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# Investigating IAQ on a Budget

By Paul T. Garrison, P.E.

I once worked for a large suburban school division with adequate resources for full-time staff members and consultants, if necessary, to address indoor air quality (IAQ) complaints. However, I often think back to the rural schools I attended as a child that had no budget for environmental matters or dedicated staff. I wonder how they respond to IAQ complaints and develop low-cost solutions.

I will attempt to provide some guidelines and techniques for conducting IAQ investigations that may benefit school personnel who must fund investigations within meager budgets.

## Occupant Interviews

When responding to a complaint at a school, I always interview the principal first. They usually are able to shed some light on the problems and can advise if the complaints are genuine.

Next, interview each complainant (teachers, parents or students) individu-

ally. I prefer not to use a prepared checklist because they tend to put words into the complainant's mouth. When I first started in this position, I used a checklist but found that many people would check every symptom. Simply asking them to define the problem requires them to identify and prioritize their main symptoms.

## Other Questions

- Are the symptoms recently acquired?
- Do you have a history of allergy complaints?
- Do your symptoms go away over the

weekend and return during the week?

- Have any changes happened that coincide with the onset of symptoms?
  - New classroom?
  - New janitorial supplies?
  - Changes in weather?
  - Has the room been painted?
  - Has the HVAC system been broken?
- Are the symptoms limited to a certain day or time of day?
- What do you think is causing the problems?

You get the idea. Your job is to get them to help you focus the investigation, so you can begin to eliminate possible sources.

## Physical Survey

Next, inspect the classroom environment for clues. Here, a checklist is helpful. I keep a running checklist, which I add tricks learned on each investigation. A sampling of typical items:

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## About the Author

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**‘I have spent thousands of dollars on equipment that usually sits on a shelf collecting dust.’**

- Is the HVAC system running? Is the filter clean?
- Open the HVAC unit and inspect its condition. (Take the maintenance man along.)
- Confirm that the outside air damper is open during occupied periods.
- Is the room clean? Is there excessive clutter?
- Are there plants, animals, aquariums, chemicals, etc. present?
- Is the room noticeably hot, cold or humid? (Note the temperature setpoint.)
- Is there an odor?
- Are the ceiling tiles bowed or stained?
- Is there visible mold on the walls, ceiling, books, etc.?
- Is there carpet?
- Is there evidence of water intrusion (efflorescence/peeling paint) along the baseboard?
- Look above the ceiling for anything out of the ordinary.
- Check adjacent rooms, exterior of the room, and the roof.
- Is there a sink or drain with a dry trap that could be introducing sewer gas?

Often, just these simple visual/sensory indicators will identify several areas for more detailed investigation.

#### **IAQ Toolkit**

For a modest investment, you can prepare an IAQ toolkit that is perfectly adequate for a “first-response” type of investiga-

tion. I have spent thousands of dollars on testing equipment that usually sits on a shelf collecting dust. The list below includes items I always grab on my way to an investigation:

#### **A Sling Psychrometer (\$65).**

- I include this only because it fits in a shirt pocket and gives a snapshot of the temperature and relative humidity (RH) that can quickly show the occupants if they are keeping the space too hot or cold.

- I have found digital thermohygrometers to be unsatisfactory. They take a long time to stabilize and, when several different brands were lined up side-by-side, their RH readings varied by as much as 20%. Therefore, I have made the sling psychrometer my “gold standard.”

#### **IAQ Monitor (sensors and data logger with graphing software) (\$700 – \$7,000).**

- I purchased very expensive units because the money was available and they offered additional ports for measuring a great many variables. However, these units are very heavy to transport. The basic parameters of temperature, RH, and carbon dioxide (CO<sub>2</sub>) alone are good indicators.

- With a little research, you can put together a hybrid monitor consisting of temperature, RH, and CO<sub>2</sub> sensors with a separate data logger and graphing software for about \$700. This system should meet basic needs and indicate if your usage justifies a more expensive system.



- Calibration of the CO<sub>2</sub> sensor can be an unforeseen ongoing expense.

- Check with your maintenance staff — they may already have one.

#### **A Non-Destructive Moisture Meter (\$350).**

- This hand-held unit has been helpful in identifying hidden moisture sources in walls and roofs.

