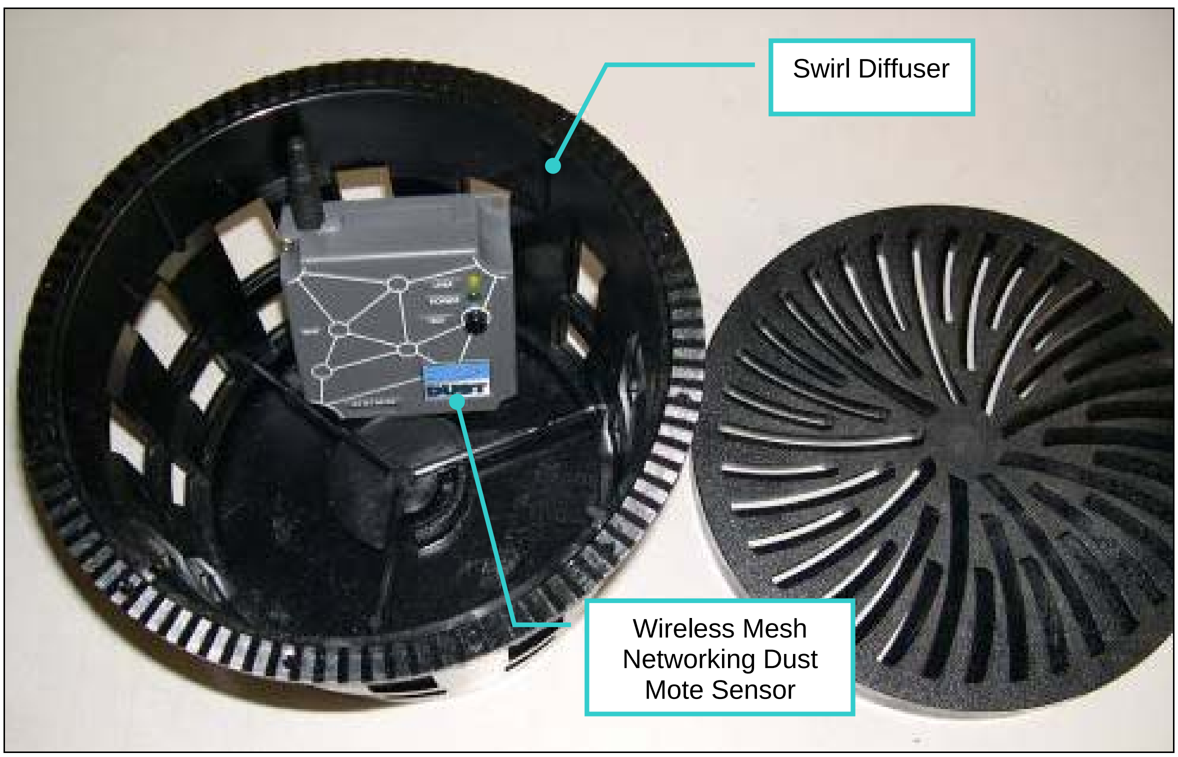
Flexibility of Space

The New York Times Company desired an open space to capture as much daylight and outdoor views possible. Due to constantly changing departments and the shuffling of desks, flexibility was a requirement.

UFAD allows for an adaptable environment that a conventional overhead system does not. The ability to move desks and reposition floor tiles made the system very advantageous and met the needs of the space in regards to floor registers.

More Occupant and Comfort Control

One of the benefits of the UFAD system is occupant control. Each desk typically has a swirl diffuser for air delivery. If the occupant is to warm or too cold the end user has the ability to either open the diffuser for more conditioned air or close the diffuser for reduced airflow. This allows the end user to create an environment that is right for them.



Energy Consumption Reduction

The space that humans occupy is the first six feet or 72 inches off of the floor. This is called the occupied zone. If the occupant is comfortable within this zone then the UFAD system created a desirable condition for the end user. Cooling of just the first 72 inches is performed with a low air velocity discharge from the swirl diffusers. Upon release into the space the air slowly absorbs heat and allows the hot air to rise. From the underfloor to the first 72 inches, a four degree rise in temperature is achieved creating a stratification of the air or temperature barrier. The air discharged from the diffuser should be between 64 and 67 degrees Fahrenheit for maximum user comfort.

