SZÉKELY ENGINEERING
EXPLANATIONS & EXAMPLES

Air Conditioning (and Heating) in Rooms with High Ceilings

The late Robert A. Heinlein, in one of the aphorisms in the interludes in his novel of a fellow who's lived for thousands of years, points out that if "everyone knows" something, it likely isn't so. In the case of the heading of this piece, it's not so much that rooms with high ceilings *don't* require more cooling, but that it's *not* the increase in room *volume* because of the high ceiling that calls for a larger air conditioning system, but the concomitant increase in *wall area* exposed to the sun and the hot outdoors. If two identical rooms with 20 foot high ceilings are in a building, but one of them has its floor 10 feet below grade, there's no external heat gain through the wall for the below-grade portion of the wall, and it's why there used to be things such as root cellars in the days before refrigeration.

Experience and common sense has taught us that hot things cool off, and that energy has to be added to objects to heat them up. Physicists call this property Entropy, and it's because of this that buildings need to be heated and cooled. That is, in winter the heat in a building "cools off" to the cooler outdoors, while in summer the heat of the hotter outdoors "cools off" into the building raising its temperature, with sunlight providing the heat energy for everything from seasonal and day-night temperature swings, and weather, to the photosynthesis of plants (for more, read Life and Energy, by Isaac Asimov).

Experience has also taught us that because warm air is less dense than cold air, it rises and stratifies, which causes the air near the ceiling of a high room to be substantially warmer than the air in the rest of the room, but this really isn't an issue unless you're seven and a half feet tall, and certainly isn't an issue in room with ceilings higher than twelve feet or so for the simple reason that you don't live on the ceiling.

This *not* to say that de-stratification via ceiling fans or the like isn't desirable, because substantial reductions in the capacity of heating and cooling equipment are possible when a room's air is de-stratified, but one does *not* need a larger heating or cooling plant than would *otherwise* be selected, because the extra heating or cooling load which results from the greater amount of exposed wall area of the taller walls is already accounted for in the load calculations.

Having said that, however, understand that radiant heating or cooling overcomes the inefficiency of using air as a heat transfer medium, making the whole issue of de-stratification moot, which is one of the reasons that hot air furnaces are such a lousy way to provide heat and why future cooling systems will likely be via radiant chilled beams or the like, and the only forced air in a system will be that amount of outdoor air needed for ventilation to expel contaminants.

But, for now, while the use of ceiling fans might allow for a reduction in the size of a heating or cooling system, such fans would need to be automatically controlled to operate when the respective system is in operation, pulling air up to the ceiling during the cooling season and pushing it down from the ceiling during the heating season.

Airflow Throw, Noise, and Drafts

To start in the middle of the above heading, is it just me? Or have you been annoyed by the roar of supply air when the air conditioning kicks on in a meeting room or in a commuter railcar? (Subway cars are different - the environment is so noisy the AC system's noise doesn't make much difference; usually.)

In really poorly designed meeting rooms, first there's the thud of the electromagnetic contactor telling you it's just started the AC system, followed by the rumble of air being delivered to the space. It's as if the designer never heard of the concept of noise control, or that s/he believes that such is unimportant in a room full of a few hundred persons since they're so noisy even when trying to be quiet.

Yeah, but how goes it in the middle of a lecture when only one person is speaking?

I believe I may have discussed NC (Noise Criteria, of late supplanted by RC – Room Criteria) curves and ratings in an earlier newsletter, but suffice it to say that AC grille and diffuser manufacturers provide such information in their engineering data sheets and that while they usually don't list values lower (quieter) than NC-25, that's the *maximum* that should be considered anywhere except a factory or an indoors sports arena or gymnasium.

As for airflow throw and drafts, the first is yet another thing that "everyone knows" that's wrong, while the second, while it's obvious, is something that few have thought of.

You *don't* want to select an outlet to throw air across the entire room because it'll bounce off the opposite wall, and at some point have enough velocity and be high enough to be at head/neck height *and* . . . air in your face is a breeze, but turn around and have it hit the back of your neck, and it's a *draft*.

The safe and correct thing to do is to design to throw air about halfway across a room, with the Coanda effect keeping it at or near the ceiling until it finally slows down to gently settle to the floor and mix with the room's ambient air.

Plans, Permits, and Repairs, or "Whaddaya mean this work has to be [engineered and] filed!??"

I am continually amazed at the ignorance of some people who should know better, of the fact that it's illegal to install central air conditioning systems without filing plans with the NYC Department of Buildings. §28-105.1 of the Building Code of the City of New York tells us *"It shall be unlawful to . . . install, alter, remove, convert or* ***replace*** [emphasis added] *. . . any gas, mechanical, plumbing, or fire protection system . . . subject to such exceptions and exemptions as may be provided in section 28-105.4."* which lists 6 such exemptions, among which are 'minor alterations and ordinary repairs', but then §28-105.4.2.1 takes the trouble to define what does ***not*** constitute minor alterations or ordinary repairs, and where replacement is limited to replacement by the *"* *. . . same or equivalent materials or equipment parts . . ."* and minor alterations ***cannot*** *" . . . affect . . . light, heat, ventilation . . . "*

Now while I suppose you can argue that since the Building Code does not appear to require mechanical ventilation of residential occupancies (though this is not as clear as it was in the old Code), installing central air conditioning in a dwelling unit thus wouldn't require a permit, but you'd still have to explain how such is not a mechanical system, and since I've seen no systems where monkeys operate fans over beds of ice to provide cooling, plans would have to be filed and permits pulled, even in the case of a dwelling unit.

So, who am I talking about who should know better? Well, before I say so, remember I said *some* people who should know better, and those people are *some* Architects and Managing Agents.

And then, what also surprises me is that *some* Architects seem to think it's OK for a Contractor to design the air conditioning system, missing the point that now, not only is the project in violation of the NYC Building Code, but NYS Education Law as well, with the unlicensed entity of the Contractor providing engineering services.

And what also seems to elude them, as it also apparently did the last Mayor of the City vis-à-vis the Commissioner of the Department of Buildings, is that one cannot have a licensed Engineer or Architect employee as a means to provide such professional services where the employer is not so licensed. Parenthetically, in New York State, not only is there not specialty licensing of engineering in discrete fields such as structural or mechanical, but by law, I can provide any services an Architect might provide, and vice-versa, provided I'm "competent" in those services. Not smart, but legal.

The reason the employ *of* design professionals *by* other than design professionals to provide professional design services is illegal is because the design professional employee is then subject to an unqualified employer's direction, opening up the possibility of the latter's overriding the former's engineering decisions. Challenger disaster anyone?

Thankfully, that although former Mayor Bloomberg and the City Council repealed that section of the City Charter which *mandated* a licensed design professional head the Department of Buildings, the current commissioner is such a person, and while the recognition that DOB Plans Examiners perform Architecture and Engineering services in the review of plans to assure compliance with Code has resulted in all of them being licensed design professionals, they sometimes forget it's my name on the drawings, not theirs.