

The Importance of HVAC System Commissioning in Achieving Satisfactory Air Quality

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INTRODUCTION

The purpose of this presentation is to discuss how commissioning HVAC systems can help ensure satisfactory indoor air quality.

In the traditional commissioning process, the object is to perform all necessary inspections and performance tests during construction to verify that the design intent will be met. Adding IAQ procedures to this process is straightforward, requiring only that verified indoor air quality be added to the criteria for successful commissioning.

It is important, at the outset, to note that everything discussed here about IAQ procedures and commissioning applies equally well to renovations as it does to new construction—the format and procedures do not change.

ASHRAE makes this point explicitly in its *Guideline for Commissioning of HVAC Systems*, describing the need for a continuing commissioning process throughout the life of a facility:

9. POST-ACCEPTANCE PHASE

9.1 Introduction Post-acceptance commissioning is a critical step in ensuring the effective, ongoing functioning of a facility's HVAC system. As use and function of facilities change, HVAC systems need to be adapted to the changing requirements of occupancy and utilization. It is appropriate to maintain a history of the facility, recording changes and verifying the effect on the previously commissioned system.

If we were to add the phrase "and the IAQ procedures" after "HVAC system" each time it appears in this paragraph, we would establish the criteria for maintaining satisfactory IAQ performance throughout the life of the building.

There are four aspects of commissioning and indoor air quality to be considered.

1. Team leadership: Who should lead the team of IAQ investigators?
2. Indoor air quality procedures: Which IAQ testing and mitigation procedures should be performed?
3. The process of commissioning an HVAC system: How does one define a "comprehensive commissioning process"?
4. Testing responsibilities: What role can testing and balancing HVAC systems play in commissioning for acceptable IAQ?

Who Should Lead the IAQ Team?

Air-quality procedures often require the efforts of a knowledgeable, multi-disciplinary team. At a minimum, this team

will include industrial hygienists, microbiologists, and test-and-balance (TAB) contractors.

With these divergent professions represented, it is essential to have a team leader who can apportion the work to best take advantage of the strengths of each discipline.

I believe that the individual best equipped to bring these groups together is the consulting engineer. The engineer has the best knowledge of how the HVAC system must perform to provide the required environment. The engineer also is the one who provides the design documents that guide the construction and commissioning of the HVAC system and the establishment of satisfactory air quality. This is true of both new construction and renovations.

Indoor Air Quality Procedures

The participants and leadership of the IAQ team greatly affect the type of procedures performed. For example, investigations led by an industrial hygienist can be expected to emphasize air sampling and source control. Likewise, a balancing agency might concentrate on ventilation analysis and testing and balancing the HVAC system.

This observation is not to find fault but to reaffirm the importance of having a capable team leader who, regardless of personal background, can ensure that all necessary procedures are performed and that all disciplines are properly represented.

Commissioning an HVAC System

Let us proceed now to see how the commissioning process can incorporate IAQ procedures:

I would begin with a definition of commissioning as I view it. I emphasize that this is my view (as well as the ASHRAE guideline committee's) because others may have different definitions.

Definition: Commissioning is a comprehensive process for bringing an HVAC system on line in a more effective manner in accordance with the design intent.

It will involve greater participation by the design engineer, the owner, and the operating and maintenance personnel. It will introduce a commissioning authority who will prepare, administer, and supervise the commissioning plan.

Let's go through the process and see how it could work with regard to the HVAC system and IAQ procedures.

1. The design consultant will have an increased role to play in the commissioning process. In addition to the normal plans and

specifications that have always been prepared, the consultant will prepare these additional contract documents:

- A) A format for the commissioning plan.
- B) The type and extent of the functional performance tests to be made.
- C) The documentation requirements that will certify the as-built performance of the HVAC system.
- D) A system operations manual.

The engineer must design into the system all of the provisions necessary to achieve the required air quality in accordance with the codes and the specific requirements of the facility being designed.

Code requirements for air quality are being developed. In New York City, an ASHRAE committee is being formed to work with the building department in an advisory capacity to include the recommendations of ASHRAE's Standard 62-1989 into the air-quality requirements of the building code. In general, we can expect increasing initiatives to regulate ventilation rates and effectiveness through code requirements.