All the cooling and dehumidification is accomplished at the air handler prior to distribution under the floor. This allows a large mass to be heated at a higher temperature yielding the same amount of cooling but for less BTU input. Operationally, this system saves the end user on energy consumption.

Airborne Illness Decrease

Not only did The New York Times Company feel that it was a more energy efficient system, but also a healthier system for the space. A typical overhead system forces air from the ceiling down to the occupied zone and then is distributed laterally throughout the space. Therefore, if an individual sneezes or coughs those germs are spread laterally throughout the space. However, in a UFAD system, if those germs are produced by the occupant they are slowly carried away through the natural ventilation of the hot air rising until the air is filtered or sent out of the building.

UFAD Design at The Times

The design of the UFAD system at The New York Times Corporate headquarters is an air highway delivery system with pressure zone barriers.

Medium pressure air is delivered from each air handler on the floor via a loop of ductwork that surrounds the core of the building called an air highway. Off of the ductwork a series of modulating dampers control the pressure in six zoned off underfloor low pressure zones. Around each perimeter a series of fan power boxes control the temperature in the space. If heating is required then the fans turn on delivering heat via a hot water coil. In cooling mode, the fans operate to give increased ventilation around the perimeter spaces.

The temperature of the space is controlled via thermostat located at 52 inches off of the floor to maintain proper temperature in the occupied area of each zone. The air is then exhausted out through the return plenum located through the light panels and returned back to the air handler.

Fresh air is supplied by two air handling units on the 28th floor sending fresh treated outside air to each floor where a constant volume VAV controls the amount of air entering the system. The air is then conditioned for proper cooling and humidity before being sent to the air highway.

All penetrations for electric or data were specifically laid across the air highway to prevent leakage. Penetrations through pressure barrier walls were constructed as per a specific detail to prevent leakage.

Educating the Team

Once the decision was made to use a UFAD system on the project, the education began. The New York Times Company sponsored a one day UFAD summit to gather the parties of the design and construction teams, as well as the commissioning authority. The summit brought both teams together to discuss the design and how to construct the system, as well as the pitfalls that may arise. The theory that if the contractors knew the commissioning team's approach to ensuring the systems were installed correctly would pay off in the long run was right on. There were many sessions with the contractors to demonstrate how the commissioning authority wanted them to test the systems from the air highway through the low pressure barriers and then finally to the commissioning cart. They were educated on what the expectations would be in regards to testing and installation. The commissioning authority developed construction inspection checklists for validation and they were distributed to the contractors.

To ensure the UFAD system was installed correctly The New York Times Company decided to write their own specification for commissioning of the system with the help of the engineer, Paul Linden of Natural Works and chair of the mechanical and aeronautical engineering department at University of California in San Diego.

