Overview of Underfloor Air Distribution (UFAD) Systems

An Online Continuing Education Course for Engineers

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Overview of Underfloor Air Distribution (UFAD) Systems

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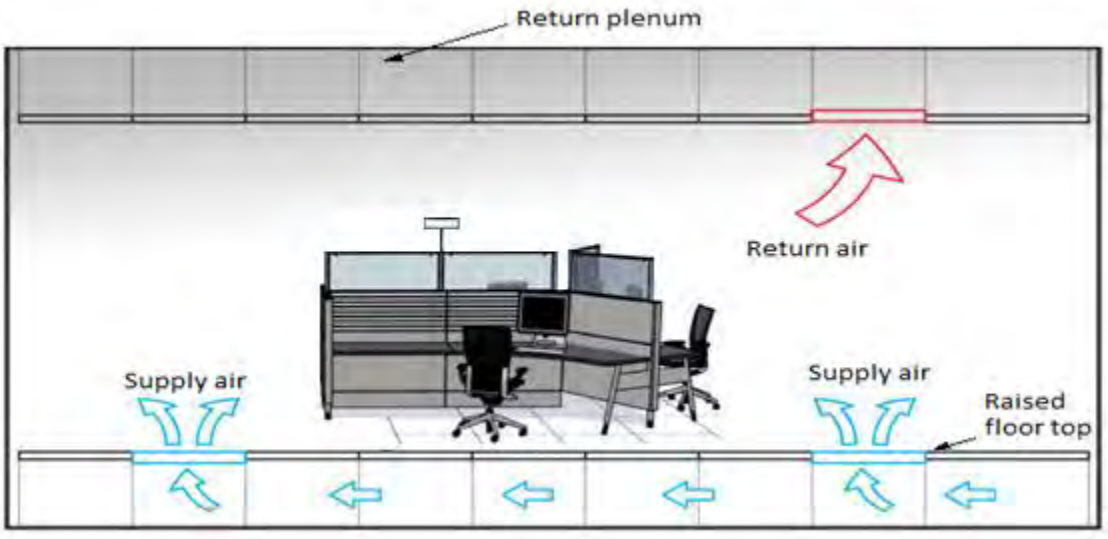
An Underfloor Air Distribution (UFAD) system uses the open space below a raised floor system to deliver conditioned air to supply outlets located in the floor. It is best to think UFAD as an upside down alternative to conventional overhead (OH) air distribution. Since air is supplied in much closer proximity to occupants than in OH systems, supply air temperatures must be higher usually 63°F or higher and at much lower pressure. The concept enhances energy efficiency and boosts indoor air quality.

The development of this technology was largely driven by the changing work environment. The advent of computer, communication and internet based technologies along with advances in flexible interior furnishings drove organizations to adapt to these new technologies. Today UFAD systems comprise an estimated 58% of new commercial building projects in Japan and about half of all new commercial projects in Europe. In North America, the UFAD technology was introduced in the 1990s, and several buildings have been designed to this technology.



The components of the UFAD system are highly modular making it much convenient and less expensive to reconfigure workspaces during renovation of the building. To better integrate with the raised floor system, electric power, telephone, data cable and other portions of the building's infrastructure are located in the underfloor space. Plug-in electrical boxes, power/data outlet boxes and air diffusers are flush mounted in the floor panels and can easily be moved to accommodate reconfiguration of the workspace or floor plan. UFAD systems allow for the lower costs associated with churn rates when tenants reconfigure, relocate or change the interior of the building.

The course will discuss fundamentals of UFAD design process, the potential benefits, economic issues and the pitfalls. The course is divided into 5 sections:

SECTION -1 **Overhead Systems V/s UFAD System**

SECTION -2 **UFAD System Design Parameters**

SECTION -3 **UFAD Layout and Components**

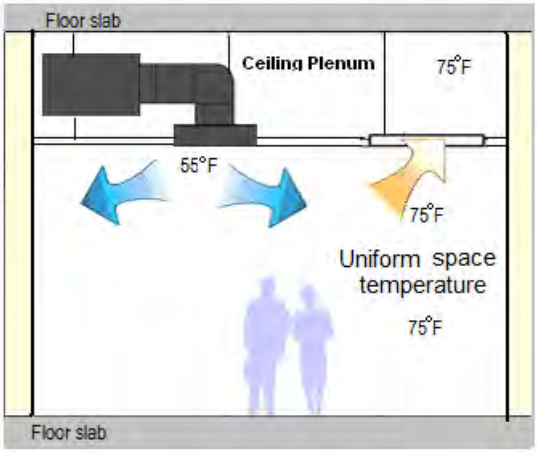
SECTION -4 **UFAD Design Issues**

SECTION -5 **UFAD & Sustainable Green Buildings**

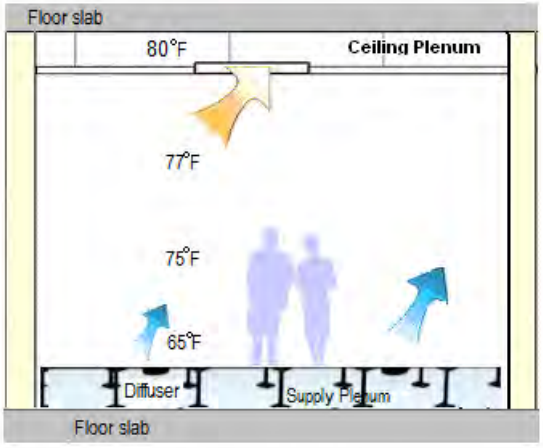
SECTION -1 OVERHEAD SYSTEMS V/s UFAD SYSTEM