#### **A Stick of Incense (\$.50).**

- This beats the daylighters out of the other smoke puffers that I have used and leaves a nice smell in the room.

- An incense stick produces a stream of smoke that can be used to check for infiltration, air movement, and pathways.

- Besides, Material Safety Data Sheets (MSDS) for some of the other products reveal some nasty chemicals as ingredients.

#### **Architectural Plans for the Building (Free).**

- Learn to read the plans and specs:

- Architectural plans include wall sections and waterproofing details.

- Mechanical plans show the system type, control sequences, ductwork configuration, etc., which can be very enlightening during your investigation.

- As Indiana Jones wisely instructed his students, “95% of archaeology is in the library.” Good advice — you can learn a lot about the building before even opening the door.

- Determine if the space with the complaint was designed for occupancy. I have conducted investigations where the “office” with the problem still had a “STORAGE” label on the door.

#### **Air Sampling (Can be expensive).**

- I am not a proponent of air sampling, except in the case of pre- and post-mitigation comparisons.

- Even then, once you start this expensive process, even with a satisfactory result, complainants can and will insist on routine follow-up testing.

- I prefer to control the indoor RH below 60% to preclude the amplification of microbial growth.

- If you should decide to initiate a sampling program, leave it to an experienced consultant. Sampling and analysis are tricky and best left to the experts.

#### **Monitor Data Analysis**

Assuming that most of the previous is straightforward and can stimulate further insights of your own into conducting an IAQ investigation, I want to elaborate on the analysis of IAQ monitor output.

It is generally agreed that three of the most important measurements in an IAQ investigation are temperature, RH, and CO<sub>2</sub>. The temperature is measured because occupant comfort is critical to an occupant’s perception of a good indoor environment. The relative humidity also affects comfort and whether the conditions exist for mold growth. Finally, the CO<sub>2</sub> measurement is used to indicate whether or not adequate ventilation is provided to the space.

I prefer to monitor on several occupied days and during the

weekend in an uninterrupted session. This can indicate time clock or scheduling settings that can adversely affect conditions within the space. Remember that the trends in the graphs are at least as important as numerical values. Also, remember that school buildings are unoccupied for at least 75% of the time, and that the cooling loads of people and lights are not present during that time. This reduces the opportunity for the HVAC equipment to provide indirect dehumidification.

Analysis of the temperature is straightforward. However, it is important to recognize the inverse relationship between temperature and RH. Warmer air can hold more moisture so even a slight increase in space temperature can cause a significant reduction in relative humidity.

In the school division, we found relative humidity control to be the greatest challenge. After analyzing the trends, there are several operational opportunities to reduce high RH readings—close outside air dampers and cycle fans with compressors during unoccupied hours; raise the temperature setpoint; eliminate plants and aquariums from the rooms; and others.

CO<sub>2</sub> must be viewed as an indicator of ventilation effectiveness, not as a toxic gas. High levels indicate that airborne or gaseous pollutants within the space are not being effectively eliminated by dilution ventilation. The fix may be as simple as opening the outside damper that had a broken linkage. The trending of the CO<sub>2</sub> can also be telling. Look at the rate of decline of the CO<sub>2</sub> levels. A very slow decline indicates little ventilation at all. Perhaps the building’s exhaust system is not operating so that no fresh air can be induced into the building.

#### **Identify Potential Sources**

After conducting the interviews and physical survey, assembling the tools, and analyzing the plans and measured data, develop a hypothesis.

- What clues were revealed by the interviews?

- What measurements are out of whack?

- What visual indicators point to a specific problem?

- What aspects of the indoor environment might be exacerbating the symptoms?

- What physical/operational parameters can be adjusted to improve the condition?

- Does your gut reaction lead you to believe the problems are chemical, ventilation, humidity (microbial), or something else?

Try to prioritize your efforts. If you know the outside air damper is closed, don’t perform an exhaustive search for pollutant pathways. Fix the obvious first and try other remediation actions incrementally and no matter what, keep the complainants informed. To do otherwise can seriously affect your credibility.

#### **Conclusion**

This approach is not intended to be an all-encompassing course in IAQ investigations. It is intended to be a primer for those with little background and even smaller budgets. Particularly vexing problems may require an experienced consultant. ●