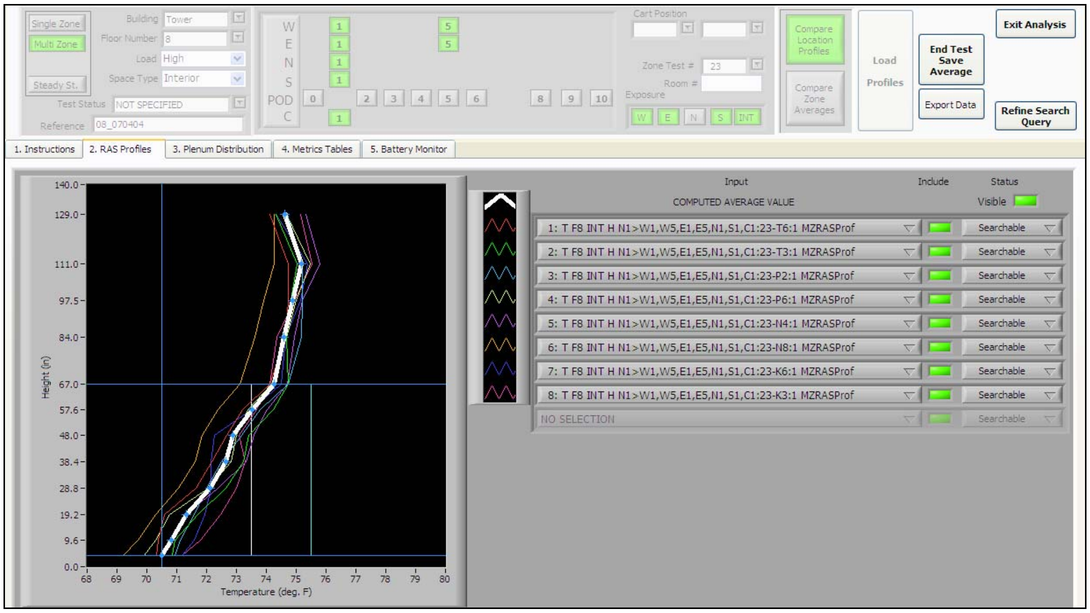
CBE - Center for the Built Environment

The team of Tom Webster and Fred Bauman from the University of California, Berkeley Campus were retained by The New York Times Company to develop testing tools and protocols, including a mobile UFAD commissioning cart for the UFAD system. In a two day session with both the New York Times team and the commissioning authority, different elements of the design and methods to measure results were discussed to ensure the team got the desired outcome.

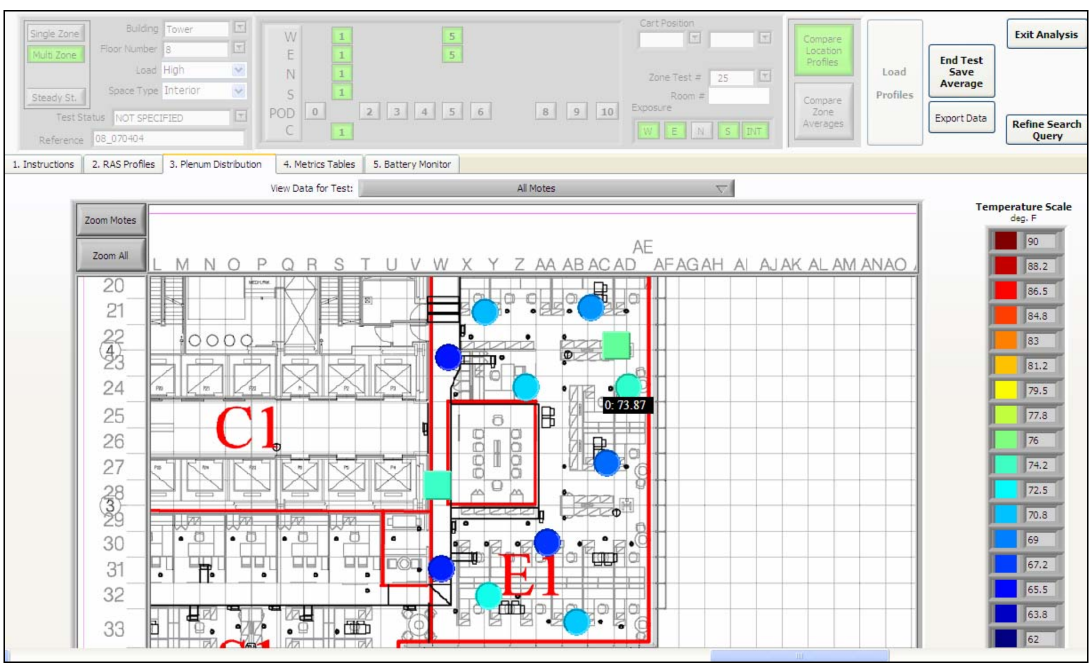
Testing Tools and Protocols

After two days of open forum discussion and troubleshooting on UFAD systems, the CBE team was on a mission to develop testing tools and protocols. Simulating live conditions and measuring them before staff moved into the space was one of the biggest challenges for the CBE team. In addition to measuring the results, the team had to develop a way to capture the data in a useable format. The information was needed to tune the system and find any trouble areas. Two items that were critical to the successful operation of the UFAD system were occupied average temperature and stratification within the space.