Overhead air distribution (OH) systems supply conditioned air through ducts at the ceiling and typically takes return air back through a plenum above the ceiling. The diffusers, or air outlets, connected to the supply duct system are designed to throw the air around the room in such a manner to induce full mixing of the air in the occupied space. For this reason, these systems are called “mixing” systems. The desired result of mixing systems is the complete mixing of supply air with room air, thereby creating a uniform thermal environment across the entire space. The temperature of the uniform environment is controlled with HVAC equipment to a desired setpoint. Typical operating temperatures for overhead mixing systems include supply air temperatures in the range of 55°F to 57°F and thermostat setpoints in the range of 72°F to 78°F.

Underfloor air distribution (UFAD) systems, unlike conventional OH system, deliver conditioned air at the floor level at low velocities. The air distribution creates an upward flow of air in the space allowing for the effective removal of heat, pollutants and odors. There is, typically a large temperature variance between the floor and the ceiling level the return air leaves at higher temperature to the room temperature.



Conventional System



UFAD System

Comparison of Overhead (OH) vs. Underfloor (UFAD)

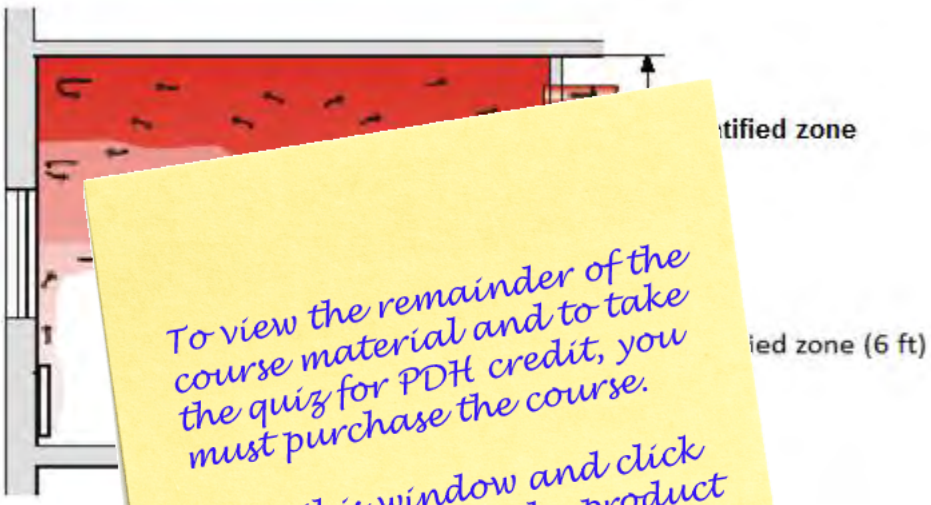
Issue	OH	UFAD
Supply air temperature	~50 to 55 °F supply air	~60 -68°F supply air
Temperature control	- Most uniform - Mixes the entire space	- Commonly cold at the bottom and warm at the top. - Partially mixing in the occupied zone only
Temperature profile	- Uniform temperature - Mixes the entire space - Conditions entire room	- Stratified temperature - Partial mixing in the occupied zone only - Only conditions the occupied zone (the first six feet of the space)
Return air temperature	~75 °F, almost the room air temperature	~77- 85°F, room temperature is higher at ceiling level.
Air delivery	Ceiling diffusers provide high velocity supply air throw.	Air delivered at low velocity and heat sources drive air motion via thermal plume

CLASSIFICATION OF UFAD SYSTEMS

UFAD systems fall in two general categories distinguishable from one another by the temperature and velocity profiles they create in the occupied space. The first type is displacement ventilation (DV) and the second is a hybrid UFAD system.

Displacement Ventilation (DV) Systems

Displacement ventilation (DV) delivers supply air low in the space at a lower velocity to minimize mixing and utilizes buoyancy forces generated by heat sources such as people, lighting, computers, electrical equipment etc. in a room to stratify heat out of the occupied zone.



The temperature profil ir at the top of the room is warmer than th as a higher level of contaminants than supp

DV systems create a nor level called the "stratification height" (labeled SH in th peratures increase with increasing height. Above the stratification height, the zone is relatively well mixed and a more uniform temperature profile is created.

DV System Characteristics:

- Air is delivered between 60°F and 70°F;
- Air delivered at lower discharge air velocity (approximately 50 fpm);
- Air is supplied horizontally into the room low on the side wall;