CASE HISTORY

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Minor Adjustments Solve Air Quality Problems in Italian Building

Although the downtown Milan office building that was the subject of this study was almost thirty years old, its central heating, ventilation and air conditioning (HVAC) system was not installed until ten years ago. Each floor of the building had a separate air handling unit (AHU) supplying five distinct zones with individual thermostatic temperature controls for each zone. The supply air was heated by steam heat coils in each branch duct to each zone just after leaving the main duct. In addition, each floor had about thirty fan coil units (FCUs) located around the perimeter of the building and they simply recirculated office air, heating or cooling as required by the season, from water supplied coils.

System Inspection:

Each air handling unit drew outside air in through grilles located in the exterior wall of their respective mechanical rooms through dampers which had a minimum open set position of 30 percent. The outside air was mixed with a volume of return air and filtered first through polyester media pads and then a bank of low quality bag filters rated as EU3 (DIN 24185). The air then passed through the heating and cooling coils. The cooling coils were fitted with a spray humidifier system that was no longer being used and which had a water reservoir underneath the coils. After passing through water spray baffles, the air entered the fan chamber where the centrifugal fan propelled the air into the supply ductwork. These main air supply ducts split almost immediately into five branches, each with a reheat coil, to supply the five zones on each floor via ceiling mounted air supply diffusers.

Return air was drawn from individual offices by way of grilles located at floor level into vertical columns containing ducts which rose to the ceiling void to connect with main return air ducts running to the mechanical rooms and then to the mixing chamber on each AHU.

The ceilings of the offices on each floor were fitted with a gridwork of ceiling tiles hanging perpendicular from the suspended ceiling to form a honeycomb effect. These were designed for sound attenuation, but the vertical panels greatly interfered with the supply of air and its circulation since the air supply diffusers fitted almost flush with the drop-ceiling. This meant that the air flow from the diffusers instead of being "four-way" became "one-way"—almost vertically downward. With the combination of the return air grilles being almost at floor level, and only on certain columns, the result was the uneven distribution of air in the offices with many "dead air pockets." The situation was exacerbated in many areas where desks or office partitions had been placed close enough to the return air grilles to obstruct air flow from the offices.

The peripheral FCUs operated by pulling air in from the adjacent office area through a panel filter before passing through the coils and fins and out through a grille on the top of the unit. The fans on these FCUs recirculated room air and were controlled by manual switches on each unit and their coils could provide heating or cooling depending on the season.

The FCUs each had a common design problem—there was no access to their internals for filter changes or routine maintenance and cleaning. Since most of these panel filters were fitted at the time of installation, they were all filthy. Many were disintegrating and were totally ineffective at removing airborne particles. Furthermore, in several of the units, rodent poison was visible in the fan chambers; traces of this poison could easily be carried in the air leaving the unit and into the office space. The internals of the air supply ducts were generally in good condition and were only lightly deposited with mixed particulates.

Sampling Contaminants:

Measurements of airborne dusts taken in the occupied areas were higher than desirable, especially the smaller, respirable sized particles. These high dust levels were caused by office activities, however, because of the poor air distribution coupled with the poor air filtration, the airborne particle levels were not being ad-

Inadequate air circulation was exacerbated by furniture blocking return air grilles

The lack of adequate air circulation in the office areas was addressed by opening up the vertical "honeycomb" of ceiling tiles.

equately reduced in the recirculated air.

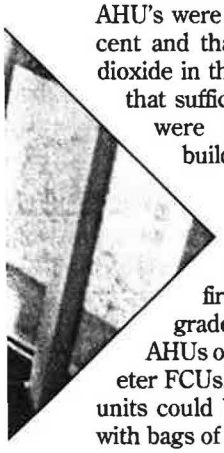
Levels of carbon dioxide in the offices ranged from 500 to 650 parts per million (ppm) during times of high occupancy, confirming that adequate volumes of outside air were being brought into the building. Screening for a range of inorganic gases showed that no significant levels were present. These gases included ammonia, carbon monoxide, ozone, oxides of nitrogen and sulfur. Similarly, no levels of a range of volatile organic gases were found to even approach minimum suggested standards and formaldehyde tests showed levels only slightly above the detection limit for the test.

Sampling for airborne microbial contaminants in the occupied areas showed relatively high numbers of members of the fungal genera Alternaria and Cladosporium, types known to cause allergic reactions in susceptible people. Surface sampling from the internal surfaces of the AHUs supplying these areas showed that the same species were present, often in excessive numbers after the filters, and these could certainly be entrained in the supply air and carried to the offices.