CBE developed ways to capture these crucial pieces of information on the commissioning cart. The cart included a telescoping arm for equally spaced temperature sensors at various heights to provide average occupied temperatures. It also gave us the opportunity to determine the stratification within the occupied zone. Additionally, a pressure and temperature gauge was installed to measure underfloor pressure readings to sense pressure under the floor as well as in the ductwork. Below is a screenshot of a room air stratification profile:



The probability that the UFAD system would function properly was increased by limiting and the stabilizing thermal decay. To accomplish this, mesh network wireless temperature sensors called motes were placed in each swirl diffuser to determine the temperature discharge at each diffuser. A map and numbering system for the motes was developed to identify their location on a print so the system could be tuned. All the data was then fed into a laptop located on the cart with the labview program installed. Now the team could determine what adjustments needed to be made to achieve the most optimal results. The motes were able to identify the location of hot spots and problem areas allowing the system to be accurately tuned. Below is a sample screenshot of the mote data.



CBE modeled thermal heat load for a human body. The model had to be durable as it would be used on a construction site. Thermal plume generators were created and tested in CBE's lab in Berkeley, California. CBE developed a heat source that required a 120 VAC electrical outlet and simulated heat plumes that would typically come off of humans and computers. Over 200 of these devices were scattered at desks and chairs to simulate the occupants. They simulated 30 – 60 percent of heat load of an entire floor.

Testing Time

The first sessions of tests were for the air highway. Each air highway had a precut tile installed where air was pumped in to generate a pressure in the floor of .5" wc. Data supplied to the team by the floor manufacturer provided accurate information on how much leakage could be anticipated from the floor under various conditions and pressures. This data was used as the baseline leakage requirement and passed each test based on SMACNA guidelines for medium pressure ductwork.

Upon passing that test, the fan powered boxes that serve the perimeter were tested. The fan was tested pre-functionally and then for air output to ensure the fan was producing the designed amount of air, as well as that same amount on the perimeter linear grills.

Next, the raised floor was finished and then a low pressure zone test occurred. Each low pressure zone was tested to determine the leakage rate. Once again, the manufacturer's leakage rate was used as baseline data.

Because of the initial education, the contractors fully understood what was required from them. From the beginning of installation through the first test, they met the expectations of the project team. They were also a willing participant in the process, as they understood the methods and what it meant to the project's success. Also, a fully operating and functioning system meant they would be released from their contact responsibilities on time.

The testing protocols that were developed ensured that the UFAD system was constructed correctly and would now be ready for tuning and proper adjustments.

The Functional Test

With the assistance of the contractors and commissioning authority each floor was tested with the commissioning UFAD cart. All the heat plume generators were plugged in throughout a typical floor and the team tested the temperature discharge in all the swirl diffusers with the motes, as well as the stratification and average occupied zone temperature.

Each floor below and above had to maintain steady state conditions as if it were occupied to achieve the best outcome. The optimal supply air temperature was determined on a multi-zone floor wide basis by setting the supply air temperature and using the cart to determine average occupied zone temperature and stratification in the occupied zone. As the supply air temperature raised, the stratification decreased. When the stratification was less than 3 degrees, it was determined the supply air temperature was set too high and it was backed down one degree. At this point the supply air temperature had been optimized.

Average occupied zone temperature and stratification were then measured on a zone by zone basis and stratification setting on the interior and perimeter space control was adjusted until we achieved specified conditions. During the tests on the first few floors, improved sequences for control of the automatic louver damper and perimeter fan powered box were established.

It was uncovered that base building system sequences needed to be adjusted, specifically in winter mode. The hot water system needed two revisions. The outdoor reset was changed to maintain high hot water temperatures to avoid the subcooling of the space. Additionally, in a more typical design the hot water system is turned off at some predetermined outdoor temperature such as 50 degrees. That had to be modified to meet the buildings demands.

Lessons Learned

The successful installation of the UFAD system at The New York Times headquarters was accomplished due to the detailed research, proactive education and training and the commitment from all parties involved. The New York Times Company invested in the research of the UFAD system to prevent any costly problems from happening during later phases in the construction process. Their enthusiastic and aggressive approach from the beginning of the project moved for contractor buy in from the start. Education was the key to success in regard to the installation of the UFAD system.

With the correct instructions to measure space temperature and supply air temperature, the comfort of the occupants is now assured by achieving any occupied zone temperature desired. This process is aided by using the correct software and BMS system specifically written for UFAD.

Undoubtedly, this system should eliminate the cause for comfort complaints and utilize less energy, therefore reducing operational costs and decrease the spread of airborne illnesses in any conventional building.