The mechanical design will have to make provisions for the verification procedures to be implemented. For example, if the verification tests or the code require a direct measurement of the rate of fresh-air intake, the HVAC equipment will have to be arranged so that this measurement is possible.

The design documents will have to be clear on all of the air-quality requirements and the verification procedures so that the commissioning authority can prepare and implement the commissioning plan for the HVAC system to the full extent of the design documents.

The specifications will also have to be clear about the various contractors' participation in the verification (functional performance tests). The contractors so involved will have to include an allowance in their bids to cover the costs of these tests.

As far as air-quality procedures are concerned, there may be additional tests to be made beyond ventilation rates. It may also be necessary to determine the efficiency or effectiveness of the ventilation within certain spaces.

There is sophisticated test equipment available that uses tracer gases to evaluate the efficiency of the ventilation within a space. I expect that as the need to do these tests develops, new procedures will also develop. Let me give you an example of such a condition.

A room with a high ceiling has ceiling diffusers that distribute conditioned air in a nice horizontal pattern so that no drafty conditions develop. If the return-air inlets are also at the ceiling level, the ventilation in the upper portion of the room could be excellent, while in the lower part of the room, where occupants are breathing, ventilation could be poor. It is possible to maintain the required temperature conditions in a room like this and have inefficient ventilation at the breathing level.

All of the verification procedures will be included in the documentation of the commissioning process and become a part of the "as built" record of the commissioning of the HVAC system. It will also be necessary for the IAQ procedures to be certified by the agency responsible for implementing them and by the authority who witnessed and accepted the verification tests.

The completed documentation of the commissioning process will be submitted to the design engineer for review and acceptance. If the engineer is satisfied that the HVAC system and the air quality conform with design intent, he or she will recommend to the owner that the HVAC system be accepted.

After the HVAC system is accepted, any modifications that have to be made will use the commissioning documentation as a reference for the design engineer to determine whether the existing services are adequate for occupancy.

When the renovations are completed, the HVAC system will be recommissioned and the documentation brought up to date. This ongoing commissioning process should continue throughout the life of the facility.

The Role of Testing and Balancing in Commissioning

Why am I, a TAB engineer, so interested in the commissioning process and IAQ procedures?

There are two reasons. One is that the implementation of the commissioning process can increase the scope of work that we can do on a project. The services that we can provide have a direct effect on the commissioning of an HVAC system and in establishing the required air quality. I will mention these services in a moment, but let me introduce the second reason for my interest in these developments.

I have become convinced that a new approach to bringing HVAC systems on line is necessary. As the design of HVAC systems has become more complex, it is clear that the older methods do not provide the required results in a consistent, dependable manner.

Now let us look at the services beyond TAB that people like me can provide to the commissioning process:

1. Insight: Our normal TAB work has always been considered as part of the commissioning process, even before the word "commissioning" came into use. We have a built-in acquaintance with the process.

2. Experience: Many TAB firms are capable of and willing to carry out complete verification tests; we have been doing some of these tests for many years, including

a) Verification of the performance of the temperature control system;

b) Verification of the installed capacity of the major heat exchange components—chillers, pumps, and boilers.

3. Certification: TAB agencies that are members of the AABC certify their TAB reports and offer a warranty on each project.

It is certain that all air quality procedures will have to be certified. We are prepared to offer that service now.

CONCLUSION

In conclusion, I want to apologize for my continuous use of the word "verification." To a hands-on engineer like me, you cannot imagine the importance of this concept.

I will close with one more example. Imagine what would happen if a TAB contractor knew he would have to go back to the job after submitting his final report and remeasure air and water flow rates at random locations selected by the commissioning authority. Two things would happen. First, the TAB contractor would do a better job and, second, the TAB report as submitted would be an accurate record of the air and water flow rates. The TAB contractor would not want to be forced to repeat the balancing because the report was found to be in error.

The same analysis applies to air-quality procedures and to any other systems that are to be verified after installation is complete.

Commissioning can lead to improved indoor air quality and more effective operation of the HVAC system.