Comfort factors such as temperature, relative humidity, noise and light levels were within satisfactory ranges at the time of our inspection.

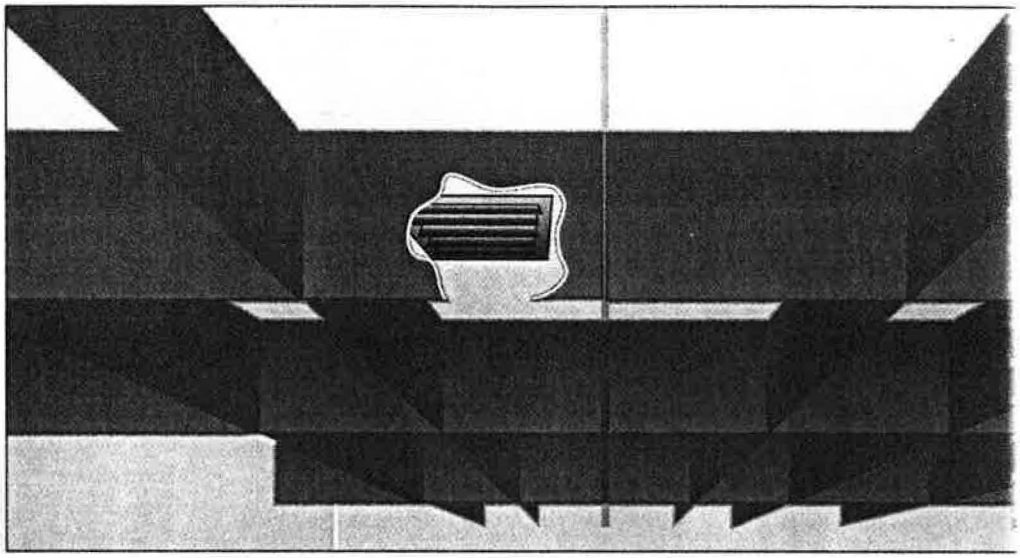
Recommendations:

The outside air dampers on each of the AHU's were open a minimum of 30 percent and that the low levels of carbon dioxide in the occupied areas confirmed that sufficient volumes of outdoor air were being brought into the building.



The major problem with this building's air was the "higher than desirable" airborne dust levels. Our first recommendation was to upgrade the filters both in the main AHUs on each floor and in the perimeter FCUs. The bag filters in the main units could be replaced relatively easily with bags of classification EU5. However, it would require some modifications to the perimeter FCUs to allow the necessary access for replacing the present panel filters and routinely checking and changing them in the future.

The lack of adequate air circulation in the office areas was addressed by opening up the vertical "honeycomb" of ceiling tiles. By removing sections of tiles that interfered with the correct air distribution from the ceiling diffusers, air circulation was vastly improved. The furniture blocking the return air grilles was moved to allow better air circulation.



Dead air pockets were created throughout the office when a gridwork of ceiling tiles was installed perpendicular from the suspended ceiling to act as a sound buffer

The levels of dust and dirt in the various chambers of the AHUs had a direct effect on the airborne microbial counts, particularly because the filters were installed upstream of most of these chambers. Thus, immediate cleaning was recommended to reduce the amounts of airborne particles and microbes in the airstream. Similarly, pieces of conditioning equipment no longer in use, such as the spray-jets and tubes of the old humidification system, were to be removed because they were rusting and corroding thereby adding to the contamination problems.

With regard to rodent poison in the perimeter FCUs, it was obvious that such materials should not have been placed in locations where the possibility exists for even trace amounts of this toxic material to be carried in the supply air to an area occupied by people.

The air conditioning system retrofitted to this office building was rather unconventional. Having supply air come in at the ceiling and exhausted at the floor is the reverse of an optimum design. Furthermore, the installation of filters into the FCUs without allowing any access to the filters was incredibly short-sighted — the dirty contaminated filters in the FCUs were a liability. This fact, coupled with the choice of low-efficiency filters in the main AHUs was contributing to the high airborne dust and microbe levels.

Finally, the installation of the acoustical baffles across the ceiling, in an attempt to reduce noise levels, was inadvertently contributing to poor air distribution. The latter being further exacerbated by the careless positioning of office furniture directly in front of the return air grilles inside the office.

The indoor air quality problems found in this Italian building, as in so many others across the globe, were caused by a lack of knowledge about the proper operation and functioning of the building's ventilation system. Fortunately, these indoor air quality problems could be easily eradicated through minor, inexpensive adjustments together with a basic knowledge of the ventilating system.