Wet Ceilings

Untreated and uncontrolled fresh air can cause severe condensation problems in air conditioned offices

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Look at a not-very-uncommon installation – 21 x 7½ ton ceiling suspended ductable split air conditioning units installed for cooling an office space of approximately 20,000 sq. ft. The AC units are spread out evenly, over the conditioned space – each cooling a small dedicated area. Chances are that when you visit this office you will be given an umbrella, along with your visitors badge at the reception counter. The umbrella is to keep you "dry" from the water that drips all over.

Jokes apart – the above signifies that wet false ceilings due to condensation are a grim reality. Here is a live case study.

Space under investigation : 30,000 sq. ft. of office space.

Cooling equipment : Multiple ceiling suspended 7/10 ton single skin AHUs connected to a central, rooftop chilled water system. Total capacity of the AHUs exceeds 200 tons.

System layout : The AHUs are distributed in ones and twos all over the conditioned area, chilled water piping with EPS insulation, duly sand cement plastered, connects the AHUs to the pipe risers.

Fresh air intake : Sometimes a "hole" in the wall near the ceiling hung AHU, some times a common, central, treated FA unit with no control on air entering conditions – more often than not the TFA unit is "off" or at least the chilled water flow through it is stopped.

Problems : The maintenance staff call in a false-ceiling contractor, a painting contractor, virtually, every alternate week end; sometimes it is to clean fungi which has started growing on the underside of the false ceiling, at other times it is to replace the soggy ceiling rendered "wet" by water on its top side. Everyday, when the system starts there is a musty smell from the wet false ceiling, which stops after the AC system has run for 2 hours.

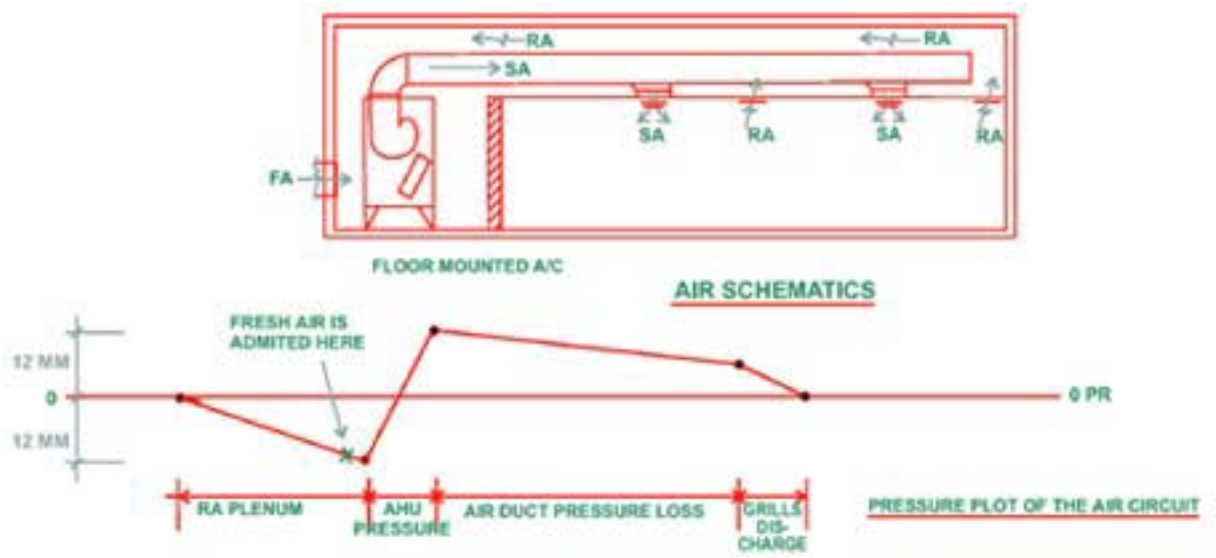

Figure 1: Conventional AHU room schematic

More details of the office : The office consists of small work zones, within the full area covered by all the AHUs, the zones are clearly partitioned from one another – but over the false ceiling – the void is generally one large return air plenum with selective placement of return air grilles. Some zones work in the day time, some at night and yet others – all the time.

Our observations

A. In addition to the above a scan with an infra-red thermometer yielded the following results:

Temperature readings in a zone which was not working and its windows had been kept open by the janitorial staff (AHU switched off with no occupants)

- Outside ambient 34°C
- Space temperature 29°C
- Return air grille temperature 32°C
- Coldest supply air diffuser temperature 24°C
- Supply air duct temperature 22°C
- AHU temperature (in spots) 15°C
- Cold water – runs in the coil (as AHU controls are not interlocked with the AHU units)
- Cold spots on pipe insulation – visible
- Cold spots on drain lines – visible
- Hot spots in RA plenum – 34°C

B. Apart from the above measurements the following observations were also made:

- The toilets were ventilated by a simple ducted exhaust system – the horizontal toilet ducts connect into a masonry shaft – which has a common centrifugal fan on the rooftop (10 floor

building). The fan was sized for 10 air changes per hour – but system leaks made the system ineffective and there was barely any exhaust of air. When the central exhaust fan was 'off' the toilets were having air movement from floor to floor depending on the door opening and door closing – this being a multi tenanted building with as many as 4 tenants per floor. This air movement was pushing air into the AC space thro' the toilets at unpredictable conditions.

- Holes made for cables, pipes, etc., over the false ceiling (into the RA plenum) were not effectively sealed.
- False ceiling contractors had created, ceiling coffers where ever possible and put in cove lighting to show off greater heights, in some places the false ceiling frame work had cut into the pipe insulating plaster with the result that the continuity and cross sectional needs of the return air plenums was vitiated. In no place was the level of false ceiling established as more than 4 inches lower than the equipment it sought to cover/conceal. Due to this the return air plenum temperatures varied significantly depending on the freedom of return air flowing in it.

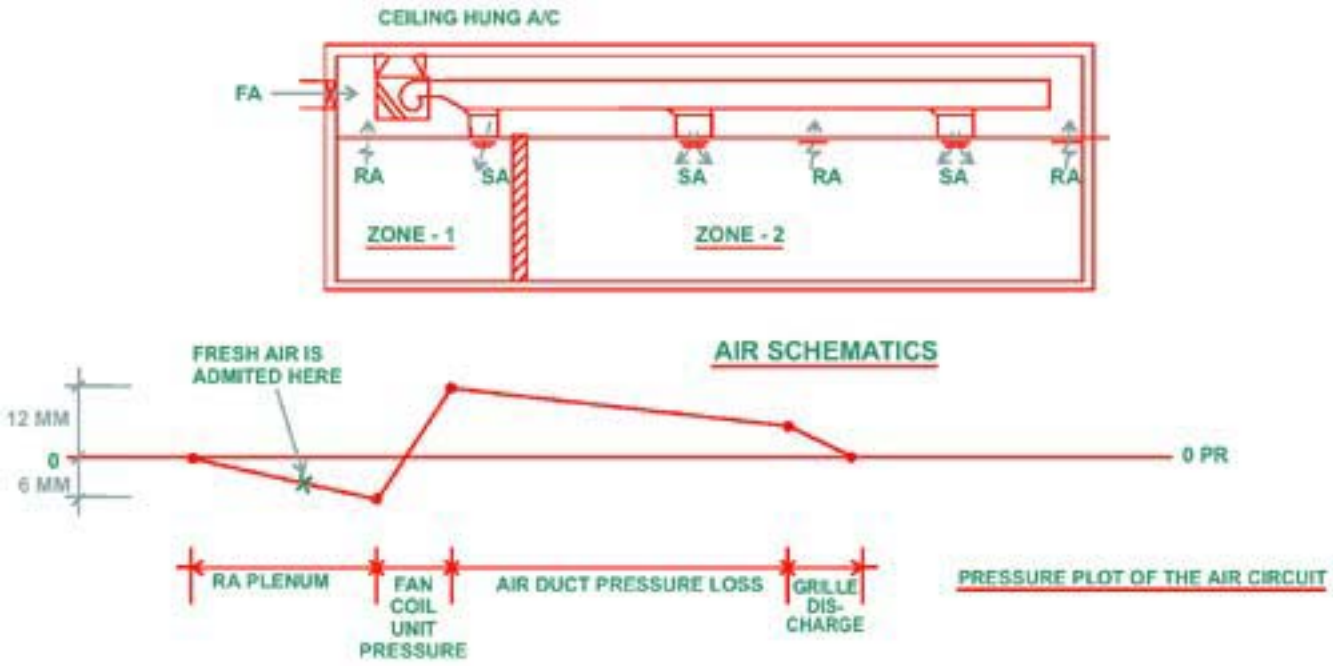

Figure 2: Ceiling hung AC equipment schematic

- Most of the areas were cooled with side-blowing grilles – with cfm levels in excess of 3 cfm/sq. ft. The place was very drafty making comfort very difficult.
- In areas which were not conditioned – if windows were opened – broad-side winds pushed in outside air into the space. This outside air goes thro' the RA grilles into the return air void. Once in the return air void – the outside air moved in the most unpredictable manner – it would cause condensation on any cold spots – stems of valves, air purge cocks, control valve spindles, thermowells, pressure gauge nipples etc.

And the solution

1. Seal all fresh air ingress into the return air plenum and have the main fresh air intake fitted with a motorized damper, to open only when the related air handling unit is on.
2. Connect fresh air positively into the AHU where feasable.
3. Wire AHU controls to stop water flow through the coils when the AHU is off.

4. Never open any window of any zone (even if it is not conditioned).
5. Stop fresh air ingress from toilet by good door closers and continuously running of the toilet exhaust fan.
6. Ensure that the TFA feeds air at a dew point lower than the coldest item in the RA void (15°C). As the condensation risk is high with ceiling units, all recommendations made out earlier must be followed. Another simple way of ensuring positive fresh air intake can be by using a small toilet exhaust fan, 200/300 cfm size. This fan can be interlocked with the air conditioning unit and will admit outside air through a 4 inches diameter duct into the unit (or very close to it). In most cases the small toilet exhaust fans, have integral dampers which close when the fan is off – thus precluding fresh air ingress into the return air void when the AC is "off".

Conclusion

In closing one cannot stop from going one more step in the thought process of condensation problems and split units. Most design engineers feel that floor space is conserved by using ceiling hung equipment and tend to overlook the fact, that ceiling hung equipment will never get the degree of maintenance which floor mounted equipment will receive. It is not unusual for most AMC (Annual Maintenance Contract) contractors to spend the month before summer time, running a "car air washer" over the cooling coil of all air handling units / package units. A 300 psi jet of water is invariably run over the cooling coil, for hours on end, to clean them. This annual exercise ensures that summer passes of without putting too much pressure on the maintenance man. This pressure jet cleaning is just not possible with ceiling hung equipment placed over a false ceiling. Hence, split AC units can never be as well maintained as floor mounted equipment. The above is not to be taken as a case for stopping the use of split units but the equipment layout should be looked at carefully. Split units when installed in an AHU room will overcome the above disadvantage and may be considered to be as good as floor mounted equipment, all other points being equal.